Appendix D – Effectiveness evidence

Abdollahi, 2018

Bibliographic Reference	Abdollahi, F.; Corrigan, M.; Lazzaro, E. D. C.; Kenyon, R. V.; Patton, J. L.; Error-augmented bimanual therapy for stroke survivors; Neurorehabilitation; 2018; vol. 43 (no. 1); 51-61

Study details

Secondary publication of another included study- see primary study for details	NR
Other publications associated with this study included in review	NR
Trial name / registration number	NCT01574495
Study type	Randomised controlled trial (RCT)
Study location	USA
Study setting	outpatient rehabilitation hospital
Study dates	NR
Sources of funding	NR

Inclusion criteria	Eligible participants were all adults aged 18 or over and had suffered a single hemispheric stroke at least six months prior to enrollment. Participation also required some recovery of proximal strength in the hemiparetic limb as confirmed by an upper extremity Fugl-Meyer score of 25–50.
Exclusion criteria	Participants were excluded if there was multiple strokes, bilateral paresis, severe spasticity or contracture, severe concurrent medical problems, severe sensory deficits, cerebellar strokes resulting in severe ataxia, significant shoulder pain, focal tone management with botulinim toxin injection to the hemiparetic upper extremity within the previous four months, depth perception impairment (<3/9 on Stereo Circle Test), visual field cut, cognitive impairment (Mini Mental State Examination <23/30), or if the patient had severe aphasia, affective dysfunction, or hemisensory neglect that would influence the ability to perform the experiment or provide informed consent. Participants were also excluded if they were currently receiving any other skilled upper extremity rehabilitation in a clinical setting.
Recruitment / selection of participants	Study participants were recruited from a registry of post-stroke individuals or who responded to local flyer postings.
Intervention(s)	Error-augmented (E-A) bimanual therapy n=12 For all participants, each session began with five minutes to position the participant in the apparatus, then six 5-minute blocks of training with two-minutes of rest between each block. The blocks alternated, and were either bimanual targeted-reaching or free bimanual practice. Targeted reaching blocks involved attempts to reach from a location above the centers of the thighs out both to one of 4 target sets, and then stop for at least a half-second. The system allowed 3 seconds to make this motion, at which point the system cued a return to the starting point and proceeded to the next motion. The targets were spaced evenly in the reaching workspace and were also meant to probe the patient's range of motion. If subjects successfully attained more than 70% of the targets on any block, the targets were moved 20% more distant. The free movement blocks were meant to address participants' self-tailored ideas of therapy, which included the possibility of choosing the previous standardized five-minute block for practice. This allowed the participants to partially customize their own therapy, focusing on their perceived deficits. Quantitative assessments were performed at the beginning and end of the treatment (pre- and post-) as well as one week after the post-treatment assessment (follow-up). During all sessions, participants were seated in a chair with the hemiparetic arm supported by the WREX™ gravity-balanced orthosis. One cursor displayed the movement of left hand, another cursor displayed the right. The hemiparetic hand was placed in an exotendon glove that assisted with a functional hand and wrist position. The robot was connected

	near the wrist joint center to allow the hand to open freely as well as allow free pronation and supination of the forearm. Both the PHANTOM™ robot and the position tracker were attached to the affected and non-affected forearms respectively, with the center of the devices located above the radiocarpal joint. The error augmenting treatment involved subtle, haptic error-augmenting forces were applied by the robot during the EA treatment but not in non-EA treatment. Participants were instructed to keep moving their arms together as much as possible while reaching to targets throughout the workspace. For the EA treatment, the error vector, defined as the instantaneous difference in position between the participant's wrists was visually magnified by a factor of 1.5 as part of the error augmentation. Additionally, an error augmenting force of 100 N/m was applied pushing the participant's affected hand further away from the non-affected hand. For safety purposes, this force was designed to saturate at a maximum of 4 Newtons. Concomitant therapy: not reported.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Not stated/unclear
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Not stated/unclear
Subgroup 8: Type of movement	Not stated/unclear

delivered by robotic device	
Population subgroups	NR
Comparator	Non error augmented (non-EA) bimanual therapy n=10 Each group had the same amount of practice in two weeks of training with three, 45-minute sessions per week (six sessions total). As per the intervention group, but without error augmentation.
Number of participants	26
Duration of follow-up	1 week after the end of treatment.
Indirectness	N/A

Study arms

Bilateral arm training with error augmentation (robot attached and used) (N = 12)
Duration 2 weeks. Three 45 minute sessions per week (six sessions total).

Bimanual training without error augmentation (robot attached but was not used) (N = 10)
Duration 2 weeks. Three 45 minute sessions per week (six sessions total).

Characteristics

Study-level characteristics

Characteristic	Study (N = 26)
% Female No of events	n = 8 ; % = 31
Mean age (SD) Mean (SD)	53.86 (NR)

Outcomes

Study timepoints

- Baseline
- 3 week (1 week post-intervention)

Dichotomous outcome

Outcome	Bilateral arm training with error augmentation (robot attached and used), Baseline, N = 12	Bilateral arm training with error augmentation (robot attached and used), 3 week, N = 12	Bimanual training without error augmentation (robot attached but was not used), Baseline, N = 10	Bimanual training without error augmentation (robot attached but was not used), 3 week, N = 10
Withdrawal for any reason Both were due to medical issues not related to treatment.	n = NA ; % = NA	n = 2 ; % = 17	n = NA ; % = NA	n = 0 ; % = 0

Outcome	Bilateral arm training with error augmentation (robot attached and used), Baseline, N = 12	Bilateral arm training with error augmentation (robot attached and used), 3 week, N = 12	Bimanual training without error augmentation (robot attached but was not used), Baseline, N = 10	Bimanual training without error augmentation (robot attached but was not used), 3 week, N = 10
No of events				

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Bilateral arm training with error augmentation (robot attached and used)-Bimanual training without error augmentation (robot attached but was not used)-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Both groups received robot therapy but only the intervention group received error augmentation.)*

Abdullah, 2011

Bibliographic Reference	Abdullah, Hussein A.; Tarry, Cole; Lambert, Cynthia; Barreca, Susan; Allen, Brian O.; Results of clinicians using a therapeutic robotic system in an inpatient stroke rehabilitation unit; Journal of neuroengineering and rehabilitation; 2011; vol. 8 (no. 1); 1-12

Study details

Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Mixed Starting with passive and moving up to active assisted

Study arms

Robot-mediated therapy (N = 9)
45 minutes, 3 times a week for 8-11 weeks

Conventional arm therapy (N = 11)
45 minutes, 3 times a week for 8-11 weeks

Outcomes

Study timepoints
- Baseline
- 11 week (Post-intervention)

Continuous outcome

Outcome	Robot-mediated therapy, Baseline, N = 9	Robot-mediated therapy, 11 week, N = 9	Conventional arm therapy, Baseline, N = 11	Conventional arm therapy, 11 week, N = 11
Arm function (Chedoke Arm and Hand Activity Inventory CAHAI-7) Scale range: Unclear, likely 1-7. Final values. Values reported in the Cochrane review used. Mean (SD)	NR (NR)	2.75 (1.8)	NR (NR)	1 (1.69)

Arm function (Chedoke Arm and Hand Activity Inventory CAHAI-7) - Polarity - Higher values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcome-Armfunction(ChedokeArmandHandActivityInventoryCAHAI-7)-MeanSD-Robot-mediated therapy-Conventional arm therapy-t11

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Amirabdollahian, 2007

Bibliographic Reference	Amirabdollahian, Farshid; Loureiro, Rui; Gradwell, Elizabeth; Collin, Christine; Harwin, William; Johnson, Garth; Multivariate analysis of the Fugl-Meyer outcome measures assessing the effectiveness of GENTLE/S robot-mediated stroke therapy; Journal of neuroengineering and rehabilitation; 2007; vol. 4 (no. 1); 1-16

Study details

Secondary publication of another included study- see primary study for details	
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.

Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	<1 hour Three ten minute sessions over two weeks
Subgroup 5: Dose (days per week)	<5 days per week Three ten minute sessions over two weeks
Subgroup 6: Dose (duration)	<6 weeks Three ten minute sessions over two weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Mixed

Study arms

Robot-mediated therapy (N = 16)
ABC - 3 weeks at baseline (phase A), then 3 weeks robot-mediated therapy (phase B) then 3 weeks sling suspension (phase C). Follow up at 6 weeks.

Sling suspension (non-robot therapy) (N = 15)
ACB - 3 weeks at baseline (phase A), then 3 weeks sling suspension (phase C), then 3 weeks robot-mediated therapy. Follow up at 6 weeks.

Outcomes

Study timepoints
- Baseline
- 6 week (End of intervention (only including first phase of crossover trial))

Dichotomous outcome

Outcome	Robot-mediated therapy, Baseline, N = 16	Robot-mediated therapy, 6 week, N = 16	Sling suspension (non-robot therapy), Baseline, N = 15	Sling suspension (non-robot therapy), 6 week, N = 15
Withdrawal for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Cross-over trial

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-mediated therapy-Sling suspension (non-robot therapy)-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Ang, 2014

Bibliographic Reference	Ang, Kai Keng; Guan, Cuntai; Phua, Kok Soon; Wang, Chuanchu; Zhou, Longjiang; Tang, Ka Yin; Ephraim Joseph, Gopal J.; Kuah, Christopher Wee Keong; Chua, Karen Sui Geok; Brain-computer interface-based robotic end effector system for wrist and hand rehabilitation: results of a three-armed randomized controlled trial for chronic stroke; Frontiers in neuroengineering; 2014; vol. 7; 30

Study details

Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Mixed total mean FMMA at baseline: 27.0 (13.8)
Subgroup 2: Time after stroke at the start of the trial	Mixed

	>4 months subacute and chronic.
Subgroup 3: Region of upper limb trained	Mixed
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Passive movement

Study arms

Robot-mediated therapy (N = 15)
group 1: robot-mediated therapy with the haptic knob robot and a brain computer interface for 60 minutes + therapist-assisted arm mobilisation for 30 minutes Total of 18 sessions over 6 weeks, 3 times per week, 90 min per session. group 2: robot-mediated therapy with the haptic knob robot alone for 60 minutes + therapist-assisted arm mobilisation for 30 minutes We combined the results of both HK groups in 1 (collapsed) group and compared this collapsed group with the results of the standard arm therapy group

Standard arm therapy (N = 7)
Standard arm therapy for 60 minutes + therapist-assisted arm mobilisation for 30 minutes. Total of 18 sessions over 6 weeks, 3 times per week, 90 min per session.

Outcomes

Study timepoints
- Baseline
- 6 week (End of intervention)
- 18 week (Longest follow-up (post-intervention))

Continuous outcomes

Outcome	Robot-mediated therapy, Baseline, N = 15	Robot-mediated therapy, 6 week, N = 15	Robot-mediated therapy, 18 week, N = 15	Standard arm therapy, Baseline, N = 7	Standard arm therapy, 6 week, N = 7	Standard arm therapy, 18 week, N = 7
Arm function (Fugl-Meyer assesment) Scale range: 0-66. Change scores. Values reported in the Cochrane review used. Mean (SD)	30.5 (15.2)	7.3 (3.5)	9.2 (3.8)	23.4 (14.5)	4.9 (4.1)	3.6 (5.9)

Arm function (Fugl-Meyer assesment) - Polarity - Higher values are better
Change scores. Baseline values (FM): BCI+HK group: 33.0 (16.2), HK group: 25.5 (11.5); 6 week values: BCI+HK group: 7.2 (2.3), HK group: 7.3 (4.7); 18 week values BCI+HK group: 9.7 (2.9), HK group: 8.3 (5.0) Robot groups were combined for analysis. Also reports FM outcome by proximal and distal limb.

Dichotomous outcomes

Outcome	Robot-mediated therapy, Baseline, N = 15	Robot-mediated therapy, 6 week, N = 15	Robot-mediated therapy, 18 week, N = 15	Standard arm therapy, Baseline, N = 7	Standard arm therapy, 6 week, N = 7	Standard arm therapy, 18 week, N = 7
Adverse events No of events	n = NA	n = 1	n = 0	n = NA	n = 0	n = 0
Withdrawal for any reason No of events	n = NA ; % = NA	n = 1	n = NA ; % = NA	n = NA ; % = NA	n = 0	n = NA ; % = NA

One participant in the robot therapy group dropped out on the 5th week of the intervention due to a transient mild seizure occurring several hours after the intervention (same participant recorded as adverse event and withdrawal).

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(Fugl-Meyerassesment),changescores-MeanSD-Robot-mediated therapy-Standard arm therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerassesment)-MeanSD-Robot-mediated therapy-Standard arm therapy-t18

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot-mediated therapy-Standard arm therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot-mediated therapy-Standard arm therapy-t18

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Aprile, 2020

Bibliographic Reference	Aprile, I.; Germanotta, M.; Cruciani, A.; Loreti, S.; Pecchioli, C.; Cecchi, F.; Montesano, A.; Galeri, S.; Diverio, M.; Falsini, C.; Speranza, G.; Langone, E.; Papadopoulou, D.; Padua, L.; Carrozza, M. C.; Group, F. D. G. Robotic Rehabilitation; Upper Limb Robotic Rehabilitation After Stroke: A Multicenter, Randomized Clinical Trial; Journal of Neurologic Physical Therapy; 2020; vol. 44 (no. 1); 3-14

Study details

Secondary publication of another included study- see primary study for details	NA
Other publications associated with this study included in review	Padua L, Imbimbo I, Aprile I, Loreti C, Germanotta M, Coraci D, Piccinini G, Pazzaglia C, Santilli C, Cruciani A, Carrozza MC; FDG Robotic Rehabilitation Group†. Cognitive reserve as a useful variable to address robotic or conventional upper limb rehabilitation treatment after stroke: a multicentre study of the Fondazione Don Carlo Gnocchi. Eur J Neurol. 2020 Feb;27(2):392-398. doi: 10.1111/ene.14090. Epub 2019 Oct 18. PMID: 31536677.
Trial name / registration number	(NCT02879279)
Study location	Italy
Study setting	The study was conducted in 8 rehabilitation centers of the Fondazione Don Carlo Gnocchi, in Italy.
Study dates	August 2016 to March 2018.
Sources of funding	NR
Inclusion criteria	subjects with 1 ischemic or hemorrhagic stroke (verified by MRI or CT), aged between 40 and 85 years, with a time since stroke ranging from 2 weeks to 6 months (ie, after the acute phase)1 and cognitive and language abilities adequate to understand the experiments and the follow instructions. Subjects' upper extremity Fugl-Meyer Assessment (FMA) score (0-66 version) had to be 58 or less
Exclusion criteria	Exclusion criteria were behavioural and cognitive disorders and/or reduced compliance, fixed contraction in the affected limb (ankylosis, Modified Ashworth Scale equal to 4), and severe deficits in visual acuity.
Recruitment / selection of participants	We recruited consecutive subjects with 1 ischemic or haemorrhagic stroke (verified by MRI or CT).

Intervention(s)	In the RG, both the distal and the proximal segments of the subjects' UL were treated by means of robotic and sensor based devices. Specifically, subjects were treated with the following systems: (a) a robotic device that allows passive, active, and active-assistive planar movements of the shoulder and elbow joints (Motore, Humanware, Italy); (b) a robotic device that allows passive, active, and active-assistive finger flexion and extension movements (Amadeo, Tyromotion, Austria); (c) a sensor-based system that allows unsupported 3-dimensional movements of shoulder, elbow, and wrist joint, both unimanual and bimanual (Pablo, Tyromotion, Austria); and (d) a robotic system that allows 3-dimensional, unimanual and bimanual, movements of the shoulder joint, with arm weight support (Diego, Tyromotion, Austria). During the treatment, subjects performed both motor and cognitive tasks, and the devices provided visual and auditory feedback. In addition, a vibratory treatment (with a frequency of 60 Hz) was applied, using the Amadeo system, to increase the proprioception of the hand, before the finger training. The experimental treatment was aligned among the centers in terms of protocol and intensity. During the treatment, a group of 3 subjects was supervised by 1 therapist. During each session, the physical therapist used 1 system for each subject, to minimize the time required to move the subjects from one system to another. The rehabilitation program started with the robotic device for the shoulder and elbow joints, followed by the robotic device for the hand, the sensor-based device for the shoulder, elbow, and wrist, and, finally, the robotic system for the shoulder. The adopted protocol provided general guidelines, which were organized into a flowchart, in order to ensure the homogeneity of treatment. However, the physical therapist selected and adapted the exercises, in term of workspace and difficulty, to the subject's residual ability. Concomitant therapy - In both groups, the treatment was performed daily for 45 minutes, 5 days a week, for a total of 30 sessions. In addition to the UL rehabilitation session (according to the allocated group), all subjects underwent conventional rehabilitation sessions (6 times/week), lasting 45 minutes, focused on lower limb, sitting and standing training, balance, and walking. Subjects underwent occupational and speech therapy, if needed. To avoid the possibility of performance bias, the therapists who treated the subjects in the RG were different from therapists who treated the subjects in the CG.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Mixed

Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Mixed
Population subgroups	NR
Comparator	In the CG, subjects underwent a conventional treatment, with a ratio of 1 therapist to 1 subject, that followed the guidelines provided in literature. The therapeutic task focused on functional improvement, including task-oriented exercises, sensorimotor reorganization, and spasticity inhibition. Subjects performed passive, active, and active-assisted exercises on the 3 UL joints, in the 3-dimensional space, to improve joint function, to prevent contractures, to inhibit spasticity, and to improve motor function. The therapeutic task focused on functional improvement, sensorimotor reorganization, and spasticity inhibition. Subjects performed passive, active, and active-assisted exercises on the 3 UL joints, in the 3-dimensional space to gain strength and motor function, improve joint range of motion, prevent contractures, and inhibit spasticity. They also performed task-oriented exercises included reaching and grasping movements (eg, reaching and picking up a glass or other objects), activities of daily living (eg, transfers, dressing, brushing/combing hair, according to subject's ability), to increase the subject's participation so as to promote neuroplasticity and improve upper limp motor recovery. At the first treatment session each subject underwent an UL evaluation aimed to personalize the rehabilitation program and determine the exercises to deliver. Each therapist was free to adapt every rehabilitation session to the subject, according to their functional assessment and needs. Therefore, each activity duration, specific number of repetitions or difficulty of exercise to be performed during a conventional rehabilitation session was not predefined in the protocol.
Number of participants	247

Duration of follow-up	6 weeks immediately post intervention
Indirectness	NR
Additional comments	NR

Study arms

robotic group (N = 123)

conventional group (N = 124)

Characteristics

Study-level characteristics

Characteristic	**Study (N = 247)**
Ethnicity Nominal	NR
Comorbidities Nominal	NR
Severity Nominal	NR

Arm-level characteristics

Characteristic	robotic group (N = 123)	conventional group (N = 124)
% Female Nominal	43.2	43.4
Mean age (SD) Mean (SD)	69.5 (10.9)	68.5 (11.5)
Time after stroke Nominal	NR	NR
15-30 days Nominal	51.4	53.1
31-90 days Nominal	35.1	31.9
91-180 days Nominal	13.5	15

Outcomes

Study timepoints

- Baseline
- 6 week

continuous outcomes

Outcome	robotic group, Baseline, N = 123	robotic group, 6 week, N = 91	conventional group, Baseline, N = 124	conventional group, 6 week, N = 99
Arm function (FMA UE) 0-66 change score Mean (95% CI)	NR (NR to NR)	8.5 (6.82 to 10.17)	NR (NR to NR)	8.57 (6.97 to 10.18)
Arm strength (Motricity Index) 0-100, change score Mean (95% CI)	NR (NR to NR)	17.35 (14.35 to 20.34)	NR (NR to NR)	12.92 (10.05 to 15.79)
Arm strength (Motricity Index) 0-100, change score Mean (SD)	37.6 (27.6)	NR (NR)	33.2 (28.8)	NR (NR)
Person/participant generic health related quality of life (SF-36 MCS) (intervention N= 89, control N = 91) 0-100, change score Mean (95% CI)	NR (NR to NR)	3.15 (1.18 to 5.11)	NR (NR to NR)	4.46 (2.52 to 6.4)
Person/participant generic health related quality of life (SF-36 MCS) (intervention N= 89, control N = 91) 0-100, change score Mean (SD)	41.8 (12.2)	NR (NR)	40 (12)	NR (NR)
Person/participant generic health related quality of life (SF-36 PCS) 0-100, change score Mean (95% CI)	NR (NR to NR)	1.66 (0.48 to 2.84)	NR (NR to NR)	1.37 (0.2 to 2.54)

Outcome	robotic group, Baseline, N = 123	robotic group, 6 week, N = 91	conventional group, Baseline, N = 124	conventional group, 6 week, N = 99
Person/participant generic health related quality of life (SF-36 PCS) 0-100, change score Mean (SD)	26.6 (7.2)	NR (NR)	28.1 (6.7)	NR (NR)
Activities of daily living (Modified Barthel Index) 0-100, change score Mean (SD)	34.3 (25.8)	NR (NR)	33 (27.5)	NR (NR)
Activities of daily living (Modified Barthel Index) 0-100, change score Mean (95% CI)	NR (NR to NR)	23.87 (20.02 to 27.73)	NR (NR to NR)	22.98 (19.28 to 26.67)

Arm function (FMA UE) - Polarity - Higher values are better
Arm strength (Motricity Index) - Polarity - Higher values are better
Person/participant generic health related quality of life (SF-36 MCS) - Polarity - Higher values are better
Person/participant generic health related quality of life (SF-36 PCS) - Polarity - Higher values are better
Activities of daily living (Modified Barthel Index) - Polarity - Higher values are better

dichotomous outcomes

Outcome	robotic group, Baseline, N = 123	robotic group, 6 week, N = 123	conventional group, Baseline, N = 124	conventional group, 6 week, N = 124
Withdrawal for any reason No of events	n = 0 ; % = 0	n = 32 ; % = 26	n = 0 ; % = 0	n = 25 ; % = 20

Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-robotic group-conventional group-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to adhering to intervention and missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

continuousoutcomes-Armstrength(MotricityIndex)-MeanNineFivePercentCI-robotic group-conventional group-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to adhering to intervention and missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

continuousoutcomes-Armfunction(FMAUE)-MeanNineFivePercentCI-robotic group-conventional group-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to adhering to intervention and missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

continuousoutcomes-Activitiesofdailyliving(ModifiedBarthelIndex)-MeanNineFivePercentCI-robotic group-conventional group-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to adhering to intervention and missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

continuousoutcomes-Activitiesofdailyliving(ModifiedBarthelIndex)-MeanSD-robotic group-conventional group-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to adhering to intervention and missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

continuousoutcomes-Armstrength(MotricityIndex)-MeanSD-robotic group-conventional group-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to adhering to intervention and missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

continuousoutcomes-Person/participantgenerichealthrelatedqualityoflife(SF-36MCS)-MeanNineFivePercentCI-robotic group-conventional group-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to adhering to intervention and bias in the measurement of outcome missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

continuousoutcomes-Person/participantgenerichealthrelatedqualityoflife(SF-36PCS)-MeanNineFivePercentCI-robotic group-conventional group-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to adhering to intervention and bias in the measurement of outcome missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

continuousoutcomes-Person/participantgenerichealthrelatedqualityoflife(SF-36MCS)-MeanSD-robotic group-conventional group-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to adhering to intervention and bias in the measurement of outcome missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

continuousoutcomes-Person/participantgenerichealthrelatedqualityoflife(SF-36PCS)-MeanSD-robotic group-conventional group-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to adhering to intervention and bias in the measurement of outcome missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

Aprile, 2021

Bibliographic Reference	Aprile, I.; Germanotta, M.; Cruciani, A.; Pecchioli, C.; Loreti, S.; Papadopoulou, D.; Montesano, A.; Galeri, S.; Diverio, M.; Falsini, C.; Speranza, G.; Langone, E.; Carrozza, M. C.; Cecchi, F.; Poststroke shoulder pain in subacute patients and its correlation with upper limb recovery after robotic or conventional treatment: A secondary analysis of a multicenter randomized controlled trial; International Journal of Stroke; 2021; vol. 16 (no. 4); 396-405

Study details

Secondary publication of another included study- see primary study for details	Aprile, Irene MD, PhD; Germanotta, Marco PhD; Cruciani, Arianna PT; Loreti, Simona MD; Pecchioli, Cristiano BS; Cecchi, Francesca MD; Montesano, Angelo MD; Galeri, Silvia MD; Diverio, Manuela MD; Falsini, Catuscia MD; Speranza, Gabriele MD; Langone, Emanuele MD; Papadopoulou, Dionysia PT; Padua, Luca MD, PhD; Carrozza, Maria Chiara PhD; for the FDG Robotic Rehabilitation Group Upper Limb Robotic Rehabilitation After Stroke: A Multicenter, Randomized Clinical Trial, Journal of Neurologic Physical Therapy: January 2020 - Volume 44 - Issue 1 - p 3-14doi: 10.1097/NPT.0000000000000295
Other publications associated with this study included in review	Padua L, Imbimbo I, Aprile I, Loreti C, Germanotta M, Coraci D, Piccinini G, Pazzaglia C, Santilli C, Cruciani A, Carrozza MC; FDG Robotic Rehabilitation Group†. Cognitive reserve as a useful variable to address robotic or conventional upper limb rehabilitation treatment after stroke: a multicentre study of the Fondazione Don Carlo Gnocchi. Eur J Neurol. 2020 Feb;27(2):392-398. doi: 10.1111/ene.14090. Epub 2019 Oct 18. PMID: 31536677.

Bishop, 2014

Bibliographic Reference	Bishop, L.; Stein, J.; Schoenherr, G.; Chen, C.; Nilsen, D.; Beer, R.; Robot-assisted hand exercise compared with conventional exercise therapy after ischemic stroke: a pilot study; Neurorehabilitation and Neural Repair; 2014; vol. 28 (no. 9); 919

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review. Helbok R. Robot-assisted hand training (AMADEO) compared with conventional physiotherapy techniques in chronic ischemic stroke patients: a pilot study. *Neurologie und Rehabilitation*. 6. Innsbruck, Austria: Hippocampus Verlag, 2010:281.
Trial name / registration number	No additional information.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear

Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Not stated/unclear
Subgroup 8: Type of movement delivered by robotic device	Not stated/unclear
Population subgroups	No additional information.

Study arms

Robot-assisted arm therapy (N = 16)
Robot therapy with the Amadeo Hand robot three times per week for eight weeks, for 60 minutes. Concomitant therapy: No additional information.

Any other intervention (N = 15)
Standard arm therapy for three times per week for eight weeks, for 60 minutes. Concomitant therapy: No additional information.

Outcomes

Study timepoints

- Baseline
- 8 week (Post-intervention)

Continuous outcomes

Outcome	Robot-assisted arm therapy, Baseline, N = 16	Robot-assisted arm therapy, 8 week, N = 14	Any other intervention, Baseline, N = 15	Any other intervention, 8 week, N = 14
Activities of daily living (barthel index) Scale range: 0-100. Change scores. Mean (SD)	NR (NR)	-0.36 (12.3)	NR (NR)	6.78 (19.1)
Arm function (Fugl-meyer Upper Extremity) Scale range: 0-66. Change scores. Mean (SD)	NR (NR)	2.1 (16.3)	NR (NR)	5.9 (13.7)
Arm muscle strength (Motor Activity Log) Scale range: 0-5. Change scores. Mean (SD)	NR (NR)	0.84 (5.3)	NR (NR)	1.63 (7.8)

Activities of daily living (barthel index) - Polarity - Higher values are better

Arm function (Fugl-meyer Upper Extremity) - Polarity - Higher values are better
Arm muscle strength (Motor Activity Log) - Polarity - Higher values are better

Dichotomous outcome

Outcome	Robot-assisted arm therapy, Baseline, N = 16	Robot-assisted arm therapy, 8 week, N = 16	Any other intervention, Baseline, N = 15	Any other intervention, 8 week, N = 15
Withdrawal for any reason No additional information. No of events	n = NA ; % = NA	n = 2 ; % = 13	n = NA ; % = NA	n = 1 ; % = 7

Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Activitiesofdailyliving(barthelindex)-MeanSD-Robot-assisted arm therapy-Any other intervention-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-meyerUpperExtremity)-MeanSD-Robot-assisted arm therapy-Any other intervention-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armmusclestrength(MotorActivityLog)-MeanSD-Robot-assisted arm therapy-Any other intervention-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm therapy-Any other intervention-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Brokaw, 2014

Bibliographic Reference	Brokaw, Elizabeth B.; Nichols, Diane; Holley, Rahsaan J.; Lum, Peter S.; Robotic therapy provides a stimulus for upper limb motor recovery after stroke that is complementary to and distinct from conventional therapy; Neurorehabilitation and neural repair; 2014; vol. 28 (no. 4); 367-376

Study details

Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Mixed
Subgroup 4: Dose (hours per day)	Not stated/unclear
Subgroup 5: Dose (days per week)	Not stated/unclear
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Active assisted movement

Study arms

Robotic training (N = 7)
group AB: 12 hours of robotic training within a month (A) and 12 hours of conventional therapy within a month (b), separated by a month of wash-out period.

Conventional therapy (N = 5)
group BA: 12 hours of conventional therapy within a month (b), and 12 hours of robotic training within a month (A) separated by a month of wash-out period.

Outcomes

Study timepoints
- Baseline
- 1 month (Post-intervention)

Continuous outcomes

Outcome	Robotic training, Baseline, N = 7	Robotic training, 1 month, N = 7	Conventional therapy, Baseline, N = 5	Conventional therapy, 1 month, N = 5
Arm function (Fugl-Meyer assessment) (0-66) Mean (SD)	NR (NR)	1.8 (2)	NR (NR)	1.2 (2)

Arm function (Fugl-Meyer assessment) - Polarity - Higher values are better
Change scores. Also reports ARAT and BBT. Values taken from graph.

Dichotomous outcome

Outcome	Robotic training, Baseline, N = 7	Robotic training, 1 month, N = 7	Conventional therapy, Baseline, N = 5	Conventional therapy, 1 month, N = 5
Withdrawal for any reason 2 lost to follow-up: 1 due to transportation, 1 unknown. No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 2 ; % = 40

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Cross-over trial

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robotic training-Conventional therapy-t1

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-MeanSD-Robotic training-Conventional therapy-t1

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Budhota, 2021

Bibliographic Reference	Budhota, A.; Chua, K. S. G.; Hussain, A.; Kager, S.; Cherpin, A.; Contu, S.; Vishwanath, D.; Kuah, C. W. K.; Ng, C. Y.; Yam, L. H. L.; Loh, Y. J.; Rajeswaran, D. K.; Xiang, L.; Burdet, E.; Campolo, D.; Robotic Assisted Upper Limb Training Post Stroke: A Randomized Control Trial Using Combinatory Approach Toward Reducing Workforce Demands; Frontiers in neurology [electronic resource].; 2021; vol. 12; 622014

Study details

Secondary publication of another included study- see primary study for details	NR
Other publications associated with this study included in review	NR
Trial name / registration number	NCT02188628
Study type	Randomised controlled trial (RCT)
Study location	Singapore
Study setting	The study was conducted at the outpatient clinic of the Tan Tock Seng Hospital, Centre for Advanced Rehabilitation Therapeutics (TTSH-CART), Singapore, a tertiary rehabilitation center with direct links to a national stroke center.
Study dates	Conducted over two years from 1st April 2016 to 31st April 2018.
Sources of funding	This work was supported by the National Medical Research Council (NMRC, NMRCB2b0006c) Singapore and the H-Man project (NMRC/BnB/0006b/2013), Ministry of Health, Singapore; Ageing Research Institute for Society and Education (ARISE), Singapore: M4082063 and Interdisciplinary Graduate School, Nanyang Technological University, Singapore. Grant support duration: 2013–2018.

Inclusion criteria	Inclusion criteria for this study were: a first-ever stroke diagnosed by stroke neurologists or neurosurgeons and brain imaging, age between 21 and 85 years, time since stroke within 3–24 months, predominant arm motor function deficits with baseline FMA score between 20 and 50 or presence of motor ataxia, and the ability to understand instructions and give informed consent.
Exclusion criteria	Exclusion criteria for this study were: uncontrolled medical illnesses, pregnancy, life expectancy <6 months, inability to sit upright with support for <90 min due to postural hypotension or pressure intolerance, arm related contraindications to robot aided therapy such as shoulder pain [Visual Analog Scale (55), VAS > 4/10], spasticity [Modified Ashworth Scale (56), MAS > 2], severe sensory and visual impairments, hemi spatial neglect assessed using the line bisection test, and screening Mini-Mental State Examination score, MMSE <27/30.
Recruitment / selection of participants	Participants were consecutively identified through an inpatient stroke rehabilitation standing database and their involvement lasted a total of 24 weeks. Majority of subjects had completed inpatient rehabilitation at the centre's rehabilitation hospital
Intervention(s)	Robotic Therapy (RT) n=22 The group underwent a 60 min robotic therapy session, minimally supervised by occupational therapists and bio-engineers, followed by a 30 min 1:1 conventional therapy session. During the robotic therapy, the subjects performed a point-to-point reaching task (in different shape patterns) with H-Man, which incorporated a performance based adaptive controller. The controller adjusts the interaction dynamics trial-by-trial based on an online estimation of patients task performance during a point to point reaching task, ranging from performance enhancement to performance degradation. The conventional therapy included passive mobilization and active-assisted approaches based on neuro-developmental techniques to enhance normal movement patterns, repetitive tasks, specific training for functional reach training and the use of upper limb inclined board and motorized arm bike. Both of the groups received the same number of training sessions (*n* = 18) of 90 min each, three times a week and over a span of 6 weeks. Concomitant treatment: 30 min 1:1 conventional therapy session.
Subgroup 1: Severity	Not stated/unclear

Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Not stated/unclear
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised 'minimally supervised'
Subgroup 8: Type of movement delivered by robotic device	Not stated/unclear
Population subgroups	NR
Comparator	Conventional Therapy (CT) n=22 The group received 90 min of 1:1 conventional therapy from a trained occupational therapist. The conventional therapy included passive mobilization and active-assisted approaches based on neuro-developmental techniques to enhance normal movement patterns, repetitive tasks, specific training for functional reach training and the use of upper limb inclined board and motorized arm bike. Both of the groups received the same number of training sessions (*n* = 18) of 90 min each, three times a week and over a span of 6 weeks

	Concomitant treatment: none reported.
Number of participants	44
Duration of follow-up	24 weeks
Indirectness	N/A

Study arms

Robotic therapy (N = 22)
18 training sessions of 90 min each, three times a week and over a span of 6 weeks.

Conventional therapy (N = 22)
18 training sessions of 90 min each, three times a week and over a span of 6 weeks.

Characteristics

Study-level characteristics

Characteristic	**Study (N = 44)**
% Female No of events	n = 19 ; % = 43

Arm-level characteristics

Characteristic	Robotic therapy (N = 22)	Conventional therapy (N = 22)
Mean age (SD) Mean (SD)	56.32 (10.37)	54.59 (10.92)
Time after stroke Days Median (IQR)	458 (451.3 to *empty data*)	390 (327.5 to *empty data*)

Outcomes

Study timepoints

- Baseline
- 6 week (Post-intervention)
- 24 week (Post-intervention)

Dichotomous outcome

Outcome	Robotic therapy, Baseline, N = 22	Robotic therapy, 6 week, N = 22	Robotic therapy, 24 week, N = 22	Conventional therapy, Baseline, N = 22	Conventional therapy, 6 week, N = 22	Conventional therapy, 24 week, N = 22
Withdrawal for any reason The week 24 outcome assessment in one participant could not be performed due to a wrist injury related to a fall	n = NA ; % = NA	n = 0 ; % = 0	n = 1 ; % = 5	n = NA ; % = NA	n = 0 ; % = 0	n = 0 ; % = 0

Outcome	Robotic therapy, Baseline, N = 22	Robotic therapy, 6 week, N = 22	Robotic therapy, 24 week, N = 22	Conventional therapy, Baseline, N = 22	Conventional therapy, 6 week, N = 22	Conventional therapy, 24 week, N = 22
during the follow-up phase that was unrelated to training. No of events						
Adverse events Narrative statement: 'there were no training related adverse side effects or drop outs up to week 6 of the study'. No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NR ; % = NR	n = NA ; % = NA	n = 0 ; % = 0	n = NR ; % = NR

Continuous outcomes

Outcome	Robotic therapy, Baseline, N = 22	Robotic therapy, 6 week, N = 22	Robotic therapy, 24 week, N = 21	Conventional therapy, Baseline, N = 22	Conventional therapy, 6 week, N = 22	Conventional therapy, 24 week, N = 22
Arm function (Fugl-Meyer assessment) Final values. Scale range 0-66. Mean (SD)	40.23 (9.3)	44.64 (9.77)	45.33 (11.43)	35.86 (11.65)	38.86 (11.69)	40.36 (11.57)
Arm muscle strength (grip strength) Final values. Mean (SD)	7.49 (3.22)	9.41 (4.84)	10.86 (6.28)	6.72 (4.12)	7.81 (3.7)	8.94 (4.01)

Arm function (Fugl-Meyer assessment) - Polarity - Higher values are better
Arm muscle strength (grip strength) - Polarity - Higher values are better
Also reports ARAT.

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armmusclestrength(gripstrength)-MeanSD-Robotic therapy-Conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robotic therapy-Conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robotic therapy-Conventional therapy-t24

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns

Section	Question	Answer
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Continuousoutcomes-Armmusclestrength(gripstrength)-MeanSD-Robotic therapy-Conventional therapy-t24

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-MeanSD-Robotic therapy-Conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-MeanSD-Robotic therapy-Conventional therapy-t24

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Dichotomousoutcome-Adverseevents-NoOfEvents-Robotic therapy-Conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Adverseevents-NoOfEvents-Robotic therapy-Conventional therapy-t24

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Burgar, 1999

Bibliographic Reference	Burgar, C. G.; Lum, P. S.; Shor, M.; Van der Loos, H. F. M.; Rehabilitation of upper limb dysfunction in chronic hemiplegia: robot-assisted movements vs. conventional therapy; Arch Phys Med Rehabil; 1999; vol. 80 (no. 9); 1121

Study details

Secondary publication of another included study- see primary study for details	Lum PS, Burgar CG, Shor PC, Majmundar M, Van der Loos M. Robot-assisted movement training compared with conventional therapy techniques for the rehabilitation of upper-limb motor function after stroke. *Archives of Physical Medicine and Rehabilitation* 2002;83(7):952-9.

Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review. Burgar C, Lum P, Shor P, Van der Loos H. Development of robots for rehabilitation therapy: the Palo Alto VA/Stanford experience. *Journal of Rehabilitation Research and Development* 2000;37(6):663-73.

Burgar, 2011

Bibliographic Reference	Burgar, Charles G.; Lum, Peter S.; Scremin, A. M.; Garber, Susan L.; Van der Loos, H. F.; Kenney, Deborah; Shor, Peggy; Robot-assisted upper-limb therapy in acute rehabilitation setting following stroke: Department of Veterans Affairs multisite clinical trial; J Rehabil Res Dev; 2011; vol. 48 (no. 4); 445-458

Study details

Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Mixed Mean 27 points FIM upper limb.

Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months) mean 11 days.
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Mixed

Study arms

Robot therapy (N = 36)
15 x1 hour therapy sessions over a 3 week period (1 robot group received 30 1 hour therapy sessions over 3 week period).

Control (N = 18)
15 x1 hour therapy sessions over a 3 week period

Outcomes

Study timepoints

- Baseline
- 3 week (Post-intervention)
- 6 month (Post-intervention)

Continuous outcomes

Outcome	Robot therapy, Baseline, N = 36	Robot therapy, 3 week, N = 36	Robot therapy, 6 month, N = 25	Control, Baseline, N = 18	Control, 3 week, N = 18	Control, 6 month, N = 12
Arm function (Fugi-Meyer) (0-66) Change score Mean (SE)	23 (3.23)	10.6 (1.93)	23.1 (3.88)	24.2 (4.8)	14 (15.3)	15.3 (17)
Activities of daily living(FIM upper limb) (0-63) Change score Mean (SE)	28.2 (1.59)	19.6 (1.42)	25.7 (2.12)	26.9 (2)	15.9 (1.5)	26.8 (3.1)
Arm muscle strength (motor power) (0-70) Change score Mean (SE)	24.9 (1.76)	14.9 (1.86)	22.3 (2.72)	24.9 (4.2)	15.4 (3.7)	24.4 (4.8)
Spasticity (Ashworth MAS) (max 5 points) Change score	0.38 (0.063)	0.09 (0.02)	0.4 (0.1)	0.33 (0.08)	0.11 (0.1)	0.16 (0.15)

Outcome	Robot therapy, Baseline, N = 36	Robot therapy, 3 week, N = 36	Robot therapy, 6 month, N = 25	Control, Baseline, N = 18	Control, 3 week, N = 18	Control, 6 month, N = 12
Mean (SE)						

Arm function (Fugi-Meyer) - Polarity - Higher values are better
Activities of daily living(FIM upper limb) - Polarity - Higher values are better
Arm muscle strength (motor power) - Polarity - Higher values are better
Spasticity (Ashworth MAS) - Polarity - Lower values are better
Change scores. Robot groups combined for analysis. FM values (mean plus SE): at baseline, Robot-Lo: 26.7 (5.0), Robot-Hi: 19.0 (3.7); at post-intervention, Robot-Lo: 6.8 (1.9), Robot-Hi: 14.4 (3.6); at 6 month follow-up: Robot-Lo: 15.9 (3.5), Robot-Hi: 23.6 (5.8). FIM values (mean plus SE): at baseline, Robot-Lo: 28.4 (2.6), Robot-Hi: 27.9 (1.7); at post-intervention, Robot-Lo: 17.7 (1.9) , Robot-Hi: 21.5 (2.1) at 6 month follow-up: Robot-Lo: 24.2 (2.9), Robot-Hi: 27.5 (3.0). Motor Power values (mean plus SE): at baseline, Robot-Lo: 27.9 (4.8), Robot-Hi: 21.5 (4.2); at post-intervention, Robot-Lo: 13.7 (2.3) , Robot-Hi: 16.0 (3.0) at 6 month follow-up: Robot-Lo: 18.0 (3.3), Robot-Hi: 27.8 (4.0). Ashworth values (mean plus SE): at baseline, Robot-Lo: 0.44 (0.10), Robot-Hi: 0.31 (0.08); at post-intervention, Robot-Lo: 0.00 (0.06) , Robot-Hi: 0.19 (0.09) at 6 month follow-up: Robot-Lo: 0.02 (0.14), Robot-Hi: 0.83 (0.25). Also reports WMFT

Dichotomous outcome

Outcome	Robot therapy, Baseline, N = 36	Robot therapy, 3 week, N = 36	Robot therapy, 6 month, N = 36	Control, Baseline, N = 18	Control, 3 week, N = 18	Control, 6 month, N = 18
Withdrawal for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NR ; % = NR	n = NA ; % = NA	n = 0 ; % = 0	n = NR ; % = NR

Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(Fugi-Meyer)-MeanSE-Robot therapy-Control-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugi-Meyer)-MeanSE-Robot therapy-Control-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Activitiesofdailyliving(FIMupperlimb)-MeanSE-Robot therapy-Control-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Activitiesofdailyliving(FIMupperlimb)-MeanSE-Robot therapy-Control-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armmusclestrength(motorpower)-MeanSE-Robot therapy-Control-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armmusclestrength(motorpower)-MeanSE-Robot therapy-Control-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(AshworthMAS)-MeanSE-Robot therapy-Control-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(AshworthMAS)-MeanSE-Robot therapy-Control-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot therapy-Control-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Burgar, 2000

Bibliographic Reference	Burgar, Charles G.; Lum, Peter S.; Shor, Peggy C.; Van der Loos, H. F. Machiel; Development of robots for rehabilitation therapy: The Palo Alto VA/Stanford experience; Journal of rehabilitation research and development; 2000; vol. 37 (no. 6); 663-674

Study details

Secondary publication of another included study- see primary study for details	Lum PS, Burgar CG, Shor PC, Majmundar M, Van der Loos M. Robot-assisted movement training compared with conventional therapy techniques for the rehabilitation of upper-limb motor function after stroke. *Archives of Physical Medicine and Rehabilitation* 2002;83(7):952-9.

Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review. Burgar CG, Lum PS, Shor M, Loos HFM. Rehabilitation of upper limb dysfunction in chronic hemiplegia: robot-assisted movement versus conventional therapy. *Archives of Physical Medicine and Rehabilitation* 1999;80:1121.

Calabro, 2019

Bibliographic Reference	Calabro, R. S.; Accorinti, M.; Porcari, B.; Carioti, L.; Ciatto, L.; Billeri, L.; Andronaco, V. A.; Galletti, F.; Filoni, S.; Naro, A.; Does hand robotic rehabilitation improve motor function by rebalancing interhemispheric connectivity after chronic stroke? Encouraging data from a randomised-clinical-trial; Clinical Neurophysiology; 2019; vol. 130 (no. 5); 767-780

Study details

Secondary publication of another included study- see primary study for details	NR
Other publications associated with this study included in review	NR

Trial name / registration number	NCT03292276
Study location	Italy
Study setting	In-patient, at the Neuro-robotic Rehabilitation Unit of the IRCCS Centro Neurolesi Bonino Pulejo.
Study dates	Between January and February 2018.
Sources of funding	No funding.
Inclusion criteria	Patients were rated as eligible according to the following criteria: (i) age ≤55 years; (ii) a first, single, ischemic, supra-tentorial, chronic-stage stroke at least 6 months after the event, confirmed by T1-weighted structural whole brain Magnetic Resonance Imaging, performed at the scoring of chronic upper limb function; (iii) a Muscle Research Council score ≤3 concerning shoulder abduction –deltoid– elbow flexion –biceps brachii– and wrist flexion –wrist flexors); (iv) a Mini–Mental State Examination score >24 (that is, the patient was able to follow verbal instructions); (v) a Modified Ashworth Scale score of the hand muscles ≤2; (vi) no prior history of severe bone or joint disease; and (vii) no prior history of concomitant neurodegenerative diseases or brain surgery.
Exclusion criteria	Not reported.
Recruitment / selection of participants	Not reported (all were inpatients at the unit where the study was taking place).
Intervention(s)	AmadeoTM hand training (AHT) n=25 The patients in the AHT group underwent 40 individual conventional 3-hour physiotherapeutic training sessions, 5 days a week for 8 weeks (starting between 9:00 am and 11:00 am). The sessions were divided into 45 min of occupational therapy (daily living and reaching activities), 45 min of biomechanical training of both upper and lower limbs, 30 min of gait training, 30 min of speech therapy, and 30 min of rest period (distributed between the sessions) followed by 45 min of robot-assisted therapy of the affected limb using AmadeoTM. Each hand training session consisted of random order exercises: (i) 15 min of continuous passive motion; (ii) 25 min of assisted therapy (movements were robot-assisted according to individual performance); and (iii) 5 min of rest period between the two sessions. The movement execution was standardised: the fingers were first extended for 1 s and then flexed and extended continuously for 5 s at a frequency of 0.2 Hz. The entire flexion–extension cycle lasted 6 s. The device guidance force (DGF), during assisted therapy, was adapted to each patient's progress. Specifically, the machine detected the patient's finger movements and intervened to drive and/or complete them within the span of 6 s. The amount of required assistance was recorded by the device itself. During the

	session, an AmadeoTM–trained physiotherapist supervised each patient's intervention adherence. Distinct video–acoustic cues signalled the patient when each movement cycle began and ended (in the passive condition) and when to move (in the assisted condition). Concomitant treatment: The patients were asked not to undertake other physiotherapy treatments during the 8-week training period.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Not stated/unclear
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Mixed
Population subgroups	Not reported.

Comparator	Conventional hand training n=25 The patients in the CHT group also underwent 40 individual conventional 3-hour physiotherapy sessions, 5 days a week for an 8–week period, between 9:00 am and 11:00 am. This training had the same characteristics described for the AHT group. Each session was then followed by a 45 min conventional hand therapy session carried out by an occupational therapist, who both performed and assisted the patient in the execution of finger movements, reproducing the same experimental conditions of the AHT group (upper limb position and constrainment, movement execution, flexion–extension finger movements, movement frequency and velocity, degree of assistance, and video–acoustic cueing). The similar setup was necessary to avoid biasing effects on sensory processing due to differences in the restraint of the wrist between AHT and CHT. Muscle synergies are affected by robot-dependent mechanical constraints and forces, thus affecting the sensorimotor system. Concomitant treatment: The patients were asked not to undertake other physiotherapy treatments during the 8-week training period.
Number of participants	50
Duration of follow-up	8 weeks
Indirectness	None.
Additional comments	All of the randomized patients were included in the primary analysis, as an intent-to-treat approach was adopted.

Study arms

Amadeo hand training (N = 25)
40 hand training sessions of 45min each, 5 times a week, for 8 consecutive weeks.

Conventional hand training (N = 25)
40 hand training sessions of 45min each, 5 times a week, for 8 consecutive weeks.

Characteristics

Arm-level characteristics

Characteristic	Amadeo hand training (N = 25)	Conventional hand training (N = 25)
% Female No of events	n = 14 ; % = 56	n = 11 ; % = 44
Mean age (SD) Mean (SD)	65 (3)	64 (3)
Time after stroke months Mean (SD)	10 (2)	10 (2)

Outcomes

Study timepoints
- Baseline
- 8 week (Post-intervention)

Dichotomous outcomes

Outcome	Amadeo hand training , Baseline, N = 25	Amadeo hand training , 8 week, N = 25	Conventional hand training, Baseline, N = 25	Conventional hand training, 8 week, N = 25
Withdrawal for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0
Adverse events Narrative report of no adverse events in either group No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Continuous outcomes

Outcome	Amadeo hand training , Baseline, N = 25	Amadeo hand training , 8 week, N = 25	Conventional hand training, Baseline, N = 25	Conventional hand training, 8 week, N = 25
Arm function (Fugl-meyer Upper Extremity) Final values. Scale range 0-66 Mean (SD)	29 (3)	36 (4)	30 (3)	34 (4)

Arm function (Fugl-meyer Upper Extremity) - Polarity - Higher values are better
Also reports 9 Hole Peg Test, Motor Evoked Potential, Short latency afferent inhibition and repetitive paired associative stimulation.

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Function(Fugl-meyerUpperExtremity)-MeanSD-Amadeo hand training -Conventional hand training-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Amadeo hand training -Conventional hand training-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Adverseevents-NoOfEvents-Amadeo hand training -Conventional hand training-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Carpinella, 2020

Bibliographic Reference	Carpinella, I.; Lencioni, T.; Bowman, T.; Bertoni, R.; Turolla, A.; Ferrarin, M.; Jonsdottir, J.; Effects of robot therapy on upper body kinematics and arm function in persons post stroke: a pilot randomized controlled trial; Journal of Neuroengineering & Rehabilitation; 2020; vol. 17 (no. 1); 10

Study details

Secondary publication of another included study- see primary study for details	NR
Other publications associated with this study included in review	Lencioni T, Jonsdottir J, Ferrarin M, Marzegan A, Bowman T, Turolla A, et al. Effects of planar robotic rehabilitation on muscle synergies of the upper limbs in post-stroke subjects. Gait & Posture. 2016;49:S4.
Trial name / registration number	NCT03530358
Study location	Italy
Study setting	2 stroke rehabilitation hospitals
Study dates	March 2015 to November 2017.
Sources of funding	This work was supported by the Italian Ministry of Health (Ricerca Corrente and Ricerca Finalizzata: grant no. GR-2011-02348942).
Inclusion criteria	Inclusion criteria were: first ischemic or hemorrhagic stroke, a score between 1 and 3 at the upper limb sub-item on the Italian version of the National Institute of Health stroke scale (IT - NIHSS), a score higher than 6 out of 66 points on the Fugl-Meyer Motor Assessment of Upper Extremity (FM-UE) scale
Exclusion criteria	Exclusion criteria were: presence of a moderate cognitive decline defined as a Mini Mental State Examination score < 20 points, evidence of severe verbal comprehension deficit, apraxia and/or visuospatial neglect as assessed through neurological examination, report in the patient's clinical history or evidence from the neurological examination of behavioral disturbances (i.e. delusions, aggressiveness and severe apathy/depression) that could affect compliance with the rehabilitation programs, presence of non-stabilized fractures, presence of traumatic brain injury, presence of drug resistant epilepsy.

Recruitment / selection of participants	A consecutive sample of 116 adults post-stroke from the Neurorehabilitation Department of IRCCS Don Carlo Gnocchi Foundation (Milan, Italy) was assessed for eligibility from March 2015 to November 2017.
Intervention(s)	Participants allocated to the R_Group received a robot based training using a planar robotic manipulandum (Braccio di Ferro, Celin s.r.l., Italy) aimed at practicing shoulder and elbow movements in the horizontal plane. Subjects were seated on a chair while grasping the handle of the robot with the paretic hand. A large computer screen was used to display the current position of the hand and the target represented by circles with a diameter of 3 cm (Fig. 2a). The task consisted of repeated centre-out reaching movements and back, from a central target to a peripheral target randomly presented in one of five positions arranged on a semicircle with a 20 cm radius. The robotic system enabled the execution of reaching movements in two force modes, assist-as-needed and resistive. At the beginning of the following sessions, the physiotherapist analysed the summary report (see the example of Fig. 2b) showing the values of three robot-based indexes (i.e. maximum assistive force, reaching duration and number of movements units) related to the first and the last sessions performed. If the maximum assistive force generated by the robot during the previous session was greater than 1. N, the current session was still executed in the assist-as needed mode, otherwise the physiotherapist changed the exercise to the resistive mode, setting the rigidity K to the minimum value of 5 N/m. If the participant was unable to reach at least five targets within 10 s each, or if he/she had arm pain, the physiotherapist reloaded the exercise in the assist-as-needed mode, otherwise the session was executed in the resistive mode. The number of reaching movements executed during each 45-min session was between 240 in most impaired participants and 500 in less impaired participants. Trunk was not constrained during the training and the training did not directly involve intrinsic movements of the hand. Concomitant therapy -Participants in both the Robot and Control groups received a rehabilitation treatment for the affected upper limb consisting of 20 sessions of 45 min each, 5 times a week by trained physiotherapists.
Subgroup 1: Severity	Mild (or NIHSS 1-5)
Subgroup 2: Time after stroke at the start of the trial	Mixed
Subgroup 3: Region of upper limb trained	Proximal limb

Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Active assisted movement
Population subgroups	NR
Comparator	Participants allocated to the C_Group underwent usual care arm-specific physiotherapy that typically consisted of passive and active mobilization of scapula, shoulder, elbow and wrist, followed by task-oriented exercises that incorporated single or multi-joint movements aimed at improving arm functionality. Task-oriented activities were tailored to participants' abilities, and included hand to mouth movements, reaching towards and grasping objects, moving objects from one location to another. Participants that were not able to grasp would aim at moving towards objects in various trajectories, pushing them from one setting to another. Progression was obtained by increasing range of motion, number of repetitions and muscular coordination requests. A paper published by Kimberley et al. estimated that a typical number of movements executed in a usual care rehabilitation session, such as that carried out by the C_ Group, was around 40–45 repetitions.
Number of participants	40
Duration of follow-up	4 weeks end of intervention
Indirectness	NR
Additional comments	NR

Study arms

robot therapy (N = 20)

Conventional therapy (N = 20)

Characteristics

Study-level characteristics

Characteristic	Study (N = 40)
Ethnicity Nominal	NR
Comorbidities Nominal	NR

Arm-level characteristics

Characteristic	robot therapy (N = 20)	Conventional therapy (N = 20)
% Female Nominal	47	47
Mean age (SD) Median (IQR)	67 (58 to 70)	59 (46 to 69)

Characteristic	robot therapy (N = 20)	Conventional therapy (N = 20)
Severity Nominal	NR	NR
Time after stroke Median (IQR)	7 (1.7 to 11.9)	5.3 (1.9 to 89.6)

Outcomes

Study timepoints

- Baseline
- 4 week

Continuous outcomes

Outcome	robot therapy, Baseline, N = 20	robot therapy, 4 week, N = 19	Conventional therapy, Baseline, N = 20	Conventional therapy, 4 week, N = 19
Arm function (Fugl Meyer UE) 0-66, change scores Mean (SD)	35.3 (18.6)	7 (6.3)	28.1 (18.5)	6.2 (9.3)
Activties of daily living (functional independence measure) 18-126, change score Mean (SD)	99.9 (14.1)	9.3 (5.8)	92 (16.7)	8.7 (11.6)

Arm function (Fugl Meyer UE) - Polarity - Higher values are better

Activties of daily living (functional independence measure) - Polarity - Higher values are better

Dichotomous outcomes

Outcome	robot therapy, Baseline, N = 20	robot therapy, 4 week, N = 20	Conventional therapy, Baseline, N = 20	Conventional therapy, 4 week, N = 20
Withdrawal for any reason Two persons discontinued the training, one for medical complications unrelated to the study, and one for early discharge from the hospital. No of events	n = 0 ; % = 0	n = 1 ; % = 5	n = 0 ; % = 0	n = 1 ; % = 5

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(FuglMeyerUE)-MeanSD-robot therapy-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Activtiesofdailyliving(functionalindependencemeasure)-MeanSD-robot therapy-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-robot therapy-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Chen, 2022

Bibliographic Reference	Chen, Y. W.; Chiang, W. C.; Chang, C. L.; Lo, S. M.; Wu, C. Y.; Comparative effects of EMG-driven robot-assisted therapy versus task-oriented training on motor and daily function in patients with stroke: a randomized cross-over trial; Journal of Neuroengineering & Rehabilitation; 2022; vol. 19 (no. 1); 6

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with	No additional information.

this study included in review	
Trial name / registration number	Clinicaltrials.gov = NCT03624153
Study type	Randomised controlled trial (RCT)
Study location	Taiwan
Study setting	Outpatient follow up
Study dates	No additional information
Sources of funding	This study was supported by Chang Gung Memorial Hospital (BMRP553, CMRPD1I0033), the Ministry of Science and Technology (MOST 109-2314-B-192-027-MY3) and Healthy Aging Research Center, Chang Gung University from the Featured Areas Research Center Program within the Framework of the Higher Education Sprout Project by the Ministry of Education in Taiwan (EMRPD1L0411).
Inclusion criteria	Unilateral stroke at least 3 months prior to study enrolment; Fugl-Meyer Assessment for Upper Extremity score <60; without excessive spasticity in any of the upper extremity joint (modified Ashworth scale no more than 3); Mini Mental State Exam score >24, indicating no serious cognitive impairment; between the ages of 20 and 75 years.
Exclusion criteria	Histories of other neurological diseases such as dementia and peripheral polyneuropathy; difficulties in following and understanding instructions such as global aphasia; enroll in other rehabilitation or drug studies simultaneously; receiving botulinum toxin injections within 3 months.
Recruitment / selection of participants	No additional information.
Intervention(s)	Robot-assisted arm training N=16 Hand of Hope robotic hand system which had training modes including: continuous passive motion, EMG biofeedback - trigger and go, EMG biofeedback - trigger and maintain and interactive passive games. 12 sessions of robot-assisted intervention first, followed by a 1-month washout period, then 12 sessions of task-oriented interventions (only the follow up at the initial 12 sessions will be used in this data extraction). Each sessions consisted of 20-minutes continuous passive motion, 20-minutes active motion practice and 30-minutes interactive gaming practice.

	Concomitant therapy: No additional information.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Mixed
Population subgroups	No additional information.
Comparator	Usual care N=15 Task-oriented interventions. 12 sessions. After which they had a 1-month washout period and then participated in 12 sessions of robot assisted arm training (only the follow up at the initial 12 sessions will be used in this data extraction).

	Included 20-minutes warm up including range of motion exercise and strengthening exercise followed by 50-minutes task-oriented training for activities of daily living under the supervision of a senior occupational therapist. Concomitant therapy: No additional information.
Number of participants	31
Duration of follow-up	4 weeks (after the first phase of treatment will be the follow up period used in this review as stated in the protocol)
Indirectness	No additional information
Additional comments	No additional information

Study arms

Robot-assisted arm training (N = 16)
Hand of Hope robotic hand system which had training modes including: continuous passive motion, EMG biofeedback - trigger and go, EMG biofeedback - trigger and maintain and interactive passive games. 12 sessions of robot-assisted intervention first, followed by a 1-month washout period, then 12 sessions (3 sessions per week for 4 consecutive weeks) of task-oriented interventions (only the follow up at the initial 12 sessions will be used in this data extraction). Each sessions consisted of 20-minutes continuous passive motion, 20-minutes active motion practice and 30-minutes interactive gaming practice. Concomitant therapy: No additional information.

Usual care (N = 15)
Task-oriented interventions. 12 sessions (3 sessions per week for 4 consecutive weeks). After which they had a 1-month washout period and then participated in 12 sessions of robot assisted arm training (only the follow up at the initial 12 sessions will be used in this data extraction). Included 20-minutes warm up including range of motion exercise and strengthening exercise followed by 50-minutes task-oriented training for activities of daily living under the supervision of a senior occupational therapist. Concomitant therapy: No additional information.

Characteristics

Arm-level characteristics

Characteristic	Robot-assisted arm training (N = 16)	Usual care (N = 15)
% Female Sample size	n = 4 ; % = 29	n = 1 ; % = 10
Mean age (SD) (years) Mean (SD)	54.58 (10.98)	64.98 (8.22)
Ethnicity Sample size	n = NR ; % = NR	n = NR ; % = NR
Comorbidities Sample size	n = NR ; % = NR	n = NR ; % = NR
Severity Sample size	n = NR ; % = NR	n = NR ; % = NR
Time after stroke (Months) Mean (SD)	37.07 (34.39)	59.8 (43.34)

Outcomes

Study timepoints

- Baseline

- 4 week (Post-intervention)

Continuous outcome

Outcome	Robot-assisted arm training, Baseline, N = 16	Robot-assisted arm training, 4 week, N = 14	Usual care, Baseline, N = 15	Usual care, 4 week, N = 10
Arm function (Fugl-Meyer assessment- upper extremity) Scale range: 0-66. Final values. Mean (SD)	33 (8.53)	35.64 (9.3)	36.4 (10.1)	38.8 (10.32)

Arm function (Fugl-Meyer assessment- upper extremity) - Polarity - Higher values are better

Dichotomous outcome

Outcome	Robot-assisted arm training, Baseline, N = 16	Robot-assisted arm training, 4 week, N = 16	Usual care, Baseline, N = 15	Usual care, 4 week, N = 15
Withdrawal for any reason Intervention: 2 discontinued due to hospital discharge or personal issues. Control: 5 discontinued due to hospital discharge or personal issues. No of events	n = NA ; % = NA	n = 2 ; % = 13	n = NA ; % = NA	n = 5 ; % = 33

Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Cross-over trial

Continuousoutcome-Armfunction(Fugl-Meyerassessment-upperextremity)-MeanSD-Robot-assisted arm training-Usual care-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm training-Usual care-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Chen, 2021

Bibliographic Reference	Chen, Z. J.; Gu, M. H.; He, C.; Xiong, C. H.; Xu, J.; Huang, X. L.; Robot-Assisted Arm Training in Stroke Individuals With Unilateral Spatial Neglect: A Pilot Study; Frontiers in neurology [electronic resource].; 2021; vol. 12; 691444

Study details

Secondary publication of another included study- see primary study for details	NR

Other publications associated with this study included in review	NR
Trial name / registration number	ChiCTR1900026656
Study type	Randomised controlled trial (RCT)
Study location	China
Study setting	Department of Rehabilitation Medicine.
Study dates	Eligible patients were screened and enrolled from November 2018 until February 2021.
Sources of funding	This work received financial support for the research and publication of this article from National Natural Science Foundation of China (U 1913601 and No. 91648203).
Inclusion criteria	Inclusion Criteria included: (a) age 18–80; (b) clinical diagnosis of right hemisphere stroke (stroke onset from 2 weeks to 6 months); (c) Fugl-Meyer assessment of the upper extremity (FMA-UE) score 8–47; and (d) presence of USN defined by scoring of any item lesser than its cutoff value of the Behavioral Inattention Test conventional section (BIT-C).
Exclusion criteria	Exclusion criteria included: (a) not first-ever stroke; (b) other current significant impairments, for example, visual impairment, fixed contracture, shoulder subluxation; (c) diagnosis likely to interfere with rehabilitation or outcome assessments, for example, traumatic brain injury, epilepsy; and (d) unable to understand the intervention because of aphasia or other cognitive impairments
Recruitment / selection of participants	NR
Intervention(s)	Robot-assisted therapy (RAT) n=10 Participants in the RAT group received RAT (Armule®, Intelbot intelligent machine Co., Ltd, Wuhan, China) for remediating patients' neglect of contralateral space and affected upper extremity supervised by a therapist. When receiving robotic therapy, patients sat in a height-adjustable chair in front of the exoskeleton and looked at the computer monitor connected to the robotic device. Linkages between patients and the Armule were custom-fitted based on arm length and circumference. In addition, motion sensors were placed in the linkage cuffs of upper arm and forearm to detect the patient's

	movement intention. The robotic programs in this study were adapted to apply training for motor impairment and USN simultaneously by increasing left-side Armule sensorimotor interaction with the patients. Each training session consisted of 15-min passive mode and 30-min assist-as-need mode. During passive mode, the exoskeleton manipulated upper extremity with three-dimensional trajectory predetermined by the therapists according to patient-centered goals. Moreover, with the three-dimensional animation and voice prompts from the exoskeleton, patients were required to pay attention to the left side. During assist-as-need mode, patients practiced games and ADL training programs dedicated to the left side with audiovisual feedback, such as shooting targets, Whack-a-Mole, and cleaning windows. The Armule detected human-robot interaction forces and momentary position via the sensors in the linkage cuffs to estimate the participants' real-time movement intentions and performance for assistance when necessary. Training programs were progressed according to the performance of patients. The difficulty level for USN intervention was changed during robotic training by adjusting where the targets occurred on the computer screen, range of motion, and the robotic assistance. Besides, therapists could regulate the motion sensitivity of the exoskeleton to increase training difficulty for motor function. When the patient was not able to complete the tasks actively, the exoskeleton gave acoustic cues to patients and assistance supplied for the upper extremity supervised by the therapist. Interventions in both groups were delivered at the same frequency, intensity, and duration: 45 min daily, 5 days/week for 4 weeks. Concomitant treatment: conventional rehabilitation programs continued as usual for all the participants.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Not stated/unclear
Subgroup 4: Dose (hours per day)	<1 hour

Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Mixed
Population subgroups	NR
Comparator	Control group n=10 Participants in the group received general cognitive and occupational rehabilitation dedicated for unilateral spatial neglect, consisting of visual scanning therapy, passive range of movement of upper extremity and perceptual retraining integrated with task-specific activities. Interventions in both groups were delivered at the same frequency, intensity, and duration: 45 min daily, 5 days/week for 4 weeks. Concomitant treatment: conventional rehabilitation programs continued as usual for all the participants.
Number of participants	20
Duration of follow-up	4 weeks (immediately post-intervention).
Indirectness	N/A

Additional comments	NR

Study arms

Robot-assisted arm training (N = 10)
45 min daily, 5 days/week for 4 weeks.

Conventional therapy (N = 10)
45 min daily, 5 days/week for 4 weeks.

Characteristics

Study-level characteristics

Characteristic	**Study (N = 20)**
Mean age (SD) Mean (SD)	47.4 (8.47)
Ethnicity Not reported. Nominal	NR
Comorbidities Not reported Nominal	NR

Characteristic	Study (N = 20)
Severity Not reported Nominal	NR

Arm-level characteristics

Characteristic	Robot-assisted arm training (N = 10)	Conventional therapy (N = 10)
% Female No of events	n = 2 ; % = 20	n = 3 ; % = 30
Time after stroke (days) Mean (SD)	97.1 (84.37)	86.4 (61.92)

Outcomes

Study timepoints

- Baseline
- 4 week (Post-intervention)

Dichotomous outcomes

Outcome	Robot-assisted arm training, Baseline, N = 10	Robot-assisted arm training, 4 week, N = 10	Conventional therapy, Baseline, N = 10	Conventional therapy, 4 week, N = 10
Withdrawal for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0
Adverse events narrative report of no adverse events No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Continuous outcomes

Outcome	Robot-assisted arm training, Baseline, N = 10	Robot-assisted arm training, 4 week, N = 10	Conventional therapy, Baseline, N = 10	Conventional therapy, 4 week, N = 10
Activities of daily living (Modified Barthel Index) Change scores. Scale range 0-100 Mean (SD)	45.6 (13.97)	28.9 (14.26)	50.4 (12.79)	21 (8.89)
Arm function (Fugl-Meyer assesment- upper extremity) Change scores. Scale range 0-66 Mean (SD)	23.1 (10.48)	13.6 (4.7)	20.5 (8.02)	9.5 (2.64)

Activities of daily living (Modified Barthel Index) - Polarity - Higher values are better
Arm function (Fugl-Meyer assesment- upper extremity) - Polarity - Higher values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Activitiesofdailyliving(ModifiedBarthelIndex)-MeanSD-Robot-assisted arm training-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Adverseevents-NoOfEvents-Robot-assisted arm training-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm training-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerassesment-upperextremity)-MeanSD-Robot-assisted arm training-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Chen, 2021

Bibliographic Reference	Chen, Z. J.; He, C.; Guo, F.; Xiong, C. H.; Huang, X. L.; Exoskeleton-Assisted Anthropomorphic Movement Training (EAMT) for Poststroke Upper Limb Rehabilitation: A Pilot Randomized Controlled Trial; Archives of Physical Medicine & Rehabilitation; 2021; vol. 102 (no. 11); 2074-2082

Study details

Secondary publication of another included study- see primary study for details	NR
Other publications associated with this study included in review	NR
Trial name / registration number	ChiCTR1900026656
Study type	Randomised controlled trial (RCT)

Study location	Unclear
Study setting	Unclear
Study dates	December 2018-May 2020
Sources of funding	Supported by the National Natural Science Foundation of China (grant nos. U 1913601, 91648203).
Inclusion criteria	The inclusion criteria included (1) age between 18-80 years; (2) a clinical diagnosis of stroke (cerebral infarction, primary intracerebral hemorrhage, subarachnoid hemorrhage) that occurred within the 6 months before enrollment; (3) motor impairment, defined as scoring between 8-47 on the Fugl-Meyer Assessment for Upper Extremity (FMA-UE); and (4) signed the written informed consent.
Exclusion criteria	The exclusion criteria were as follows: (1) >1 stroke (individuals with a previous transient ischemic attack could participate); (2) orthopedic conditions of the upper limb (eg, fixed contracture, shoulder subluxation, severe arthritis, or a recent fracture); (3) a diagnosis likely to interfere with the intervention or outcome measures (eg, traumatic brain injury, meningitis); (4) serious cognitive defects (Mini-Mental State Examination score <21) or aphasia preventing participation in the intervention; and (5) participation in any other clinical trial.
Recruitment / selection of participants	Recruited from the Department of Rehabilitation Medicine.
Intervention(s)	Exoskeleton-assisted anthropomorphic movement training n=10 The exoskeleton group received EAMT therapy that delivered task-specific training under anthropomorphic trajectories and postures. The participants sat in a height-adjustable chair in front of the exoskeleton, with their trunk strapped by a chest harness to prevent compensating movements. The upper limb remained in a neutral position initially and was fixed with Velcro straps. Linkages with the exoskeleton were adjustable to custom-fit each participant based on arm length and circumference. Each session consisted of 15-minute passive and 30-minute active-assistive exercises. During the passive mode, the individuals received mobilization under anthropomorphic movements predetermined by the therapists. During the active-assistive mode, the exoskeleton detected human−robot interaction forces and position via the sensors in the linkage cuffs to determine the participants' real-time movement intention and performance. Sensor information was synchronously projected to virtual games on the screen for EAMT training, such as shooting targets, Whack-a-Mole, drinking water, wiping their face, cleaning windows, and frying eggs.

	For both groups, therapy for the affected arm was delivered at the same frequency and duration: 45 minutes daily, 5 days per week, for 4 weeks. Concomitant treatment: all of the participants received routine multidisciplinary treatment, including medication and usual poststroke care.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Not stated/unclear
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Mixed
Population subgroups	NR

Comparator	Conventional arm therapy n=10 The control group received conventional arm therapy. Each session was composed of passive stretching, active-assisted movement training, and functional task training for the upper extremities. Training programs that incorporated single or multi-joint movements were individualized and progressed according to the participants' abilities. The functional tasks included reaching, grasping, and transporting objects to attain the therapy goals. Concomitant treatment: all of the participants received routine multidisciplinary treatment, including medication and usual poststroke care.
Number of participants	20
Duration of follow-up	4 weeks (end of intervention)
Indirectness	None

Study arms

Exoskeleton-assisted anthropomorphic movement training (N = 10)
45 minutes daily, 5 days per week, for 4 weeks.

Conventional therapy (N = 10)
45 minutes daily, 5 days per week, for 4 weeks.

Characteristics

Arm-level characteristics

Characteristic	Exoskeleton-assisted anthropomorphic movement training (N = 10)	Conventional therapy (N = 10)
% Female No of events	n = 0 ; % = 0	n = 3 ; % = 30
Mean age (SD) Mean (SD)	47.1 (11.11)	54.9 (14.49)
Time after stroke Mean (SD)	74.9 (54.52)	50.1 (38.24)

Outcomes

Study timepoints

- Baseline
- 4 week (Post-intervention)

Dichotomous outcomes

Outcome	Exoskeleton-assisted anthropomorphic movement training, Baseline, N = 10	Exoskeleton-assisted anthropomorphic movement training, 4 week, N = 10	Conventional therapy, Baseline, N = 10	Conventional therapy, 4 week, N = 10
Withdrawal for any reason	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Outcome	Exoskeleton-assisted anthropomorphic movement training, Baseline, N = 10	Exoskeleton-assisted anthropomorphic movement training, 4 week, N = 10	Conventional therapy, Baseline, N = 10	Conventional therapy, 4 week, N = 10
No of events				
Adverse events 2 individuals in the exoskeleton group reported muscle fatigue, and 1 in the control group reported shoulder pain, which was relieved after relaxation. No severe adverse events occurred during the study. No of events	n = NA ; % = NA	n = 2 ; % = 20	n = NA ; % = NA	n = 1 ; % = 10

Continuous outcomes

Outcome	Exoskeleton-assisted anthropomorphic movement training, Baseline, N = 10	Exoskeleton-assisted anthropomorphic movement training, 4 week, N = 10	Conventional therapy, Baseline, N = 10	Conventional therapy, 4 week, N = 10
Activities of daily living (Modified Barthel Index) Final values. Scale range 0-100 Mean (SD)	44.2 (13)	71 (12.82)	47.9 (5.88)	66 (11.91)
Function (Fugl-Meyer UE) Final values. Scale range 0-66 Mean (SD)	22.3 (11.42)	35.1 (13.36)	20.2 (9.48)	28.7 (11.27)

Activities of daily living (Modified Barthel Index) - Polarity - Higher values are better
Function (Fugl-Meyer UE) - Polarity - Higher values are better
Also reports ARAT, FM-UA and FM-WH.

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Function(Fugl-MeyerUE)-MeanSD-Exoskeleton-assisted anthropomorphic movement training-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Activitiesofdailyliving(ModifiedBarthelIndex)-MeanSD-Exoskeleton-assisted anthropomorphic movement training-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Adverseevents-NoOfEvents-Exoskeleton-assisted anthropomorphic movement training-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Exoskeleton-assisted anthropomorphic movement training-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Chinembiri, 2021

Bibliographic Reference	Chinembiri, B.; Ming, Z.; Kai, S.; Xiu Fang, Z.; Wei, C.; The fourier M2 robotic machine combined with occupational therapy on post-stroke upper limb function and independence-related quality of life: A randomized clinical trial; Topics in Stroke Rehabilitation; 2021; vol. 28 (no. 1); 1-18

Study details

Secondary publication of another included study- see primary study for details	No additional information
Other publications associated with	No additional information

this study included in review	
Trial name / registration number	ISRCTN = ISRCTN84804721
Study type	Randomised controlled trial (RCT)
Study location	China
Study setting	Outpatient follow up.
Study dates	January 2018 and October 2019.
Sources of funding	Supported by the Jiangsu Provincial Medical Youth Talent under Grant (number QNRC2016376).
Inclusion criteria	Age range 45 to 75 years; stroke diagnosis via MRI or CT scan; post-stroke duration (1-12 months); no comorbidities (e.g. severe heart disease, liver disease, epilepsy, psychiatric problems, infectious or skin diseases); BRS 1 to 4 of the arm; co-operative; only registered at the mentioned hospital.
Exclusion criteria	Unstable patients; history of peripheral nerve injuries; history of neurosurgical treatments; musculoskeletal deformities from other causes; recurrent stroke; BRS >5 of arm; registered in other hospitals.
Recruitment / selection of participants	People at the affiliated Xuzhou Rehabilitation Hospital of Xuzhou Medical University Hospital in China.
Intervention(s)	Robot assisted arm training N=25 Robot and occupational therapy. 50-70 minutes per day, 5 days a week for 6 weeks. Using the Fourier M2 end-effector machine. Allowed for games with real-time trajectory response, robotic assistance that commences when the muscular force is decreased via an installed tactile response software, four progressive training modes that train people from BRS 1 to 6, namely the passive, active-assistive, active and resistive. Concomitant therapy: Both groups received 30 training sessions lasting 50 minutes per day (for the control group and lower end of the intervention group), 5 days a week for a total of 6 weeks.

Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Mixed
Subgroup 3: Region of upper limb trained	Mixed
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Mixed
Population subgroups	No additional information.
Comparator	Usual care N=25 Training involving self-range of motion and passive stretch exercises for the shoulder, elbow, wrist and thumb joints, and muscles (five sets of repetitions) for the first 10 minutes, then a larger selection of upper limb exercises for the next 40 minutes.

	Concomitant therapy: Both groups received 30 training sessions lasting 50 minutes per day (for the control group and lower end of the intervention group), 5 days a week for a total of 6 weeks.
Number of participants	50
Duration of follow-up	6 weeks
Indirectness	No additional information
Additional comments	No additional information. Appears to be ITT.

Study arms

Robot assisted arm training (N = 25)
Robot and occupational therapy. 50-70 minutes per day, 5 days a week for 6 weeks. Using the Fourier M2 end-effector machine. Allowed for games with real-time trajectory response, robotic assistance that commences when the muscular force is decreased via an installed tactile response software, four progressive training modes that train people from BRS 1 to 6, namely the passive, active-assistive, active and resistive. Concomitant therapy: Both groups received 30 training sessions lasting 50 minutes per day (for the control group and lower end of the intervention group), 5 days a week for a total of 6 weeks.

Usual care (N = 25)
Training involving self-range of motion and passive stretch exercises for the shoulder, elbow, wrist and thumb joints, and muscles (five sets of repetitions) for the first 10 minutes, then a larger selection of upper limb exercises for the next 40 minutes. Concomitant therapy: Both groups received 30 training sessions lasting 50 minutes per day (for the control group and lower end of the intervention group), 5 days a week for a total of 6 weeks.

Characteristics

Arm-level characteristics

Characteristic	Robot assisted arm training (N = 25)	Usual care (N = 25)
% Female Sample size	n = NR ; % = NR	n = NR ; % = NR
Mean age (SD) (years) Mean (SD)	57.25 (9.23)	57.72 (7.37)
Ethnicity Sample size	n = NR ; % = NR	n = NR ; % = NR
Comorbidities Sample size	n = NR ; % = NR	n = NR ; % = NR
Severity Sample size	n = NR ; % = NR	n = NR ; % = NR
Time after stroke Mean (SD)	NR (NR)	NR (NR)

Outcomes

Study timepoints

- Baseline
- 6 week (Post-intervention)

Continuous outcomes

Outcome	Robot assisted arm training, Baseline, N = 20	Robot assisted arm training, 6 week, N = 20	Usual care, Baseline, N = 25	Usual care, 6 week, N = 25
Activities of daily living (barthel index) Scale range: 0-100. Change scores. Mean (SD)	31.8 (10.7)	40 (9.9)	38 (15.2)	10.2 (3.9)
Arm function (Fugl Meyer Assessment Upper Extremity Total score) Scale range: 0-66. Change scores. Mean (SD)	8.9 (7.4)	34 (10.3)	23 (12.2)	12.3 (5.4)

Activities of daily living (barthel index) - Polarity - Higher values are better
Arm function (Fugl Meyer Assessment Upper Extremity Total score) - Polarity - Higher values are better

Dichotomous outcomes

Outcome	Robot assisted arm training, Baseline, N = 25	Robot assisted arm training, 6 week, N = 25	Usual care, Baseline, N = 25	Usual care, 6 week, N = 25
Withdrawal for any reason 5 people did not receive the intervention. 3 withdrew for financial issues. 2 discontinued treatment (discharged). No of events	n = NA ; % = NA	n = 10 ; % = 40	n = NA ; % = NA	n = 0 ; % = 0
Adverse events - Other reported adverse events No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Withdrawal for any reason - Polarity - Lower values are better
Adverse events - Other reported adverse events - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Activitiesofdailyliving(barthelindex)-MeanSD-Robot assisted arm training-Usual care-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(FuglMeyerAssessmentUpperExtremityTotalscore)-MeanSD-Robot assisted arm training-Usual care-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot assisted arm training-Usual care-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Adverseevents-Otherreportedadverseevents-NoOfEvents-Robot assisted arm training-Usual care-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Conroy, 2011

Bibliographic Reference	Conroy, Susan S.; Whitall, Jill; Dipietro, Laura; Jones-Lush, Lauren M.; Zhan, Min; Finley, Margaret A.; Wittenberg, George F.; Krebs, Hermano I.; Bever, Christopher T.; Effect of gravity on robot-assisted motor training after chronic stroke: a randomized trial; Archives of physical medicine and rehabilitation; 2011; vol. 92 (no. 11); 1754-1761

Study details

Secondary publication of another included study- see primary study for details	NR
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear

Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months) > 6 months for ischaemic stroke, > 12 months for haemorrhagic stroke.
Subgroup 3: Region of upper limb trained	Not stated/unclear
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Not stated/unclear
Subgroup 8: Type of movement delivered by robotic device	Active assisted movement

Study arms

Robot assisted therapy (N = 41)
Group A received robot-assisted planar reaching tasks with the InMotion 2.0 shoulder/ arm over 6 weeks, 3 sessions per week for 1 hour. Group B received robot-assisted planar and vertical reaching tasks with the InMotion Linear Robot over the same time and frequency. The results of the planar group (A) and the planar and vertical group (B) were combined.

Intensive conventional arm exercise (N = 21)
Participants received intensive conventional arm exercise.

Outcomes

Study timepoints

- Baseline
- 6 week (Post-intervention)
- 12 week (Post-intervention)

Continuous outcome

Outcome	Robot assisted therapy, Baseline, N = 41	Robot assisted therapy, 6 week, N = 41	Robot assisted therapy, 12 week, N = 41	Intensive conventional arm exercise, Baseline, N = 21	Intensive conventional arm exercise, 6 week, N = 21	Intensive conventional arm exercise, 12 week, N = 21
Arm function (Fugi-Meyer assesment) Scale range: 0-66. Change scores. Values reported in the Cochrane review used. Mean (SE)	18.5 (2.13)	2.32 (0.53)	2.97 (0.55)	18.2 (2.73)	1.19 (0.78)	1.82 (0.78)
Stroke-specific Patient-Reported Outcome Measures (Stroke Impact Scale) Scale range: 0-100. Change scores. Values reported in the Cochrane review used.	71.97 (11.25)	3.98 (1.87)	1.09 (1.94)	71.4 (3.1)	-3.19 (2.46)	-2.6 (2.54)

Outcome	Robot assisted therapy, Baseline, N = 41	Robot assisted therapy, 6 week, N = 41	Robot assisted therapy, 12 week, N = 41	Intensive conventional arm exercise, Baseline, N = 21	Intensive conventional arm exercise, 6 week, N = 21	Intensive conventional arm exercise, 12 week, N = 21
Mean (SE)						

Arm function (Fugi-Meyer assesment) - Polarity - Higher values are better
Stroke-specific Patient-Reported Outcome Measures (Stroke Impact Scale) - Polarity - Higher values are better
FMA outcome (change scores) Baseline: (mean plus SD): planar group: 20.3 (14.7), planar with vertical group: 16.5 (10.6) Post-intervention (6 weeks): (mean plus SE): planar group: 2.94 (0.77), planar with vertical group: 1.70 (0.80) Post-intervention (12 weeks): (mean plus SE): planar group: 3.30 (0.80), planar with vertical group: 2.61 (0.81) ADL outcome (change scores) Baseline: (mean plus SD): planar group: 73.2 (15.7), planar with vertical group: 70.6 (14.4) Post-intervention (6 weeks): (mean plus SE): planar group: 1.92 (2.74), planar with vertical group: 5.95 (2.74) Post-intervention (12 weeks): (mean plus SE): planar group: 3.29 (2.80), planar with vertical group: -1.35 (2.78) Also reports WMFT outcome.

Dichotomous outcome

Outcome	Robot assisted therapy, Baseline, N = 41	Robot assisted therapy, 6 week, N = 41	Robot assisted therapy, 12 week, N = 41	Intensive conventional arm exercise, Baseline, N = 21	Intensive conventional arm exercise, 6 week, N = 21	Intensive conventional arm exercise, 12 week, N = 21
Withdrawal for any reason 6 weeks: robot group: 5 (1 hospitalisation, 1 social issues, 2 non-compliance, 1 study ended), conventional therapy group: 1 shoulder pain, 1 non-compliance. 12 weeks: robot group: 3 (2 hospitalisation, 1 moved). Conventional therapy group: 0 No of events	n = NA ; % = NA	n = 5 ; % = 12.2	n = 3 ; % = 7	n = NA ; % = NA	n = 2 ; % = 9.52	n = 0 ; % = 0

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcome-Armfunction(Fugi-Meyerassesment)-MeanSE-Robot assisted therapy-Intensive conventional arm exercise-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcome-Armfunction(Fugi-Meyerassesment)-MeanSE-Robot assisted therapy-Intensive conventional arm exercise-t12

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot assisted therapy-Intensive conventional arm exercise-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot assisted therapy-Intensive conventional arm exercise-t12

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Continuousoutcome-Stroke-specificPatient-ReportedOutcomeMeasures(StrokeImpactScale)-MeanSE-Robot assisted therapy-Intensive conventional arm exercise-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcome-Stroke-specificPatient-ReportedOutcomeMeasures(StrokeImpactScale)-MeanSE-Robot assisted therapy-Intensive conventional arm exercise-t12

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Coote, 2003

Bibliographic Reference	Coote, S.; Stokes, E. K.; The effect of robot mediated therapy on upper extremity function following stroke-initial results; Irish Journal of Medical Science; 2003; vol. 172 (no. 2); 26-7

Study details

Secondary publication of another included study- see primary study for details	Amirabdollahian et a. Multivariate analysis of the Fugl-Meyer outcome measures assessing the effectiveness of GENTLE/S robot-mediated stroke therapy Journal of neuroengineering and rehabilitation; 2007; vol. 4 (no. 1); 1-16
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review. Coote S, Murphy BT, Stokes EK. The effect of robot mediated therapy on upper extremity function post stroke. 14th International Congress of the World Confederation for Physical Therapy; 2003; Barcelona, Spain. World Confederation for Physical Therapy, 2003.

Coote et al.

Bibliographic Reference	Coote, S.; Stokes, E. K.; Murphy, B. T.; Harwin, W.; The effect of GENTLE/s robot mediated therapy on upper extremity function post stroke; 59-61

Study details

Secondary publication of another included study- see primary study for details	Amirabdollahian et al. Multivariate analysis of the Fugl-Meyer outcome measures assessing the effectiveness of GENTLE/S robot-mediated stroke therapy. Journal of neuroengineering and rehabilitation; 2007; vol. 4 (no. 1); 1-16
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review. Coote S, Stokes EK. The effect of robot mediated therapy on upper extremity function following stroke - initial results. *Irish Journal of Medical Science* 2003;172(2):26-7.

Coskunsu, 2022

Bibliographic Reference	Coskunsu, DK; Akcay, S; Ogul, OE; Akyol, DK; Ozturk, N; Zileli, F; Tuzun, BB; Krespi, Y; Effects of robotic rehabilitation on recovery of hand functions in acute stroke: a preliminary randomized controlled study; Acta neurologica Scandinavica; 2022; 499-511

Study details

Secondary publication of another included	No additional information.

study- see primary study for details	
Other publications associated with this study included in review	No additional information.
Trial name / registration number	NCT03571529
Study type	Randomised controlled trial (RCT)
Study location	Turkey
Study setting	Inpatients in Istanbul Aydın University Medicalpark Florya Hospital
Study dates	No additional information
Sources of funding	Supported by the Rehab Robotic Company.
Inclusion criteria	First ischemic stroke within 4 weeks after onset; being 18 and older; having sitting balance and being able to maintain at least an hour; Montreal Cognitive Assessment Scale 46 score more than 21; visible or palpable contraction (MMT ≥1) in the finger flexor and/or extensor muscles of the hand; full range of motion in MCP, PIP and DIP joints; Modified Ashworth Scale (MAS) ≤ 3 for finger flexors and extensors; willingness to participate in the study.
Exclusion criteria	Other neurologic or orthopedic problems that may affect the upper extremity functions; hemispatial neglect (diagnosed by Line bisection test and The Star Cancellation Test), MAS >3 (constant testing of the spasticity using MAS throughout the rehabilitation)
Recruitment / selection of participants	People admitted to Istanbul Aydın University Medicalpark Florya Hospital.
Intervention(s)	Robot-assisted arm training N=12 Robot assisted rehabilitation in addition to usual care. Hand of Hope (an EMG-driven exoskeleton) robot device used daily, 5 days/week for 3 consecutive weeks (totally 15 sessions). There were three treatment modes: Continuous Passive Motion (CPM), trigger&go and trigger&maintain. The system also had 3 different options for treatment: hand grasping, hand opening and hand grasping & opening. The patient's hand was placed inside the robot and fixed with velcro. Surface EMG

	electrodes were placed on the ED and FDS muscles according to the user manual of the device. Each robot-assisted training session lasted for approximately 1 h. Each treatment protocol was as follows: Initially treatment started with CPM mode for 10 min for warming up, then hand opening and grasping in the trigger&go or trigger&maintain mode, hand opening in the trigger&go or trigger&maintain mode and hand grasping in the trigger&go or trigger&maintain mode, each 10 min in duration, applied sequentially with 2 min of resting between sequences. Concomitant therapy: Everyone received rehabilitation exercises for 1 hour (30 minutes for the upper extremity, 30 minutes for the lower extremity). These consisted of early Bobath exercises, neurophysiological approaches including combinations of Brunnstrom, Johnstone and PNF exercises and electrical stimulation selected according to the patient's condition.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Mixed

Population subgroups	No additional information.
Comparator	Any other intervention (usual care) N=12 Usual care. Concomitant therapy: Everyone received rehabilitation exercises for 1 hour (30 minutes for the upper extremity, 30 minutes for the lower extremity). These consisted of early Bobath exercises, neurophysiological approaches including combinations of Brunnstrom, Johnstone and PNF exercises and electrical stimulation selected according to the patient's condition.
Number of participants	24
Duration of follow-up	3 weeks
Indirectness	No additional information.
Additional comments	No additional information. Method of analysis unclear, appears to be completers only.

Study arms

Robot-assisted arm training (N = 12)
Robot assisted rehabilitation in addition to usual care. Hand of Hope (an EMG-driven exoskeleton) robot device used daily, 5 days/week for 3 consecutive weeks (totally 15 sessions). There were three treatment modes: Continuous Passive Motion (CPM), trigger&go and trigger&maintain. The system also had 3 different options for treatment: hand grasping, hand opening and hand grasping & opening. The patient's hand was placed inside the robot and fixed with velcro. Surface EMG electrodes were placed on the ED and FDS muscles according to the user manual of the device. Each robot-assisted training session lasted for approximately 1 h. Each treatment protocol was as follows: Initially treatment started with CPM mode for 10 min for warming up, then hand opening and grasping in the trigger&go or trigger&maintain mode, hand opening in the trigger&go or trigger&maintain mode and hand grasping in the trigger&go or trigger&maintain mode, each 10 min in duration, applied sequentially with 2 min of resting between sequences.

Concomitant therapy: Everyone received rehabilitation exercises for 1 hour (30 minutes for the upper extremity, 30 minutes for the lower extremity). These consisted of early Bobath exercises, neurophysiological approaches including combinations of Brunnstrom, Johnstone and PNF exercises and electrical stimulation selected according to the patient's condition.

Any other intervention (usual care) (N = 12)
Usual care. Concomitant therapy: Everyone received rehabilitation exercises for 1 hour (30 minutes for the upper extremity, 30 minutes for the lower extremity). These consisted of early Bobath exercises, neurophysiological approaches including combinations of Brunnstrom, Johnstone and PNF exercises and electrical stimulation selected according to the patient's condition.

Characteristics

Arm-level characteristics

Characteristic	**Robot-assisted arm training (N = 12)**	**Any other intervention (usual care) (N = 12)**
% Female Sample size	n = 7 ; % = 64	n = 2 ; % = 22
Mean age (SD) (years) Mean (SD)	59.9 (14.3)	70 (14)
Ethnicity Sample size	n = NR ; % = NR	n = NR ; % = NR
Comorbidities Sample size	n = NR ; % = NR	n = NR ; % = NR
Severity	n = NR ; % = NR	n = NR ; % = NR

Characteristic	Robot-assisted arm training (N = 12)	Any other intervention (usual care) (N = 12)
Sample size		
Time after stroke Mean (SD)	NR (NR)	NR (NR)

Outcomes

Study timepoints

- Baseline
- 3 week (Post-intervention)

Continuous outcome

Outcome	Robot-assisted arm training, Baseline, N = 11	Robot-assisted arm training, 3 week, N = 11	Any other intervention (usual care), Baseline, N = 9	Any other intervention (usual care), 3 week, N = 9
Arm function (ARAT total score) Scale range: 0-57. Change scores. Mean (SD)	20.27 (21.31)	15.73 (14.41)	12.67 (12.76)	20 (11.61)

Arm function (ARAT total score) - Polarity - Higher values are better

Dichotomous outcome

Outcome	Robot-assisted arm training, Baseline, N = 12	Robot-assisted arm training, 3 week, N = 12	Any other intervention (usual care), Baseline, N = 12	Any other intervention (usual care), 3 week, N = 12
Withdrawal for any reason intervention reasons - (Takeayasu's arteritis). Control - distance, cardiac operation) No of events	n = NA ; % = NA	n = 1 ; % = 8.3	n = NA ; % = NA	n = 3 ; % = 25

Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcome-Physicalfunction-upperlimb(ARATtotalscore)-MeanSD-Robot-assisted arm training-Any other intervention (usual care)-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm training-Any other intervention (usual care)-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Daly, 2005

Bibliographic Reference	Daly, Janis J.; Hogan, Neville; Perepezko, Elizabeth M.; Krebs, Hermano I.; Rogers, Jean M.; Goyal, Kanu S.; Dohring, Mark E.; Fredrickson, Eric; Nethery, Joan; Ruff, Robert L.; Response to upper-limb robotics and functional neuromuscular stimulation following stroke; Journal of rehabilitation research & development; 2005; vol. 42 (no. 6)

Study details

Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	≥1 hour

Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Active assisted movement

Study arms

Robotics and motor training (N = 7)
5 hours per day, 5 days a week for 12 weeks. 1.5 hours per session for robotics shoulder and elbow training.

Functional neuromuscular stimulation and motor training (N = 6)
5 hours per day, 5 days a week for 12 weeks. 1.5 hours per session for functional neuromuscular stimulation.

Outcomes

Study timepoints
- Baseline
- 3 month (Post-intervention)

Continuous outcomes

Outcome	Robotics and motor training, Baseline, N = 7	Robotics and motor training, 3 month, N = 7	Functional neuromuscular stimulation and motor training, Baseline, N = 6	Functional neuromuscular stimulation and motor training, 3 month, N = 6
Arm function (Fugl-Meyer assessment) Scale range: 0-66. Change scores. Values reported in the Cochrane review used. Mean (SD)	NR (NR)	8.2 (7.3)	NR (NR)	9.5 (8)

Arm function (Fugl-Meyer assessment) - Polarity - Higher values are better
Also reports AMAT and motor control outcomes.

Dichotomous outcomes

Outcome	Robotics and motor training, Baseline, N = 7	Robotics and motor training, 3 month, N = 7	Functional neuromuscular stimulation and motor training, Baseline, N = 6	Functional neuromuscular stimulation and motor training, 3 month, N = 6
Withdrawal for any reason Dropped out of the study for personal reasons. No of events	n = NA ; % = NA	n = 1 ; % = 14.3	n = NA ; % = NA	n = 0 ; % = 0
Adverse events No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-MeanSD-Robotics and motor training-Functional neuromuscular stimulation and motor training-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robotics and motor training-Functional neuromuscular stimulation and motor training-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Daly et al.

Bibliographic Reference	Daly, Janis J.; Rogers, Jean; McCabe, Jessica; Monkiewicz, Michelle; Burdsall, Richard; Pundik, Svetlana; Recovery of actual functional tasks in response to motor learning, robotics, and functional electrical stimulation; vol. 41; E355-E356

Study details

Secondary publication of another included	McCabe J, Monkiewicz M, Holcomb J, Pundik S, Daly JJ. Comparison of robotics, functional electrical stimulation, and motor learning methods for treatment of persistent upper extremity dysfunction after stroke: a randomized controlled trial. *Archives of Physical Medicine and Rehabilitation* 2015;96(6):981-90.

study- see primary study for details	
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.

Daunoraviciene, 2018

Bibliographic Reference	Daunoraviciene, K.; Adomaviciene, A.; Grigonyte, A.; Griskevicius, J.; Juocevicius, A.; Effects of robot-assisted training on upper limb functional recovery during the rehabilitation of poststroke patients; Technology & Health Care; 2018; vol. 26 (no. s2); 533-542

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	No additional information.
Trial name / registration number	No additional information.

Study type	Randomised controlled trial (RCT)
Study location	Lithuania
Study setting	Outpatient follow up
Study dates	No additional information.
Sources of funding	No additional information.
Inclusion criteria	Experienced an ischaemic or haemorrhagic stroke; aged 60-74 years old and older; had stroke-affected arm paresis; experienced disturbed deep and superficial sensations and achieved a Mini-Mental Stat test score >21 points.
Exclusion criteria	Stroke-affected arm paralysis; were at less than 60 years old; achieved a MMS test score <21 points; had aphasia; experienced shoulder or wrist pain syndrome; hypertonic stroke-affected arm.
Recruitment / selection of participants	No additional information.
Intervention(s)	Robot-assisted arm training N=17 Armeo Spring training for 30 minutes a day for 10 sessions (5 days a week). Robotic training was administered under the supervision of an occupational therapist who adjusted the patient to their therapy by setting their parameters and therapy conditions. Included a sequence of motor tasks with a short resting phase. Concomitant therapy: Conventional functional rehabilitation for 35-60 minutes/day in approximately 10 occupational therapy sessions (including exercising, physical activities, active table games etc.).
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Not stated/unclear

Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Not stated/unclear
Population subgroups	No additional information
Comparator	Usual care N=17 30 minutes on 5 days a week of conventional functional rehabilitation. Concomitant therapy: Conventional functional rehabilitation for 35-60 minutes/day in approximately 10 occupational therapy sessions (including exercising, physical activities, active table games etc.).
Number of participants	34
Duration of follow-up	2 weeks (post-intervention)
Indirectness	No additional information
Additional comments	No additional information

Study arms

Robot-assisted arm training (N = 17)
Armeo Spring training for 30 minutes a day for 10 sessions (5 days a week). Robotic training was administered under the supervision of an occupational therapist who adjusted the patient to their therapy by setting their parameters and therapy conditions. Included a sequence of motor tasks with a short resting phase. Concomitant therapy: Conventional functional rehabilitation for 35-60 minutes/day in approximately 10 occupational therapy sessions (including exercising, physical activities, active table games etc.).

Usual care (N = 17)
30 minutes on 5 days a week of conventional functional rehabilitation. Concomitant therapy: Conventional functional rehabilitation for 35-60 minutes/day in approximately 10 occupational therapy sessions (including exercising, physical activities, active table games etc.).

Characteristics

Arm-level characteristics

Characteristic	Robot-assisted arm training (N = 17)	Usual care (N = 17)
% Female Sample size	n = 6 ; % = 35	n = 6 ; % = 35
Mean age (SD) (years) Mean (SD)	65.88 (4.87)	65.47 (4.05)
Ethnicity Sample size	n = NR ; % = NR	n = NR ; % = NR
Comorbidities	n = NR ; % = NR	n = NR ; % = NR

Characteristic	Robot-assisted arm training (N = 17)	Usual care (N = 17)
Sample size		
Severity Sample size	n = NR ; % = NR	n = NR ; % = NR
Time after stroke (Weeks) Mean (SD)	8.64 (3.53)	9.65 (6.18)

Outcomes

Study timepoints

- Baseline
- 2 week (Post-intervention)

Continuous outcomes

Outcome	Robot-assisted arm training, Baseline, N = 17	Robot-assisted arm training, 2 week, N = 17	Usual care, Baseline, N = 17	Usual care, 2 week, N = 17
Activities of daily living (modified FIM score) 6 item self-care scale. Scale range: 6-42. final values Mean (SD)	24.41 (5.18)	31.94 (4.39)	25.76 (8.16)	27.76 (7.62)
Arm function (Fugl Meyer Assessment Upper Extremity) Scale range: 0-66. final values Mean (SD)	32.18 (16.53)	45.17 (18.48)	32.06 (16.18)	41.76 (15.41)

Outcome	Robot-assisted arm training, Baseline, N = 17	Robot-assisted arm training, 2 week, N = 17	Usual care, Baseline, N = 17	Usual care, 2 week, N = 17
Spasticity (modified Ashworth scale) Scale range: 0-5. Final values. Individual patient data provided which was converted to continuous data (shoulder, elbow and wrist values combined). Mean (SD)	0.45 (0.86)	0.59 (0.97)	0.47 (0.78)	0.85 (1.1)

Activities of daily living (modified FIM score) - Polarity - Higher values are better
Arm function (Fugl Meyer Assessment Upper Extremity) - Polarity - Higher values are better
Spasticity (modified Ashworth scale) - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Activitiesofdailyliving(modifiedFIMscore)-MeanSD-Robot-assisted arm training-Usual care-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(FuglMeyerAssessmentUpperExtremity)-MeanSD-Robot-assisted arm training-Usual care-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(modifiedAshworthscale)-MeanSD-Robot-assisted arm training-Usual care-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dehem, 2019

Bibliographic Reference	Dehem, S.; Gilliaux, M.; Stoquart, G.; Detrembleur, C.; Jacquemin, G.; Palumbo, S.; Frederick, A.; Lejeune, T.; Effectiveness of upper-limb robotic-assisted therapy in the early rehabilitation phase after stroke: A single-blind, randomised, controlled trial; Annals of Physical & Rehabilitation Medicine; 2019; vol. 62 (no. 5); 313-320

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with	No additional information.

this study included in review	
Trial name / registration number	Clinicaltrials.gov = NCT02079779
Study type	Randomised controlled trial (RCT)
Study location	Belgium
Study setting	Three Belgian inpatient rehabilitation centres: Cliniques universitaries Saint-Luc (Brussels), Centre Hospitalier Valida (Brussels) and Centre Hospitalier Neurologique William Lennox (Ottignies).
Study dates	May 2014 to May 2017
Sources of funding	This work was supported by the Region Wallone, the Fondation Motrice and the Fondation Saint-Luc. The authors thank Axinesis (Wavre, Belgium) for development of the robot REAplan and Fishing Cactus (Mons, Belgium) for development of the game.
Inclusion criteria	Single first ischaemic or haemorrhagic stroke; <1 month delay since stroke; age at least 18 years old; Mini-Mental State Examination score at least 15; the ability to understand instructions; FMA-Upper Extremity score <80%, assessed by the computerized adaptive testing system (a higher score indicating less upper limb motor impairments); a health status allowing for rehabilitation.
Exclusion criteria	Stroke located in the brain stem or cerebellum or another orthopaedic or neurological disease altering the paretic upper limb function.
Recruitment / selection of participants	People recruited from three inpatient rehabilitation centres.
Intervention(s)	Robot-assisted arm training N=23 REAplan(R) robot arm therapy. 45 minutes sessions supervised by a therapist. 4 sessions of conventional therapy per week was replaced and was completed for 9 weeks in total. The exercises were similar in each centre and consisted of a game, involving moving the paretic hand along a reference trajectory while passing through checkpoints (for example: golf paths and golf balls). During the game the robot guided participants with assistance as needed.

	Concomitant therapy: Both groups underwent their rehabilitation sessions during their hospitalisation with their regular physical therapists and occupational therapists.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Active assisted movement
Population subgroups	No additional information
Comparator	Usual care N=22 Conventional therapy focused on motor rehabilitation, matched with their personal needs and centre's means.

	Concomitant therapy: Both groups underwent their rehabilitation sessions during their hospitalisation with their regular physical therapists and occupational therapists.
Number of participants	45
Duration of follow-up	6 months in total (followed up at 9 weeks and 6 months)
Indirectness	No additional information
Additional comments	Method of analysis unclear. Appears to be only completers.

Study arms

Robot-assisted arm training (N = 23)
REAplan(R) robot arm therapy. 45 minutes sessions supervised by a therapist. 4 sessions of conventional therapy per week was replaced and was completed for 9 weeks in total. The exercises were similar in each centre and consisted of a game, involving moving the paretic hand along a reference trajectory while passing through checkpoints (for example: golf paths and golf balls). During the game the robot guided participants with assistance as needed. Concomitant therapy: Both groups underwent their rehabilitation sessions during their hospitalisation with their regular physical therapists and occupational therapists.

Usual care (N = 22)
Conventional therapy focused on motor rehabilitation, matched with their personal needs and centre's means. Concomitant therapy: Both groups underwent their rehabilitation sessions during their hospitalisation with their regular physical therapists and occupational therapists.

Characteristics

Arm-level characteristics

Characteristic	Robot-assisted arm training (N = 23)	Usual care (N = 22)
% Female Sample size	n = 12 ; % = 52	n = 12 ; % = 55
Mean age (SD) (years) Mean (SD)	67.3 (11.1)	68.6 (19.1)
Ethnicity Sample size	n = NA ; % = NA	n = NA ; % = NA
Comorbidities Sample size	n = NA ; % = NA	n = NA ; % = NA
Severity Sample size	n = NA ; % = NA	n = NA ; % = NA
Time after stroke Sample size	n = NA ; % = NA	n = NA ; % = NA

Outcomes

Study timepoints

- Baseline
- 9 week (Post-intervention)
- 6 month (≥6 months)

Continuous outcomes

Outcome	Robot-assisted arm training, Baseline, N = 23	Robot-assisted arm training, 9 week, N = 15	Robot-assisted arm training, 6 month, N = 15	Usual care, Baseline, N = 22	Usual care, 9 week, N = 17	Usual care, 6 month, N = 13
Arm function (Fugl-Meyer assessment- upper extremity) (%) Scale range: 0-100. Final values. Mean (SD)	32.4 (25.4)	51.9 (30.9)	57.1 (33.8)	31.6 (27)	42.4 (32.6)	41.6 (34.5)
Stroke-specific Patient-Reported Outcome Measures (Stroke Impact Scale) (%) Scale range: 0-100 Mean (SD)	36.3 (21.4)	50 (21.4)	59.4 (24.1)	45.2 (26.6)	50.9 (34.7)	47.5 (31.5)

Arm function (Fugl-Meyer assessment- upper extremity) - Polarity - Higher values are better
Stroke-specific Patient-Reported Outcome Measures (Stroke Impact Scale) - Polarity - Higher values are better

Dichotomous outcomes

Outcome	Robot-assisted arm training, Baseline, N = 23	Robot-assisted arm training, 9 week, N = 23	Robot-assisted arm training, 6 month, N = 23	Usual care, Baseline, N = 22	Usual care, 9 week, N = 22	Usual care, 6 month, N = 22
Withdrawal for any reason Robot assisted therapy: 8 dropped out between pre- and post-intervention (3 health worsening, 2 personal choice, 1 shoulder pain, 1 many missing sessions, 1 death). Control: 5	n = NA ; % = NA	n = 8 ; % = 35	n = 8 ; % = 35	n = NA ; % = NA	n = 5 ; % = 23	n = 9 ; % = 41

Outcome	Robot-assisted arm training, Baseline, N = 23	Robot-assisted arm training, 9 week, N = 23	Robot-assisted arm training, 6 month, N = 23	Usual care, Baseline, N = 22	Usual care, 9 week, N = 22	Usual care, 6 month, N = 22
drop out between pre- and post-intervention (3 health worsening, 1 stroke recurrence, 1 discharge without possibility to pursue the protocol. 4 drop-out between post-intervention and 6 months post stroke (2 unreachable, 1 death, 1 personal choice). No of events						
Adverse events - Other reported adverse events Intervention: 1 shoulder pain, 1 death. Control group: 1 stroke recurrent, 1 death between post-intervention and 6 months. No of events	n = NA ; % = NA	n = 2 ; % = 9	n = 2 ; % = 9	n = NA ; % = NA	n = 1 ; % = 5	n = 2 ; % = 9

Withdrawal for any reason - Polarity - Lower values are better
Adverse events - Other reported adverse events - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(Fugl-Meyerassessment-upperextremity)-MeanSD-Robot-assisted arm training-Usual care-t9

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerassessment-upperextremity)-MeanSD-Robot-assisted arm training-Usual care-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Stroke-specificPatient-ReportedOutcomeMeasures(StrokeImpactScale)-MeanSD-Robot-assisted arm training-Usual care-t9

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Stroke-specificPatient-ReportedOutcomeMeasures(StrokeImpactScale)-MeanSD-Robot-assisted arm training-Usual care-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm training-Usual care-t9

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm training-Usual care-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Adverseevents-NoOfEvents-Robot-assisted arm training-Usual care-t9

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Adverseevents-NoOfEvents-Robot-assisted arm training-Usual care-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Fasoli, 2004

Bibliographic Reference	Fasoli, Susan E.; Krebs, Hermano I.; Ferraro, Mark; Hogan, Neville; Volpe, Bruce T.; Does shorter rehabilitation limit potential recovery poststroke?; Neurorehabilitation and neural repair; 2004; vol. 18 (no. 2); 88-94

Study details

Secondary publication of another included study- see primary study for details	Volpe et al. A novel approach to stroke rehabilitation: robot-aided sensorimotor stimulation. Neurology; 2000; vol. 54 (no. 10); 1938-1944
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.

Fazekas, 2007

Bibliographic Reference	Fazekas, Gabor; Horvath, Monika; Troznai, Tibor; Toth, Andras; Robot-mediated upper limb physiotherapy for patients with spastic hemiparesis: a preliminary study; Journal of rehabilitation medicine; 2007; vol. 39 (no. 7); 580-582

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	<1 hour 30 minutes robot therapy, plus 30 minutes Bobath therapy.
Subgroup 5: Dose (days per week)	Not stated/unclear '20 consecutive workdays'.
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Not stated/unclear

Subgroup 8: Type of movement delivered by robotic device	Passive movement

Study arms

Robot therapy (N = 15)
30 minutes of Bobath therapy sessions on 20 consecutive days, plus an additional 30 minutes of robot therapy.

Control group (N = 15)
30 minutes of Bobath therapy sessions on 20 consecutive days.

Outcomes

Study timepoints
- Baseline
- 20 day (Post-intervention.)

Dichotomous outcomes

Outcome	Robot therapy, Baseline, N = 15	Robot therapy, 20 day, N = 15	Control group, Baseline, N = 15	Control group, 20 day, N = 15
Withdrawal for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Outcome	Robot therapy, Baseline, N = 15	Robot therapy, 20 day, N = 15	Control group, Baseline, N = 15	Control group, 20 day, N = 15
Adverse events No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Continuous outcomes

Outcome	Robot therapy, Baseline, N = 15	Robot therapy, 20 day, N = 15	Control group, Baseline, N = 15	Control group, 20 day, N = 15
Activities of daiy living (FIM self-care) Change scores. Score range 6-42. Values as reported in Cochrane review. Mean (SD)	NR (NR)	12.07 (9.26)	NR (NR)	25.53 (14.32)
Arm function (Fugl-Meyer shoulder-elbow subsection) Change scores. Score range 0-36. Values as reported in Cochrane review. Mean (SD)	NR (NR)	5.53 (1.38)	NR (NR)	2.6 (1.77)
Spasticity (Modified Ashworth of shoulder adductors) Change scores. Score range 0-5. Reported mean final values and p value for the change from baseline. Mean (SD)	NA (NA)	NA (NA)	NA (NA)	NA (NA)
Spasticity (Modified Ashworth of shoulder adductors) Change scores. Score range 0-5. Reported mean final values and p value for the change from baseline. Mean (p value)	NA (NA)	NA (NA)	NA (NA)	NA (NA)

Outcome	Robot therapy, Baseline, N = 15	Robot therapy, 20 day, N = 15	Control group, Baseline, N = 15	Control group, 20 day, N = 15
Modified Ashworth of shoulder adductors Mean (SD)	NA (NA)	NA (NA)	NA (NA)	NA (NA)
Modified Ashworth of shoulder adductors Mean (p value)	1.93 (NR)	-0.73 (0.011)	1.67 (NR)	-0.2 (0.56)
Modified Ashworth of elbow flexors Mean (SD)	NA (NA)	NA (NA)	NA (NA)	NA (NA)
Modified Ashworth of elbow flexors Mean (p value)	2.87 (NR)	-0.74 (0.021)	2.13 (NR)	0 (0.71)

Activities of daiy living (FIM self-care) - Polarity - Higher values are better
Arm function (Fugl-Meyer shoulder-elbow subsection) - Polarity - Higher values are better
Spasticity (Modified Ashworth of shoulder adductors) - Polarity - Lower values are better
Also reports Rivermead arm score, ROM (range of motion) scores.

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Dichotmousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot therapy-Control group-t20

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Adverseevents-NoOfEvents-Robot therapy-Control group-t20

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Activitiesofdaiyliving(FIMself-care)-MeanSD-Robot therapy-Control group-t20

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyershoulder-elbowsubsection)-MeanSD-Robot therapy-Control group-t20

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(ModifiedAshworthofshoulderadductors)-ModifiedAshworthofshoulderadductors-MeanSD-Robot therapy-Control group-t20

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(ModifiedAshworthofshoulderadductors)-ModifiedAshworthofelbowflexors-MeanSD-Robot therapy-Control group-t20

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Fernandez-Garcia, 2021

Bibliographic Reference	Fernandez-Garcia, C.; Ternent, L.; Homer, T. M.; Rodgers, H.; Bosomworth, H.; Shaw, L.; Aird, L.; Andole, S.; Cohen, D.; Dawson, J.; Finch, T.; Ford, G.; Francis, R.; Hogg, S.; Hughes, N.; Krebs, H. I.; Price, C.; Turner, D.; Van Wijck, F.; Wilkes, S.; Wilson, N.; Vale, L.; Economic evaluation of robot-assisted training versus an enhanced upper limb therapy programme or usual care for patients with moderate or severe upper limb functional limitation due to stroke: results from the RATULS randomised controlled trial; BMJ Open; 2021; vol. 11 (no. 5); e042081

Study details

Secondary publication of	Rodgers H, Bosomworth H, Krebs HI, van Wijck F, Howel D, Wilson N, Aird L, Alvarado N, Andole S, Cohen DL, Dawson J, Fernandez-Garcia C, Finch T, Ford GA, Francis R, Hogg S, Hughes N, Price CI, Ternent L, Turner DL, Vale L, Wilkes S,

another included study- see primary study for details	Shaw L. Robot assisted training for the upper limb after stroke (RATULS): a multicentre randomised controlled trial. Lancet. 2019 Jul 6;394(10192):51-62. doi: 10.1016/S0140-6736(19)31055-4. Epub 2019 May 22. PMID: 31128926; PMCID: PMC6620612.
Other publications associated with this study included in review	Rodgers H, Bosomworth H, Krebs HI, van Wijck F, Howel D, Wilson N, Finch T, Alvarado N, Ternent L, Fernandez-Garcia C, Aird L, Andole S, Cohen DL, Dawson J, Ford GA, Francis R, Hogg S, Hughes N, Price CI, Turner DL, Vale L, Wilkes S, Shaw L. Robot-assisted training compared with an enhanced upper limb therapy programme and with usual care for upper limb functional limitation after stroke: the RATULS three-group RCT. Health Technol Assess. 2020 Oct;24(54):1-232. doi: 10.3310/hta24540. PMID: 33140719; PMCID: PMC7682262.

Franceschini, 2020

Bibliographic Reference	Franceschini, M.; Mazzoleni, S.; Goffredo, M.; Pournajaf, S.; Galafate, D.; Criscuolo, S.; Agosti, M.; Posteraro, F.; Upper limb robot-assisted rehabilitation versus physical therapy on subacute stroke patients: A follow-up study; Journal of Bodywork & Movement Therapies; 2020; vol. 24 (no. 1); 194-198

Study details

Secondary publication of another included study- see primary study for details	Sale et al. Effects of upper limb robot-assisted therapy on motor recovery in subacute stroke patients. J Neuroeng Rehabil. 2014; 11: 104.

Frisoli, 2022

Bibliographic Reference	Frisoli, A; Barsotti, M; Sotgiu, E; Lamola, G; Procopio, C; Chisari, C; A randomized clinical control study on the efficacy of three-dimensional upper limb robotic exoskeleton training in chronic stroke; Journal of neuroengineering and rehabilitation; 2022; vol. 19 (no. 1); 14

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	No additional information.
Trial name / registration number	NCT03319992
Study type	Randomised controlled trial (RCT)
Study location	Italy.
Study setting	Outpatient follow up.
Study dates	No additional information.
Sources of funding	Partially funded by SKILLS EU FP7 project. Dr Barsotti is funded by an "Cassa di Risparmio of Florence" Postgraduate Fellowship.
Inclusion criteria	Age ranged between 30 and 80 years; diagnosis of a first-ever left hemisphere ischaemic or haemorrhagic stroke at least 6 months prior to entry into the study; minimum ability for shoulder humeral elevation; upper-extremity motor function FMA score at least 15 (out of 66); absence of neurological or muscular disorders that interfere with neuromuscular function;

	absence of severe cognitive deficits that would limit patients' ability to complete the study; minimum score of 2 in the Modified Ashworth Scale.
Exclusion criteria	Participating in any experimental rehabilitation or drug studies at the same time; previous experience with robotic treatments.
Recruitment / selection of participants	People were recruited from the pool of outpatients of the Neurorehabilitation Unit of the University Hospital of Pisa.
Intervention(s)	Robot-assisted arm therapy N=13 L-EXOS robotic exoskeleton with a virtual reality rehabilitation exercise program for 3 weekly sessions of 45 minutes each over 6 weeks. People were set in front of a 46 inches LCD screen placed at least 1m away wearing stereoscopic glasses and the robot placed on their right (impaired) upper limb. People using a wheel chair had their arm rest removed to not interfere with the robot. The robot was used for reaching and manipulation exercises that required visuo-motor coordination. The robot provided active assistance to movement. Concomitant therapy: No additional information.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Mixed
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	<5 days per week

Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Active assisted movement
Population subgroups	No additional information.
Comparator	Any other intervention N=13 Manual rehabilitation including passive movement, goal directed movement and voluntary action for the same time period as the intervention group. Concomitant therapy: No additional information.
Number of participants	26
Duration of follow-up	6 weeks (end of intervention).
Indirectness	No additional information.
Additional comments	Method of analysis unclear (appears to be completers only).

Study arms

Robot-assisted arm therapy (N = 13)
L-EXOS robotic exoskeleton with a virtual reality rehabilitation exercise program for 3 weekly sessions of 45 minutes each over 6 weeks. People were set in front of a 46 inches LCD screen placed at least 1m away wearing stereoscopic glasses and the robot placed on their right (impaired) upper limb. People using a wheel chair had their arm rest removed to not interfere with the robot. The robot was used for reaching and manipulation exercises that required visuo-motor coordination. The robot provided active assistance to movement. Concomitant therapy: No additional information.

Any other intervention (N = 13)
Manual rehabilitation including passive movement, goal directed movement and voluntary action for the same time period as the intervention group. Concomitant therapy: No additional information.

Characteristics

Arm-level characteristics

Characteristic	Robot-assisted arm therapy (N = 13)	Any other intervention (N = 13)
% Female Sample size	n = 4 ; % = 36	n = 3 ; % = 27
Mean age (SD) (years) Mean (SD)	62 (12)	70 (11)
Ethnicity Sample size	n = NR ; % = NR	n = NR ; % = NR
Comorbidities	n = NR ; % = NR	n = NR ; % = NR

Characteristic	Robot-assisted arm therapy (N = 13)	Any other intervention (N = 13)
Sample size		
Severity Sample size	n = NR ; % = NR	n = NR ; % = NR
Time after stroke (Months) Mean (SD)	30 (20)	37 (24)

Reports baseline characteristics for only 11 people in each study arm.

Outcomes

Study timepoints

- Baseline
- 6 week (End of intervention)

Continuous outcomes

Outcome	Robot-assisted arm therapy, Baseline, N = 11	Robot-assisted arm therapy, 6 week, N = 11	Any other intervention, Baseline, N = 11	Any other intervention, 6 week, N = 11
Arm function (Fugl-Meyer assessment- upper extremity) Scale range: 0-66. Change scores. Mean (SD)	25.6 (12.3)	11.1 (13.9)	26.7 (16.3)	8.9 (17.6)
Spasticity (modified Ashworth scale)	17.1 (11.5)	1.5 (13.7)	20.6 (9.8)	1.4 (11.5)

Outcome	Robot-assisted arm therapy, Baseline, N = 11	Robot-assisted arm therapy, 6 week, N = 11	Any other intervention, Baseline, N = 11	Any other intervention, 6 week, N = 11
Scale range: unclear. Change scores. Mean (SD)				

Arm function (Fugl-Meyer assessment- upper extremity) - Polarity - Higher values are better
Spasticity (modified Ashworth scale) - Polarity - Lower values are better

Dichotomous outcome

Outcome	Robot-assisted arm therapy, Baseline, N = 13	Robot-assisted arm therapy, 6 week, N = 13	Any other intervention, Baseline, N = 13	Any other intervention, 6 week, N = 13
Withdrawal for any reason Intervention: medical reason unrelated to the study (2), Control: psychological reasons (1), did not come at final evaluation (1) No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(Fugl-Meyerassessment-upperextremity)-MeanSD-Robot-assisted arm therapy-Any other intervention-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(modifiedAshworthscale)-MeanSD-Robot-assisted arm therapy-Any other intervention-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm therapy-Any other intervention-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Gandolfi, 2019

Bibliographic Reference	Gandolfi, M.; Vale, N.; Dimitrova, E. K.; Mazzoleni, S.; Battini, E.; Filippetti, M.; Picelli, A.; Santamato, A.; Gravina, M.; Saltuari, L.; Smania, N.; Effectiveness of Robot-Assisted Upper Limb Training on Spasticity, Function and Muscle Activity in Chronic

Stroke Patients Treated With Botulinum Toxin: A Randomized Single-Blinded Controlled Trial; Frontiers in neurology [electronic resource].; 2019; vol. 10; 41

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	No additional information.
Trial name / registration number	Clinicaltrials.gov = NCT03590314
Study type	Randomised controlled trial (RCT)
Study location	Italy.
Study setting	People referred to the Neurorehabilitation Unit (AOUI Verona) and the Physical Medicine and Rehabilitation Section, "OORR" Hospital (University of Foggia).
Study dates	February 2017 to April 2018.
Sources of funding	No additional information.
Inclusion criteria	Age >18 years; diagnosis of ischaemic or haemorrhagic first-ever stroke as documented by a computerized tomography scan or magnetic resonance imaging; at least 6 months since stroke; Modified Ashworth Scale score (shoulder and elbow) no more than 3 and at least 1+; botulinum toxin injection within the previous 12 weeks of at least one of the muscles of the affected upper limb; Mini-Mental State Examination score at least 24; Trunk Control Test score = 100/100.
Exclusion criteria	Any rehabilitation intervention in the 3 months before recruitment; bilateral cerebrovascular lesion; severe neuropsychologic impairment (global aphasia, severe attention deficit or neglect); joint orthopedic disorders.

Recruitment / selection of participants	Chronic post-stroke patients with upper-limb spasticity referred tot eh Neurorehabilitation Unit (AOUI Verona) and the Physical Medicine and Rehabilitation Section, "OORR" Hospital (University of Foggia).
Intervention(s)	Robot-assisted arm training N=16 Robot-assisted upper limb training and botulinum toxin A treatment (onabotulinum toxin A, abobotulinum toxin A or incobotulinumtoxin A). Robot-assisted upper limb training with an Armotion device. Could provide passive, active, passive-active, perturbative and assistive modes. The robot-assisted upper limb training consisted of passive mobilisation and stretching exercises for the affected upper limb (10 minutes) followed by robot-assisted exercises (35 minutes). 2 sessions per week for 5 consecutive weeks. Four types of exercises contained within the Armotion software and amount of repetitions were selected. All exercises were oriented to achieving several goals in various directions, emphasizing the elbow flexion-extension and reaching movement. The robot allows participants to execute the exercises through an "assisted as needed" control strategy. The difficulty was increased over time by varying the assisted and non-assisted modality and increasing the number of repetitions. Concomitant therapy: All people received botulinum toxin A treatment. The dose, volume and number of injection sites were set according to the severity of spasticity.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Mixed
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	<5 days per week

Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Mixed
Population subgroups	No additional information
Comparator	Conventional training N=16 Conventional training and botulinum toxin A treatment. Conventional training consisting of upper limb passive mobilisation and stretching (10 minutes) followed by upper limb exercises (35 minutes) that incorporated single or multi-joint movements for the scapula, shoulder and elbow, performed in different positions (i.e. supine and standing position). 2 sessions per week for 5 consecutive weeks. The increase in difficulty and progression were obtained by increasing range of motion, repetitions and performing movements against gravity or slight resistance. Concomitant therapy: All people received botulinum toxin A treatment. The dose, volume and number of injection sites were set according to the severity of spasticity.
Number of participants	32
Duration of follow-up	5 weeks (end of intervention)
Indirectness	No additional information
Additional comments	Intention to treat

Study arms

Robot-assisted arm training (N = 16)
Robot-assisted upper limb training and botulinum toxin A treatment (onabotulinum toxin A, abobotulinum toxin A or incobotulinumtoxin A). Robot-assisted upper limb training with an Armotion device. Could provide passive, active, passive-active, perturbative and assistive modes. The robot-assisted upper limb training consisted of passive mobilisation and stretching exercises for the affected upper limb (10 minutes) followed by robot-assisted exercises (35 minutes). 2 sessions per week for 5 consecutive weeks. Four types of exercises contained within the Armotion software and amount of repetitions were selected. All exercises were oriented to achieving several goals in various directions, emphasizing the elbow flexion-extension and reaching movement. The robot allows participants to execute the exercises through an "assisted as needed" control strategy. The difficulty was increased over time by varying the assisted and non-assisted modality and increasing the number of repetitions. Concomitant therapy: All people received botulinum toxin A treatment. The dose, volume and number of injection sites were set according to the severity of spasticity.

Conventional training (N = 16)
Conventional training and botulinum toxin A treatment. Conventional training consisting of upper limb passive mobilisation and stretching (10 minutes) followed by upper limb exercises (35 minutes) that incorporated single or multi-joint movements for the scapula, shoulder and elbow, performed in different positions (i.e. supine and standing position). 2 sessions per week for 5 consecutive weeks. The increase in difficulty and progression were obtained by increasing range of motion, repetitions and performing movements against gravity or slight resistance. Concomitant therapy: All people received botulinum toxin A treatment. The dose, volume and number of injection sites were set according to the severity of spasticity.

Characteristics

Arm-level characteristics

Characteristic	Robot-assisted arm training (N = 16)	Conventional training (N = 16)
% Female Sample size	n = 4 ; % = 25	n = 6 ; % = 38

Characteristic	Robot-assisted arm training (N = 16)	Conventional training (N = 16)
Mean age (SD) (years) Mean (SD)	59.31 (14.4)	59.13 (14.97)
Ethnicity Sample size	n = NR ; % = NR	n = NR ; % = NR
Comorbidities Sample size	n = NR ; % = NR	n = NR ; % = NR
Severity Sample size	n = NR ; % = NR	n = NR ; % = NR
Time after stroke (years) Mean (SD)	6 (3.1)	5.1 (2.2)

Outcomes

Study timepoints

- Baseline
- 5 week (Post-intervention)

Continuous outcomes

Outcome	Robot-assisted arm training, Baseline, N = 16	Robot-assisted arm training, 5 week, N = 16	Conventional training, Baseline, N = 16	Conventional training, 5 week, N = 16
Arm function (Fugl-Meyer assessment) Scale range: 0-66. Change scores. Mean (95% CI)	NA (NA to NA)	3.62 (1.77 to 5.48)	NA (NA to NA)	6.56 (3.75 to 9.36)
Arm function (Fugl-Meyer assessment) Scale range: 0-66. Change scores. Mean (SD)	28.75 (11.92)	NA (NR)	27.94 (10.82)	NA (NR)
Arm muscle strength (Medical Research Council scale) Scale range: 0-40. Change scores. Mean (95% CI)	23 (14.37 to 25.25)	3.62 (2.16 to 5.08)	23 (16.12 to 28.37)	0.9 (-0.31 to 2.13)
Spasticity (modified Ashworth scale) Scale range: 0-5. Change scores. Mean (95% CI)	NA (NA to NA)	3.62 (1.77 to 5.48)	NA (NA to NA)	6.56 (3.75 to 9.36)
Spasticity (modified Ashworth scale) Scale range: 0-5. Change scores. Mean (SD)	28.75 (11.92)	NA (NR)	27.94 (10.82)	NA (NR)

Arm function (Fugl-Meyer assessment) - Polarity - Higher values are better
Arm muscle strength (Medical Research Council scale) - Polarity - Higher values are better
Spasticity (modified Ashworth scale) - Polarity - Lower values are better

Dichotomous outcome

Outcome	Robot-assisted arm training, Baseline, N = 16	Robot-assisted arm training, 5 week, N = 16	Conventional training, Baseline, N = 16	Conventional training, 5 week, N = 16
Withdrawal for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-MeanNineFivePercentCI-Robot-assisted arm training-Conventional training-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armmusclestrength(MedicalResearchCouncilscale)-MeanNineFivePercentCI-Robot-assisted arm training-Conventional training-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(modifiedAshworthscale)-MeanNineFivePercentCI-Robot-assisted arm training-Conventional training-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm training-Conventional training-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Grigoras, 2016

Bibliographic Reference	Grigoras, Alexandra Valer; Irimia, Danut Constantin; Poboroniuc, Marian Silviu; Popescu, Cristian Dinu; Testing of a hybrid FES-robot assisted hand motor training program in sub-acute stroke survivors; Advances in Electrical and Computer Engineering; 2016; vol. 16 (no. 4); 89-95

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Mixed mean 19 points FMA upper extremity.
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	Not stated/unclear
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised

Subgroup 8: Type of movement delivered by robotic device	Active assisted movement

Study arms

Robot therapy (N = 13)
With hybrid FES exoskeleton system for hand rehabilitation. 12 sessions of 30 minutes for 2 weeks.

Standard arm therapy (N = 12)
10 sessions of 30 minutes for 2 weeks.

Outcomes

Study timepoints
- Baseline
- 2 week (Post-intervention)

Continuous outcomes

Outcome	Robot therapy, Baseline, N = 13	Robot therapy, 2 week, N = 13	Standard arm therapy, Baseline, N = 12	Standard arm therapy, 2 week, N = 12
Arm function (Fugl-Meyer assessment) Scale range: 0-66. Change scores. Values reported in the Cochrane review used.	NR (NR)	3.23 (0.91)	NR (NR)	3.5 (0.79)

Outcome	Robot therapy, Baseline, N = 13	Robot therapy, 2 week, N = 13	Standard arm therapy, Baseline, N = 12	Standard arm therapy, 2 week, N = 12
Mean (SD)				
Stroke-specific Patient-Reported Outcome Measures (Stroke Impact Scale- hand function section) Scale range: 5-25. Change scores. Values reported in the Cochrane review used. Mean (SD)	NR (NR)	4.3 (0.85)	NR (NR)	3.5 (0.98)

Arm function (Fugl-Meyer assessment) - Polarity - Higher values are better
Stroke-specific Patient-Reported Outcome Measures (Stroke Impact Scale- hand function section) - Polarity - Higher values are better
Also reports BBT, FM score by distal and proximal limb.

Dichotomous outcome

Outcome	Robot therapy, Baseline, N = 13	Robot therapy, 2 week, N = 13	Standard arm therapy, Baseline, N = 12	Standard arm therapy, 2 week, N = 12
Withdrawals for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Dichotomousoutcome-Withdrawalsforanyreason-NoOfEvents-Robot therapy-Standard arm therapy-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-MeanSD-Robot therapy-Standard arm therapy-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Stroke-specificPatient-ReportedOutcomeMeasures(StrokeImpactScale-handfunctionsection)-MeanSD-Robot therapy-Standard arm therapy-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Gueye, 2021

Bibliographic Reference	Gueye, T.; Dedkova, M.; Rogalewicz, V.; Grunerova-Lippertova, M.; Angerova, Y.; Early post-stroke rehabilitation for upper limb motor function using virtual reality and exoskeleton: equally efficient in older patients; Neurologia i Neurochirurgia Polska; 2021; vol. 55 (no. 1); 91-96

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	No additional information.
Trial name / registration number	No additional information.
Study type	Randomised controlled trial (RCT)
Study location	Czech Republic
Study setting	Outpatient follow up
Study dates	January 2015 and June 2019.
Sources of funding	No additional information.
Inclusion criteria	First acute stroke with onset less than 30 days before the start of the therapy; ability to cooperate (as rated by the treating physician) and a post-stroke upper limb function deficit (FMA-UE 6-60 points).
Exclusion criteria	Severe cognitive impairment or severe sensoric aphasia; severe vision impairment diagnosed by an ophthalmologist, and the presence of any other neurological condition. MoCA scores were not used as an exclusion criteria.

Recruitment / selection of participants	People at the Stroke Rehabilitation Unit of the General University Hospital in Prague.
Intervention(s)	Robot-assisted arm therapy N=25 Virtual reality robot-assisted arm therapy using an Armeo Spring device and visual biofeedback from a screen in the form of games, completing different functional tasks as a part of their rehabilitation therapy. 45 minute sessions for 12 sessions over a three week period (4 sessions per week). Concomitant therapy: The programme consists of at least 3-4 hours of activity which includes one hour of physiotherapy twice a day, occupational therapy, therapies using passive or motor splints and moto operated/motor assisted/active movement training and individual or group therapy for speech and cognitive impairment.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Not stated/unclear
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Not stated/unclear

Subgroup 8: Type of movement delivered by robotic device	Not stated/unclear
Population subgroups	No additional information.
Comparator	Usual care N=25 An additional 45 minutes of physiotherapy for 12 sessions over a three week period (4 sessions per week). Concomitant therapy: The programme consists of at least 3-4 hours of activity which includes one hour of physiotherapy twice a day, occupational therapy, therapies using passive or motor splints and moto operated/motor assisted/active movement training and individual or group therapy for speech and cognitive impairment.
Number of participants	50
Duration of follow-up	Three weeks (end of intervention)
Indirectness	No additional information
Additional comments	No information on method of analysis. Appears to be completers only.

Study arms

Robot-assisted arm therapy (N = 25)
Virtual reality robot-assisted arm therapy using an Armeo Spring device and visual biofeedback from a screen in the form of games, completing different functional tasks as a part of their rehabilitation therapy. 45 minute sessions for 12 sessions over a three week period (4 sessions per week). Concomitant therapy: The programme consists of at least 3-4 hours of activity which includes one hour

of physiotherapy twice a day, occupational therapy, therapies using passive or motor splints and moto operated/motor assisted/active movement training and individual or group therapy for speech and cognitive impairment.

Usual care (N = 25)
An additional 45 minutes of physiotherapy for 12 sessions over a three week period (4 sessions per week). Concomitant therapy: The programme consists of at least 3-4 hours of activity which includes one hour of physiotherapy twice a day, occupational therapy, therapies using passive or motor splints and moto operated/motor assisted/active movement training and individual or group therapy for speech and cognitive impairment.

Characteristics

Arm-level characteristics

Characteristic	**Robot-assisted arm therapy (N = 25)**	**Usual care (N = 25)**
% Female Sample size	n = 11 ; % = 44	n = 10 ; % = 40
Mean age (SD) (years) Mean (SD)	66.56 (12.26)	68.12 (11.97)
Ethnicity Sample size	n = NR ; % = NR	n = NR ; % = NR
Comorbidities Sample size	n = NR ; % = NR	n = NR ; % = NR
Severity	n = NR ; % = NR	n = NR ; % = NR

Characteristic	Robot-assisted arm therapy (N = 25)	Usual care (N = 25)
Sample size		
Time after stroke (days) Mean (SD)	14.88 (6.45)	16.4 (7.25)

Outcomes

Study timepoints

- Baseline
- 3 week (Post-intervention)

Continuous outcomes

Outcome	Robot-assisted arm therapy, Baseline, N = 25	Robot-assisted arm therapy, 3 week, N = 25	Usual care, Baseline, N = 25	Usual care, 3 week, N = 25
Activities of daily living (functional independence measure) Scale range: 0-126. Final values. Mean (SD)	89 (14.35)	110.8 (8.17)	82.8 (19.92)	104.9 (15.49)
Arm function (Fugl-Meyer assessment- upper extremity) Scale range: 0-66. Final values. Mean (SD)	39 (14.54)	54.5 (10.06)	45.2 (15.52)	54.2 (13.93)

Activities of daily living (functional independence measure) - Polarity - Higher values are better
Arm function (Fugl-Meyer assessment- upper extremity) - Polarity - Higher values are better

Dichotomous outcome

Outcome	Robot-assisted arm therapy, Baseline, N = 25	Robot-assisted arm therapy, 3 week, N = 25	Usual care, Baseline, N = 25	Usual care, 3 week, N = 25
Withdrawal for any reason 1 drop out from each study arm due to health problems unrelated to the intervention No of events	n = NA ; % = NA	n = 1 ; % = 4	n = NA ; % = NA	n = 1 ; % = 4

Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Activitiesofdailyliving(functionalindependencemeasure)-MeanSD-Robot-assisted arm therapy-Usual care-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerassessment-upperextremity)-MeanSD-Robot-assisted arm therapy-Usual care-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm therapy-Usual care-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Helbok, 2010

Bibliographic Reference	Helbok, R.; Schoenherr, G.; Spiegel, M.; Sojer, M.; Brenneis, C.; Robot-assisted hand training (Amadeo) compared with conventional physiotherapy techniques in chronic ischemic stroke patients: a pilot study; DGNR Bremen, Nov; 2010

Study details

Secondary publication of another included study- see primary study for details	Helbok R. Robot-assisted hand training (AMADEO) compared with conventional physiotherapy techniques in chronic ischemic stroke patients: a pilot study. *Neurologie und Rehabilitation*. 6. Innsbruck, Austria: Hippocampus Verlag, 2010:281.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.

Hesse, 2014

Bibliographic Reference	Hesse, Stefan; Heß, Anke; Werner C, Cordula; Kabbert, Nadine; Buschfort, Rüdiger; Effect on arm function and cost of robot-assisted group therapy in subacute patients with stroke and a moderately to severely affected arm: a randomized controlled trial; Clinical rehabilitation; 2014; vol. 28 (no. 7); 637-647

Study details

Secondary publication of another included study- see primary study for details	NR
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months) Mean 4.5 weeks in each group.
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week

Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Mixed

Study arms

Robot-assisted therapy (N = 25)
Robot-assisted group therapy for 30 minutes plus individual arm therapy for 30 minutes, each workday for 4 weeks.

Individual arm therapy (N = 25)
Individual arm therapy for 2 x 30 minutes each workday for 4 weeks.

Outcomes

Study timepoints
- Baseline
- 4 week (Post-intervention.)
- 3 month (Post-intervention)

Dichotomous outcome

Outcome	Robot-assisted therapy, Baseline, N = 25	Robot-assisted therapy, 4 week, N = 25	Robot-assisted therapy, 3 month, N = 25	Individual arm therapy, Baseline, N = 25	Individual arm therapy, 4 week, N = 25	Individual arm therapy, 3 month, N = 25
Withdrawal for any reason 4 weeks: robot group: 1 refused to continue. 3 months: robot group: 1 not available, control group: 2 (1 refusal, 1 re-infarction). No of events	n = NA ; % = NA	n = 1 ; % = 4	n = 2 ; % = 8	n = NA ; % = NA	n = 0 ; % = 0	n = 2 ; % = 8
Adverse events Shoulder pain requiring NSAID prescription and/ or shoulder orthosis and/or physical therapy. No of events	n = NA ; % = NA	n = 4 ; % = 16	n = NR ; % = NR	n = NA ; % = NA	n = 3 ; % = 12	n = NR ; % = NR

Continuous outcome

Outcome	Robot-assisted therapy, Baseline, N = 25	Robot-assisted therapy, 4 week, N = 25	Robot-assisted therapy, 3 month, N = 25	Individual arm therapy, Baseline, N = 25	Individual arm therapy, 4 week, N = 25	Individual arm therapy, 3 month, N = 25
Activities of daily living (barthel index) Change scores. Scale range 0-100 Mean (SD)	42 (14.5)	25.2 (11)	37.1 (16.9)	46.8 (19)	16 (15.7)	29.3 (21.4)
Arm function (Fugl-Meyer assessment)	14.6 (9.4)	11.1 (10.6)	16.8 (16)	16.5 (9.8)	14.6 (11.2)	20.2 (14.6)

Outcome	Robot-assisted therapy, Baseline, N = 25	Robot-assisted therapy, 4 week, N = 25	Robot-assisted therapy, 3 month, N = 25	Individual arm therapy, Baseline, N = 25	Individual arm therapy, 4 week, N = 25	Individual arm therapy, 3 month, N = 25
Change score. Scale range 0-66 Mean (SD)						
Arm strength (MRC) Change scores. Scale range 0-5 Mean (SD)	6.4 (6.7)	7.5 (7.1)	11.3 (10.1)	8.9 (7.8)	8.1 (6.4)	12.6 (12)
Spasticity (Ashworth MAS) Change scores. Scale range 0-45 Mean (SD)	2.6 (3.2)	0.1 (3.6)	0.6 (4.9)	2.3 (3.4)	0.2 (4.1)	0.6 (5.4)

Activities of daily living (barthel index) - Polarity - Higher values are better
Arm function (Fugl-Meyer assessment) - Polarity - Higher values are better
Arm strength (MRC) - Polarity - Higher values are better
Spasticity (Ashworth MAS) - Polarity - Lower values are better
Also reports other functional outcomes: ARAT and Box and Block test.

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-assisted therapy-Individual arm therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-assisted therapy-Individual arm therapy-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Continuousoutcome-Activitiesofdailyliving(barthelindex)-MeanSD-Robot-assisted therapy-Individual arm therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcome-Activitiesofdailyliving(barthelindex)-MeanSD-Robot-assisted therapy-Individual arm therapy-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns

Section	Question	Answer
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Continuousoutcome-Armfunction(Fugl-Meyerassessment)-MeanSD-Robot-assisted therapy-Individual arm therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcome-Armfunction(Fugl-Meyerassessment)-MeanSD-Robot-assisted therapy-Individual arm therapy-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Continuousoutcome-Armstrength(MRC)-MeanSD-Robot-assisted therapy-Individual arm therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcome-Armstrength(MRC)-MeanSD-Robot-assisted therapy-Individual arm therapy-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Continuousoutcome-Spasticity(AshworthMAS)-MeanSD-Robot-assisted therapy-Individual arm therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcome-Spasticity(AshworthMAS)-MeanSD-Robot-assisted therapy-Individual arm therapy-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Dichotomousoutcome-Adverseevents-NoOfEvents-Robot-assisted therapy-Individual arm therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Hesse, 2005

Bibliographic Reference	Hesse, Stefan; Werner, C.; Pohl, M.; Rueckriem, S.; Mehrholz, Jan; Lingnau, M. L.; Computerized arm training improves the motor control of the severely affected arm after stroke: a single-blinded randomized trial in two centers; Stroke; 2005; vol. 36 (no. 9); 1960-1966

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Not stated/unclear

Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	Not stated/unclear
Subgroup 5: Dose (days per week)	Not stated/unclear
Subgroup 6: Dose (duration)	Not stated/unclear
Subgroup 7: Level of supervision	Unsupervised 'therapist remained within shouting distance in case of problems'.
Subgroup 8: Type of movement delivered by robotic device	Mixed

Study arms

Robot therapy (N = 22)

Electrical stimulation (N = 22)

Outcomes

Study timepoints

- Baseline
- 6 week

- 3 month

Continuous outcomes

Outcome	Robot therapy, Baseline, N = 22	Robot therapy, 6 week, N = 22	Robot therapy, 3 month, N = 19	Electrical stimulation, Baseline, N = 22	Electrical stimulation, 6 week, N = 22	Electrical stimulation, 3 month, N = 20
Arm function (FMA UE) 0-66, final values Mean (SD)	7.9 (3.4)	24.6 (14.9)	30 (16.8)	7.3 (3.3)	10.4 (7.5)	16.6 (14.9)
Arm strength (Total MRC) 0-45, final value Mean (SD)	2.9 (2.6)	21.8 (10.5)	22.6 (11.1)	3.5 (3.3)	6.8 (8.3)	7.9 (9)
spasticity (total MAS) 0-25, final value Mean (SD)	1.5 (2.2)	1.7 (2.4)	1.4 (2.6)	0.8 (0.7)	1.8 (1.7)	1.8 (1.7)

Arm function (FMA UE) - Polarity - Higher values are better
Arm strength (Total MRC) - Polarity - Higher values are better
spasticity (total MAS) - Polarity - Lower values are better

Dichotomous outcome

Outcome	Robot therapy, Baseline, N = 22	Robot therapy, 6 week, N = 22	Robot therapy, 3 month, N = 22	Electrical stimulation, Baseline, N = 22	Electrical stimulation, 6 week, N = 22	Electrical stimulation, 3 month, N = 22
Withdrawal for any reason No of events	n = NA ; % = NA	n = 1 ; % = 5	n = NR ; % = NR	n = NA ; % = NA	n = 0 ; % = 0	n = NR ; % = NR

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(FMAUE)-MeanSD-Robot therapy-Electrical stimulation-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to selection of reported result)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armstrength(TotalMRC)-MeanSD-Robot therapy-Electrical stimulation-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to selection of reported result)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-spasticity(totalMAS)-MeanSD-Robot therapy-Electrical stimulation-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to selection of reported result)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-spasticity(totalMAS)-MeanSD-Robot therapy-Electrical stimulation-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to selection of reported result)*
Overall bias and Directness	Overall Directness	Partially applicable *(not reported at over 6 months)*

Continuousoutcomes-Armstrength(TotalMRC)-MeanSD-Robot therapy-Electrical stimulation-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to selection of reported result)*
Overall bias and Directness	Overall Directness	Partially applicable *(not reported at over 6 months)*

Continuousoutcomes-Armfunction(FMAUE)-MeanSD-Robot therapy-Electrical stimulation-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to selection of reported result)*

Section	Question	Answer
Overall bias and Directness	Overall Directness	Partially applicable *(not reported at over 6 months)*

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot therapy-Electrical stimulation-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to selection of reported result)*
Overall bias and Directness	Overall Directness	Directly applicable

Hollenstein, 2011

Bibliographic Reference	Hollenstein, C.; Cabri, C.; Additional therapy with computer-aided training system compared to occupational therapy arm group therapy; Neuroreha; 2011; vol. 3 (no. 1); 40-2

Study details

Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear

Subgroup 2: Time after stroke at the start of the trial	Not stated/unclear
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Not stated/unclear
Subgroup 8: Type of movement delivered by robotic device	Not stated/unclear

Study arms

Robot-mediated therapy (N = 7)
With the Armeo device 5 times a week for 30 minutes over 2 weeks (10 times).

Arm group programme (N = 6)
Without device delivered by an occupational therapist for the same time and frequency as the robot therapy group.

Outcomes

Study timepoints

- Baseline
- 2 week (Post-intervention)

Dichotomous outcome

Outcome	Robot-mediated therapy, Baseline, N = 7	Robot-mediated therapy, 2 week, N = 7	Arm group programme, Baseline, N = 6	Arm group programme, 2 week, N = 6
Withdrawal for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Withdrawal for any reason - Polarity - Lower values are better

Continuous outcomes

Outcome	Robot-mediated therapy, Baseline, N = 7	Robot-mediated therapy, 2 week, N = 7	Arm group programme, Baseline, N = 6	Arm group programme, 2 week, N = 6
Arm function (Fugl-Meyer assessment) Change scores. Scale range 0-66. Values as reported in Cochrane review. Mean (SD)	NR (NR)	3.4 (3.9)	NR (NR)	3.7 (4.1)

Arm function (Fugl-Meyer assessment) - Polarity - Higher values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Cross-over trial

Continuousoutcomes-rmfunction(Fugl-Meyerassessment)-MeanSD-Robot-mediated therapy-Arm group programme-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(Insufficient information to determine- unclear risk in at least 2 domains.)*
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-mediated therapy-Arm group programme-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(Insufficient information to determine- unclear risk in at least 2 domains.)*
Overall bias and Directness	Overall Directness	Directly applicable

Housman, 2009

Bibliographic Reference	Housman, Sarah J.; Scott, Kelly M.; Reinkensmeyer, David J.; A randomized controlled trial of gravity-supported, computer-enhanced arm exercise for individuals with severe hemiparesis; Neurorehabilitation and neural repair; 2009; vol. 23 (no. 5); 505-514

Study details

Secondary publication of another included	No additional information.

study- see primary study for details	
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Trial name / registration number	
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	≥6 weeks 8-9 weeks
Subgroup 7: Level of supervision	Mixed The first 3 sessions were supervised; afterwards supervision was intermittent.

Subgroup 8: Type of movement delivered by robotic device	Passive movement

Study arms

Robot-mediated therapy (N = 17)
With T-WREX device 3 times a week for 1 hour over 8-9 weeks. The first 3 sessions were supervised; afterwards supervision was intermittent.

Non-robot therapy (N = 17)
As above, but without the device.

Outcomes

Study timepoints
- Baseline
- 9 week ((8-9 weeks) post-intervention)
- 6 month (Post-intervention)

Dichotmous outcome

Outcome	Robot-mediated therapy, Baseline, N = 17	Robot-mediated therapy, 9 week, N = 17	Robot-mediated therapy, 6 month, N = 14	Non-robot therapy , Baseline, N = 17	Non-robot therapy , 9 week, N = 17	Non-robot therapy , 6 month, N = 14
Withdrawal for any reason During treatment: robot group: 2 injured hemiparetic arm in daily life, control group: 1 onset of depression. Follow-up: robot group: 1 moved out of state, control group: 2 lost in follow-up (participated in confounding research). No of events	n = NA ; % = NA	n = 2 ; % = 11.7	n = 3 ; % = 17.7	n = NA ; % = NA	n = 1 ; % = 5.9	n = 3 ; % = 17.7

Continuous outcome

Outcome	Robot-mediated therapy, Baseline, N = 17	Robot-mediated therapy, 9 week, N = 17	Robot-mediated therapy, 6 month, N = 14	Non-robot therapy , Baseline, N = 17	Non-robot therapy , 9 week, N = 17	Non-robot therapy , 6 month, N = 14
Activities of daily living (Motor activity log amount of use) Change scores. Scale range 0-5. Values as reported in Cochrane review. Mean (SD)	0.6 (0.4)	0.2 (0.4)	0.4 (0.7)	0.3 (0.3)	0.1 (0.3)	0.3 (0.4)
Arm function (Fugl-Meyer) Change scores. Scale range	21.7 (5.9)	3.3 (2.4)	3.6 (2.9)	18.1 (5)	2.2 (2.6)	1.5 (2.7)

Outcome	Robot-mediated therapy, Baseline, N = 17	Robot-mediated therapy, 9 week, N = 17	Robot-mediated therapy, 6 month, N = 14	Non-robot therapy , Baseline, N = 17	Non-robot therapy , 9 week, N = 17	Non-robot therapy , 6 month, N = 14
0-66. Values as reported in Cochrane review. Mean (SD)						
Arm muscle strength (grip strength, kg force) Change scores. Values as reported in Cochrane review. Mean (SD)	8.2 (4.1)	0.8 (3)	1.8 (4.8)	4.2 (3)	0.8 (2.3)	1.4 (2.2)

Activities of daily living (Motor activity log amount of use) - Polarity - Higher values are better
Arm function (Fugl-Meyer) - Polarity - Higher values are better
Arm muscle strength (grip strength, kg force) - Polarity - Higher values are better
Also reports rancho level, Rancho speed, MAL Quality of control movement and ROM deficit.

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Dichotmousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-mediated therapy-Non-robot therapy -t9

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Dichotmousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-mediated therapy-Non-robot therapy -t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcome-Activitiesofdailyliving(Motoractivitylogamountofuse)-MeanSD-Robot-mediated therapy-Non-robot therapy -t9

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcome-Activitiesofdailyliving(Motoractivitylogamountofuse)-MeanSD-Robot-mediated therapy-Non-robot therapy -t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcome-Armfunction(Fugl-Meyer)-MeanSD-Robot-mediated therapy-Non-robot therapy -t9

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcome-Armfunction(Fugl-Meyer)-MeanSD-Robot-mediated therapy-Non-robot therapy -t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcome-Armmusclestrength(gripstrength,kgforce)-MeanSD-Robot-mediated therapy-Non-robot therapy -t9

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcome-Armmusclestrength(gripstrength,kgforce)-MeanSD-Robot-mediated therapy-Non-robot therapy -t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Hsieh, 2016

Bibliographic Reference	Hsieh, Yu-wei; Liing, Rong-jiuan; Lin, Keh-chung; Wu, Ching-yi; Liou, Tsan-hon; Lin, Jui-chi; Hung, Jen-wen; Sequencing bilateral robot-assisted arm therapy and constraint-induced therapy improves reach to press and trunk kinematics in patients with stroke; Journal of neuroengineering and rehabilitation; 2016; vol. 13 (no. 1); 1-9

Study details

Secondary publication of another included study- see primary study for details	Hsieh YW, Lin KC, Horng YS, Wu CY, Wu TC, Ku FL. Sequential combination of robot-assisted therapy and constraint-induced therapy in stroke rehabilitation: a randomized controlled trial. *Journal of Neurology* 2014;261(5):1037-45.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.

Hsieh, 2014

Bibliographic Reference	Hsieh, Yu-wei; Lin, Keh-chung; Horng, Yi-shiung; Wu, Ching-yi; Wu, Tai-chieh; Ku, Fang-ling; Sequential combination of robot-assisted therapy and constraint-induced therapy in stroke rehabilitation: a randomized controlled trial; Journal of neurology; 2014; vol. 261 (no. 5); 1037-1045

Study details

Secondary publication of another included study- see primary study for details	No additional information.

Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review. Hsieh Y-W, Liing R-J, Lin K-C, Wu C-Y, Liou T-H, Lin J-C, et al. Sequencing bilateral robot-assisted arm therapy and constraint-induced therapy improves reach to press and trunk kinematics in patients with stroke. *Journal of NeuroEngineering & Rehabilitation* 2016;13:1-9. [1743-0003]
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Not stated/unclear
Subgroup 8: Type of movement	Mixed

delivered by robotic device	

Study arms

Robot assisted therapy (N = 32)
Group 1: RT + CIT group (robot-assisted arm therapy (Bi-Manu-Track) + constraint-induced therapy. Group 2: RT group (robot-assisted arm therapy (Bi-Manu-Track)) Groups were combined for analysis.

Conventional therapy (N = 16)
Received a therapist-mediated intervention using conventional occupational therapy techniques, including neurodevelopmental techniques, functional task practice, fine motor training, arm exercises or gross motor training, and muscle strengthening, Participants in each group received 20 training sessions of 90 to 105 min/day, 5 days/ week for 4 weeks.

Outcomes

Study timepoints
- Baseline
- 4 week (Post-intervention)

Dichotomous outcome

Outcome	Robot assisted therapy, Baseline, N = 32	Robot assisted therapy, 4 week, N = 32	Conventional therapy, Baseline, N = 16	Conventional therapy, 4 week, N = 16
Withdrawal for any reason	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Outcome	Robot assisted therapy, Baseline, N = 32	Robot assisted therapy, 4 week, N = 32	Conventional therapy, Baseline, N = 16	Conventional therapy, 4 week, N = 16
No of events				

Continuous outcome

Outcome	Robot assisted therapy, Baseline, N = 32	Robot assisted therapy, 4 week, N = 32	Conventional therapy, Baseline, N = 16	Conventional therapy, 4 week, N = 16
Arm function (Fugl-Meyer assessment)-total Change scores. Scale range 0-66. Values as reported in Cochrane review Mean (SD)	NR (NR)	7.3 (5.5)	NR (NR)	3.8 (5)

Arm function (Fugl-Meyer assessment)-total - Polarity - Higher values are better
Also reports distal and proximal FM, WMFT, MAL. Reported baseline total FM values: RT+dCIT: 32.19 (7.2), RT: 35.69 (9.62) Post-treatment total FM values: RT+dCIT: 40.69 (8.58), RT: 41.81 (9.4)

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcome-Armfunction(Fugl-Meyerassessment)-total-MeanSD-Robot assisted therapy-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot assisted therapy-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Hsieh, 2011

Bibliographic Reference	Hsieh, Yu-wei; Wu, Ching-yi; Liao, Wan-wen; Lin, Keh-chung; Wu, Kuen-yuh; Lee, Chia-yi; Effects of treatment intensity in upper limb robot-assisted therapy for chronic stroke: a pilot randomized controlled trial; Neurorehabilitation and neural repair; 2011; vol. 25 (no. 6); 503-511

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear

Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Not stated/unclear
Subgroup 8: Type of movement delivered by robotic device	Mixed

Study arms

Robot assisted therapy (N = 12)
Group 1: Higher intensity RT group: Bi-Manu Track used in this study for 20 training sessions for 90 to 105 minutes, 5days per week for 4 weeks. After the RT, participants received 15-20 minutes of functional activities training. Group 2: Lower-intensity RT group: with the Bi-Manu Track the participants received a different frequency of RT; afterwards receiving the same treatment of functional abilities as the high intensity group. Groups were combined for analysis.

Conventional rehabilitation (N = 6)
Participants received a structured protocol using conventional occupational therapy techniques.

Outcomes

Study timepoints

- Baseline
- 4 week (Post-intervention.)

Dichotomous outcome

Outcome	Robot assisted therapy, Baseline, N = 12	Robot assisted therapy, 4 week, N = 12	Conventional rehabilitation, Baseline, N = 6	Conventional rehabilitation, 4 week, N = 6
Withdrawal for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Continuous outcomes

Outcome	Robot assisted therapy, Baseline, N = 12	Robot assisted therapy, 4 week, N = 12	Conventional rehabilitation, Baseline, N = 6	Conventional rehabilitation, 4 week, N = 6
Arm function (Fugl-Meyer scale-upper extremity) Final values. Scale range 0-33. Values as reported in Cochrane review Mean (SD)	NR (NR)	4.2 (5.9)	NR (NR)	2.8 (7.4)

Outcome	Robot assisted therapy, Baseline, N = 12	Robot assisted therapy, 4 week, N = 12	Conventional rehabilitation, Baseline, N = 6	Conventional rehabilitation, 4 week, N = 6
Arm muscle strength (MRC) Final values. Scale range 0-5. Values as reported in Cochrane review Mean (SD)	NR (NR)	3.5 (0.5)	NR (NR)	3.3 (0.7)
Activities of dailty living (Motor activity log) Final values. Scale range unclear. Values as reported in Cochrane review. Mean (SD)	NR (NR)	0.1 (0.2)	NR (NR)	0.1 (0.3)

Arm function (Fugl-Meyer scale- upper extremity) - Polarity - Higher values are better
Arm muscle strength (MRC) - Polarity - Higher values are better
Activities of dailty living (Motor activity log) - Polarity - Higher values are better
Also reports MFSI and ABILHAND

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Activitiesofdailtyliving(Motoractivitylog)-MeanSD-Robot assisted therapy-Conventional rehabilitation-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerscale-upperextremity)-MeanSD-Robot assisted therapy-Conventional rehabilitation-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armmusclestrength(MRC)-MeanSD-Robot assisted therapy-Conventional rehabilitation-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot assisted therapy-Conventional rehabilitation-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Hsu, 2019

Bibliographic Reference	Hsu, H. Y.; Chiu, H. Y.; Kuan, T. S.; Tsai, C. L.; Su, F. C.; Kuo, L. C.; Robotic-assisted therapy with bilateral practice improves task and motor performance in the upper extremities of chronic stroke patients: A randomised controlled trial; Australian Occupational Therapy Journal; 2019; vol. 66 (no. 5); 637-647

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	No additional information.
Trial name / registration number	Clinicaltrials.gov = NCT03847103.
Study type	Randomised controlled trial (RCT)
Study location	Taiwan
Study setting	Outpatient follow up
Study dates	No additional information
Sources of funding	This work was supported by Chi Mei Medical Center and National Cheng Kung University under grant #CMNCKU10304. This work was also financially supported by the Medical Device Innovation Center, National Cheng Kung University from the Featured Areas Research Center Program within the framework of the Higher Education Sprout Project by the Ministry of Education in Taiwan.
Inclusion criteria	Diagnosis of stroke with unilateral cerebral infarction of haemorrhage whose time post-stroke was more than six months; exhibit no evidence of any other cerebral pathology in study screening CT scan; have an eligibility screening score on the Fugl-Meyer upper extremity motor assessment ranging from 23-53 corresponding with poor to notable arm-hand capacity; no reported pre-stroke difficulties in verbal communication; no impairment revealed in eligibility screening tests on the mini-mental state examination score above 24 and Lowenstein occupational therapy cognitive assessment item scores at or above 8 for visual perception, 6 for spatial perceptions, 6 for praxis and 14 for visuomotor organisation; pre-stroke right-handedness.

Exclusion criteria	Not meeting the inclusion criteria; CT showing multiple cerebral infarctions or haemorrhage; with Wernicke's aphasia or global aphasia leading to difficulty with following written or spoken multi-step instruction.
Recruitment / selection of participants	No additional information.
Intervention(s)	Robot-assisted arm therapy N=22 Robot-aided rehabilitation with bilateral practice to improve upper limb motor and task performance. Bi-Manu-Track device enabling practice of two different movement cycles using an end-effector based machine to provide bimanual passive and active practice of the forearm and wrist muscles. The exercise included passive-passive, active-passive and active-active training. The repetitive task training interventions took 40 minutes with a minimum of 400 robot-facilitated repetitions of the wrist flexion/extension as well as 400 reptitions of forearm supination/pronation movement, three times per week for four weeks. Concomitant therapy: All people received a 10-minute per-protocol sensorimotor stimulation session prior to the interventions as part of usual care.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	<5 days per week

Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Mixed
Population subgroups	No additional information
Comparator	Usual care N=21 40 minutes of therapist-facilitated task-specific training for the affected limb. The task-specific training followed the same number of repetitions per task and the maximum of three tasks from the task menu as well as implementation of a consistent movement pattern for the task. Session dose consisted of 180 repetitions of three target tasks for a session time of 40 minutes done three times per week for 4 weeks. Concomitant therapy: All people received a 10-minute per-protocol sensorimotor stimulation session prior to the interventions as part of usual care.
Number of participants	43
Duration of follow-up	4 weeks (end of intervention) and 16 weeks (this time point will be included but downgraded for indirectness for being less than 6 months).
Indirectness	Outcome indirectness - Outcomes at 16 weeks will be downgraded for indirectness as they were at a time point less than 6 months but after the post-intervention follow up.
Additional comments	ITT no drop outs.

Study arms

Robot-assisted arm therapy (N = 22)
Robot-aided rehabilitation with bilateral practice to improve upper limb motor and task performance. Bi-Manu-Track device enabling practice of two different movement cycles using an end-effector based machine to provide bimanual passive and active practice of the forearm and wrist muscles. The exercise included passive-passive, active-passive and active-active training. The repetitive task training interventions took 40 minutes with a minimum of 400 robot-facilitated repetitions of the wrist flexion/extension as well as 400 reptitions of forearm supination/pronation movement, three times per week for four weeks. Concomitant therapy: All people received a 10-minute per-protocol sensorimotor stimulation session prior to the interventions as part of usual care.

Usual care (N = 21)
40 minutes of therapist-facilitated task-specific training for the affected limb. The task-specific training followed the same number of repetitions per task and the maximum of three tasks from the task menu as well as implementation of a consistent movement pattern for the task. Session dose consisted of 180 repetitions of three target tasks for a session time of 40 minutes done three times per week for 4 weeks. Concomitant therapy: All people received a 10-minute per-protocol sensorimotor stimulation session prior to the interventions as part of usual care.

Characteristics

Arm-level characteristics

Characteristic	**Robot-assisted arm therapy (N = 22)**	**Usual care (N = 21)**
% Female Sample size	n = 11 ; % = 50	n = 12 ; % = 57
Mean age (SD) (years) Mean (SD)	53.1 (13.9)	52.6 (12.5)

Characteristic	Robot-assisted arm therapy (N = 22)	Usual care (N = 21)
Ethnicity Sample size	n = NR ; % = NR	n = NR ; % = NR
Comorbidities Sample size	n = NR ; % = NR	n = NR ; % = NR
Severity Sample size	n = NR ; % = NR	n = NR ; % = NR
Time after stroke (Months) Mean (SD)	13.7 (8.6)	14.7 (13.2)

Outcomes

Study timepoints

- Baseline
- 4 week (Post-intervention)
- 16 week (≥6 months - outcomes at this time point will be downgraded for indirectness)

Continuous outcome

Outcome	Robot-assisted arm therapy, Baseline, N = 22	Robot-assisted arm therapy, 4 week, N = 22	Robot-assisted arm therapy, 16 week, N = 22	Usual care, Baseline, N = 21	Usual care, 4 week, N = 21	Usual care, 16 week, N = 21
Arm function (Fugl-Meyer Assessment - Total upper limb motor score) Scale range: 0-66. Final values. Mean (SD)	38.6 (12.4)	43.1 (13)	45.2 (13.6)	41.9 (14.9)	44.1 (15.9)	44.9 (14.5)

Arm function (Fugl-Meyer Assessment - Total upper limb motor score) - Polarity - Higher values are better

Dichotomous outcomes

Outcome	Robot-assisted arm therapy, Baseline, N = 22	Robot-assisted arm therapy, 4 week, N = 22	Robot-assisted arm therapy, 16 week, N = 22	Usual care, Baseline, N = 21	Usual care, 4 week, N = 21	Usual care, 16 week, N = 21
Withdrawal for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0	n = 0 ; % = 0
Adverse events - Other reported adverse events No of events	n = NA ; % = NA	n = 0 ; % = 0	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0	n = 0 ; % = 0

Withdrawal for any reason - Polarity - Lower values are better
Adverse events - Other reported adverse events - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcome-Armfunction(Fugl-MeyerAssessment-Totalupperlimbmotorscore)-MeanSD-Robot-assisted arm therapy-Usual care-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcome-Armfunction(Fugl-MeyerAssessment-Totalupperlimbmotorscore)-MeanSD-Robot-assisted arm therapy-Usual care-t16

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Outcome indirectness - Outcomes at 16 weeks will be downgraded for indirectness as they were at a time point less than 6 months but after the post-intervention follow up.)*

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm therapy-Usual care-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm therapy-Usual care-t16

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Outcome indirectness - Outcomes at 16 weeks will be downgraded for indirectness as they were at a time point less than 6 months but after the post-intervention follow up.)*

Dichotomousoutcomes-Adverseevents-Otherreportedadverseevents-NoOfEvents-Robot-assisted arm therapy-Usual care-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Adverseevents-Otherreportedadverseevents-NoOfEvents-Robot-assisted arm therapy-Usual care-t16

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Outcome indirectness - Outcomes at 16 weeks will be downgraded for indirectness as they were at a time point less than 6 months but after the post-intervention follow up.)*

Hsu, 2021

Bibliographic Reference	Hsu, H. Y.; Yang, K. C.; Yeh, C. H.; Lin, Y. C.; Lin, K. R.; Su, F. C.; Kuo, L. C.; A Tenodesis-Induced-Grip exoskeleton robot (TIGER) for assisting upper extremity functions in stroke patients: a randomized control study; Disability & Rehabilitation; 2021; 1-9

Study details

Secondary publication of another included study- see primary study for details	No additional information
Other publications associated with this study included in review	No additional information
Trial name / registration number	Clinicaltrials.gov = NCT03713476
Study type	Randomised controlled trial (RCT)
Study location	Taiwan
Study setting	Outpatient follow up
Study dates	No additional information
Sources of funding	Financially supported by the Medical Device Innovation Center, National Cheng Kung University, from the Featured Areas Research Center Program within the framework of the Higher Education Sprout Project by the Ministry of Education in Taiwan. This project was supported in part by the Ministry of Science and Technology, Taiwan, under Grant MOST 108-2745-8-006-009 and in part by the National Cheng Kung University Hospital, Tainan, Taiwan under Grant NCKUH 10708003.

Inclusion criteria	Chronic stroke patients with unilateral cerebral infarction of haemorrhage whose disease duration was more than 6 months following a stroke; a score on the Fugl-Meyer upper extremity motor assessment ranging from 15 to 55 corresponding to severe-moderate to moderate-mild impairment level of upper extremity; a score on the mini-mental state examination no lower than 24; first-ever stroke.
Exclusion criteria	People with shoulder-hand syndrome; wrist pain; notable joint contracture; Wernicke's aphasia or global aphasia leading to difficulty with following instructions.
Recruitment / selection of participants	Convenience sample of people referred from the Department of Physical Medicine and Rehabilitation of a medical centre in southern Taiwan
Intervention(s)	Robot-assisted arm therapy N=17 An additional 20-minutes of robot-assisted arm training using TIGER (Tenodesis-induced-grip exoskeleton robot) with two working modes: continuous passive mode and a functional mode that was built into the controller (active-assisted). Designed to train the distal limb. Two sessions of training a week for 9 weeks. Concomitant therapy: All people received 20-minutes of regular task-specific motor training.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	<5 days per week

Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Mixed
Population subgroups	No additional information.
Comparator	Usual care N=17 An additional 20-minutes of task-specific motor training through regular occupational therapy. Concomitant therapy: All people received 20-minutes of regular task-specific motor training.
Number of participants	34
Duration of follow-up	9 weeks (post-intervention), 12 weeks after post-intervention (21 weeks) - the latter time point will be included as ≥6 months but downgraded for indirectness as the value is less than 6 months).
Indirectness	Outcome indirectness - Outcomes at 21 weeks will be downgraded for indirectness as they were at a time point less than 6 months but after the post-intervention follow up.
Additional comments	No additional information. Appears to be completers only.

Study arms

Robot-assisted arm therapy (N = 17)
An additional 20-minutes of robot-assisted arm training using TIGER (Tenodesis-induced-grip exoskeleton robot) with two working modes: continuous passive mode and a functional mode that was built into the controller (active-assisted). Designed to train the distal limb. Two sessions of training a week for 9 weeks. Concomitant therapy: All people received 20-minutes of regular task-specific motor training.

Usual care (N = 17)
An additional 20-minutes of task-specific motor training through regular occupational therapy. Concomitant therapy: All people received 20-minutes of regular task-specific motor training.

Characteristics

Arm-level characteristics

Characteristic	Robot-assisted arm therapy (N = 17)	Usual care (N = 17)
% Female Sample size	n = NR ; % = NR	n = NR ; % = NR
Mean age (SD) (years) Mean (SD)	55.5 (13.4)	56.3 (16.5)
Ethnicity Sample size	n = NR ; % = NR	n = NR ; % = NR
Comorbidities Sample size	n = NR ; % = NR	n = NR ; % = NR

Characteristic	Robot-assisted arm therapy (N = 17)	Usual care (N = 17)
Severity Sample size	n = NR ; % = NR	n = NR ; % = NR
Time after stroke (Months) Mean (SD)	23.6 (15.9)	36.3 (29.5)

Outcomes

Study timepoints

- Baseline
- 9 week (Post-intervention)
- 21 week (≥6 months - outcomes at this time point will be downgraded for indirectness)

Continuous outcome

Outcome	Robot-assisted arm therapy, Baseline, N = 17	Robot-assisted arm therapy, 9 week, N = 17	Robot-assisted arm therapy, 21 week, N = 17	Usual care, Baseline, N = 15	Usual care, 9 week, N = 15	Usual care, 21 week, N = 15
Arm function (Fugl-Meyer Assessment Upper Extremity total motor score) Scale range: 0-66. Final values. Mean (SD)	35.1 (14.3)	42.1 (14.4)	44.3 (13.7)	26.2 (12.3)	27.6 (12.6)	26.7 (13.2)

Outcome	Robot-assisted arm therapy, Baseline, N = 17	Robot-assisted arm therapy, 9 week, N = 17	Robot-assisted arm therapy, 21 week, N = 17	Usual care, Baseline, N = 15	Usual care, 9 week, N = 15	Usual care, 21 week, N = 15
Spasticity (modified Ashworth Scale wrist) Scale range: 0-4. Final values. Mean (SD)	1.06 (0.77)	0.94 (0.7)	0.85 (0.7)	1.53 (0.7)	1.43 (0.56)	1.3 (0.72)

Arm function (Fugl-Meyer Assessment Upper Extremity total motor score) - Polarity - Higher values are better
Spasticity (modified Ashworth Scale wrist) - Polarity - Lower values are better

Dichotomous outcomes

Outcome	Robot-assisted arm therapy, Baseline, N = 17	Robot-assisted arm therapy, 9 week, N = 17	Robot-assisted arm therapy, 21 week, N = 17	Usual care, Baseline, N = 17	Usual care, 9 week, N = 17	Usual care, 21 week, N = 17
Withdrawal for any reason Control: 1 discontinued for personal issues, 1 lost to follow-up due to being unwilling to participate in follow-up assessments No of events	n = NA ; % = NA	n = 0 ; % = 0	n = 0 ; % = 0	n = NA ; % = NA	n = 2 ; % = 12	n = 2 ; % = 12
Adverse events - injuries and pain No of events	n = NA ; % = NA	n = 0 ; % = 0	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0	n = 0 ; % = 0

Withdrawal for any reason - Polarity - Lower values are better
Adverse events - injuries and pain - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcome-Armfunction(Fugl-MeyerAssessmentUpperExtremitytotalmotorscore)-MeanSD-Robot-assisted arm therapy-Usual care-t9

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcome-Armfunction(Fugl-MeyerAssessmentUpperExtremitytotalmotorscore)-MeanSD-Robot-assisted arm therapy-Usual care-t21

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Partially applicable *(Outcome indirectness - Outcomes at 21 weeks will be downgraded for indirectness as they were at a time point less than 6 months but after the post-intervention follow up.)*

Continuousoutcome-Spasticity(modifiedAshworthScalewrist)-MeanSD-Robot-assisted arm therapy-Usual care-t9

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcome-Spasticity(modifiedAshworthScalewrist)-MeanSD-Robot-assisted arm therapy-Usual care-t21

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Partially applicable *(Outcome indirectness - Outcomes at 21 weeks will be downgraded for indirectness as they were at a time point less than 6 months but after the post-intervention follow up.)*

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm therapy-Usual care-t9

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm therapy-Usual care-t21

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Partially applicable *(Outcome indirectness - Outcomes at 21 weeks will be downgraded for indirectness as they were at a time point less than 6 months but after the post-intervention follow up.)*

Dichotomousoutcomes-Adverseevents-injuriesandpain-NoOfEvents-Robot-assisted arm therapy-Usual care-t9

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Adverseevents-injuriesandpain-NoOfEvents-Robot-assisted arm therapy-Usual care-t21

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Partially applicable *(Outcome indirectness - Outcomes at 21 weeks will be downgraded for indirectness as they were at a time point less than 6 months but after the post-intervention follow up.)*

Hung, 2022

Bibliographic Reference	Hung, JW; Yen, CL; Chang, KC; Chiang, WC; Chuang, IC; Pong, YP; Wu, WC; Wu, CY; A Pilot Randomized Controlled Trial of Botulinum Toxin Treatment Combined with Robot-Assisted Therapy, Mirror Therapy, or Active Control Treatment in Patients with Spasticity Following Stroke; Toxins; 2022; vol. 14 (no. 6)

Study details

Secondary publication of another included	No additional information.

study- see primary study for details	
Other publications associated with this study included in review	No additional information.
Trial name / registration number	No additional information.
Study type	Randomised controlled trial (RCT)
Study location	Taiwan.
Study setting	Outpatient follow up.
Study dates	No additional information.
Sources of funding	This work was supported by the Ministry of Science and Technology in Taiwan under 105-2314-B-182A-085, 106-2314-B-182A-121 and 109-2314-B-192-027-MY3; Chang Gung Memorial Hospital under BMRP553, BMRPG8E0931, MRPD1I-0031 and CMRPD1M0041; National Health Research Institutes under NHRI-EX111-11105PI.
Inclusion criteria	Unilateral stroke for at least 6 months duration; Modified Ashworth Scale >1 over the elbow flexor, forearm pronator, wrist flexor and/or finger flexor muscles; upper extremity Fugl-Meyer Assessment score of 17 to 56; Mini-Mental State Exam at least 21.
Exclusion criteria	Pregnancy; bilateral hemispheric or cerebellar lesions; visual field deficits or hemineglect; any contraindications for botulinum toxin; prior botulinum toxin treatment within 4 months of enrollment; joint contracture over the upper extremities; other orthopaedic or neurological diseases that would prevent adherence to the rehabilitation protocol.
Recruitment / selection of participants	People were recruited from the rehabilitation department of a medical center.
Intervention(s)	Robot arm training N=13 75 minutes of training, 3 times weekly for 8 consecutive weeks. Robot arm training using the Bi-Manu-Track robotic arm training system allowing for three training modes: passive-passive, active-passive and active-active. For each movement, the participants practiced 200 repetitions in mode 1, 750 repetitions in mode 2 and 50 to 200 repetitions in mode 3. The

	feedback on actions or force they exerted during practice was provided. Following this 45 minute period of training, people received an additional 30 minutes of practice in functional activities to facilitate transferring the acquired movements to daily activities. The selected functional tasks involved forearm pronation-supination or wrist flexion-extension movements, such as twisting a towel or bouncing a ball. Concomitant therapy: All people received an injection of botulinum toxin type A (50 U/mL diluted in 0.9% saline injected into the target muscle confirmed by ultrasound). Concurrent use of muscle relaxants, antispastic agents and drugs having muscle relaxant properties was maintained at constant dosages throughout the study. All other routine rehabilitation that did not involve upper extremity training proceeded as usual.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Mixed
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Mixed

Population subgroups	No additional information.
Comparator	Any other intervention (Mirror therapy and usual care) N=24 Two arms pooled together, both 75 minutes of training, 3 times weekly for 8 consecutive weeks. 1) Mirror therapy for 45 minutes of training per session. A mirror box was placed beside the unaffected hand to block the view of the affected hand. People were instructed to focus on the unaffected hand as if it were the affected hand and to perform exercises bilaterally and symmetrically as much as possible. The activities included: transitive movements (such as fine motor tasks of squeezing sponges, placing pegs in holes, flipping a card); gross motor tasks (reaching out to touch a switch or keyboard); intransitive movements (including the distal movement of the wrist, repetitive extension-flexion, or finger opponent, and the proximal part movement of forearm pronation/supination). Following this 45 minute period of training, people received an additional 30 minutes of practice in functional activities to facilitate transferring the acquired movements to daily activities. The selected functional tasks involved forearm pronation-supination or wrist flexion-extension movements, such as twisting a towel or bouncing a ball. 2) Usual care, 45 minutes of conventional task-oriented approach with bilateral symmetric movement training. The movement training involved grasping, manipulating and picking up and placing objects. After this people took part in the same 30 minutes of functional practice as the other groups. Concomitant therapy: All people received an injection of botulinum toxin type A (50 U/mL diluted in 0.9% saline injected into the target muscle confirmed by ultrasound). Concurrent use of muscle relaxants, antispastic agents and drugs having muscle relaxant properties was maintained at constant dosages throughout the study. All other routine rehabilitation that did not involve upper extremity training proceeded as usual.
Number of participants	36
Duration of follow-up	8 weeks (end of treatment) and 5 months (end of treatment + 3 months - this is less than the 6 months required for the mirror therapy review, but is the latest possible follow up required for the robot arm therapy review so will be extracted but not used for the mirror therapy review).
Indirectness	Outcome indirectness - time point >6 months (as the outcome is at less than 6 months)
Additional comments	All people randomised were included in the analysis (ITT no dropouts).

Study arms

Robot arm training (N = 13)
75 minutes of training, 3 times weekly for 8 consecutive weeks. Robot arm training using the Bi-Manu-Track robotic arm training system allowing for three training modes: passive-passive, active-passive and active-active. For each movement, the participants practiced 200 repetitions in mode 1, 750 repetitions in mode 2 and 50 to 200 repetitions in mode 3. The feedback on actions or force they exerted during practice was provided. Following this 45 minute period of training, people received an additional 30 minutes of practice in functional activities to facilitate transferring the acquired movements to daily activities. The selected functional tasks involved forearm pronation-supination or wrist flexion-extension movements, such as twisting a towel or bouncing a ball. Concomitant therapy: All people received an injection of botulinum toxin type A (50 U/mL diluted in 0.9% saline injected into the target muscle confirmed by ultrasound). Concurrent use of muscle relaxants, antispastic agents and drugs having muscle relaxant properties was maintained at constant dosages throughout the study. All other routine rehabilitation that did not involve upper extremity training proceeded as usual.

Any other intervention (Mirror therapy and usual care) (N = 24)
Two arms pooled together, both 75 minutes of training, 3 times weekly for 8 consecutive weeks. 1) Mirror therapy for 45 minutes of training per session. A mirror box was placed beside the unaffected hand to block the view of the affected hand. People were instructed to focus on the unaffected hand as if it were the affected hand and to perform exercises bilaterally and symmetrically as much as possible. The activities included: transitive movements (such as fine motor tasks of squeezing sponges, placing pegs in holes, flipping a card); gross motor tasks (reaching out to touch a switch or keyboard); intransitive movements (including the distal movement of the wrist, repetitive extension-flexion, or finger opponent, and the proximal part movement of forearm pronation/supination). Following this 45 minute period of training, people received an additional 30 minutes of practice in functional activities to facilitate transferring the acquired movements to daily activities. The selected functional tasks involved forearm pronation-supination or wrist flexion-extension movements, such as twisting a towel or bouncing a ball. 2) Usual care, 45 minutes of conventional task-oriented approach with bilateral symmetric movement training. The movement training involved grasping, manipulating and picking up and placing objects. After this people took part in the same 30 minutes of functional practice as the other groups. Concomitant therapy: All people received an injection of botulinum toxin type A (50 U/mL diluted in 0.9% saline injected into the target muscle confirmed by ultrasound). Concurrent use of muscle relaxants, antispastic agents and drugs having muscle relaxant properties was maintained at constant dosages throughout the study. All other routine rehabilitation that did not involve upper extremity training proceeded as usual.

Characteristics

Arm-level characteristics

Characteristic	Robot arm training (N = 13)	Any other intervention (Mirror therapy and usual care) (N = 24)
% Female Sample size	n = 3 ; % = 23	n = 10 ; % = 42
Mean age (SD) (years) Mean (SD)	47.68 (12.79)	47.03 (10.8)
Ethnicity Sample size	n = NR ; % = NR	n = NR ; % = NR
Comorbidities Sample size	n = NR ; % = NR	n = NR ; % = NR
Severity Mean (SD)	NR (NR)	NR (NR)
Time after stroke (Months) Mean (SD)	33.38 (22.71)	35.63 (21.53)

Outcomes

Study timepoints

- Baseline
- 8 week (End of intervention)
- 5 month (>6 months (downgrade for indirectness))

Continuous outcomes

Outcome	Robot arm training, Baseline, N = 13	Robot arm training, 8 week, N = 13	Robot arm training, 5 month, N = 13	Any other intervention (Mirror therapy and usual care), Baseline, N = 24	Any other intervention (Mirror therapy and usual care), 8 week, N = 24	Any other intervention (Mirror therapy and usual care), 5 month, N = 24
Arm function (Fugl Meyer Assessment - Upper Extremity) Scale range: 0-66. Final values. Mirror therapy 8 weeks: 35.9 (6.48). Mirror therapy 5 months: 34.9 (8.49). Usual care 8 weeks: 32.9 (12.0). Usual care 5 months: 33.7 (11.0). Mean (SD)	32.92 (7.12)	36.46 (8.88)	34.92 (7.25)	31.17 (9.79)	34.41 (9.8)	34.33 (9.84)
Spasticity (modified Ashworth scale) Scale range: 0-4. Final values. Summed values for the elbow flexor, forearm pronator, wrist flexor and finger PIP flexor. For full details see study. Mean (SD)	1.75 (0.7)	1.16 (0.91)	1.49 (0.99)	1.69 (0.88)	1.29 (0.9)	1.54 (0.8)

Arm function (Fugl Meyer Assessment - Upper Extremity) - Polarity - Higher values are better
Spasticity (modified Ashworth scale) - Polarity - Lower values are better

Dichotomous outcome

Outcome	Robot arm training, Baseline, N = 13	Robot arm training, 8 week, N = 13	Robot arm training, 5 month, N = 13	Any other intervention (Mirror therapy and usual care), Baseline, N = 24	Any other intervention (Mirror therapy and usual care), 8 week, N = 24	Any other intervention (Mirror therapy and usual care), 5 month, N = 24
Withdrawal for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0	n = 0 ; % = 0

Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(FuglMeyerAssessment-UpperExtremity)-MeanSD-Robot arm training-Any other intervention (Mirror therapy and usual care)-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(modifiedAshworthscale)-MeanSD-Robot arm training-Any other intervention (Mirror therapy and usual care)-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot arm training-Any other intervention (Mirror therapy and usual care)-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(FuglMeyerAssessment-UpperExtremity)-MeanSD-Robot arm training-Any other intervention (Mirror therapy and usual care)-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Outcome indirectness - follow up period <6 months)*

Continuousoutcomes-Spasticity(modifiedAshworthscale)-MeanSD-Robot arm training-Any other intervention (Mirror therapy and usual care)-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Outcome indirectness - follow up period <6 months)*

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot arm training-Any other intervention (Mirror therapy and usual care)-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Outcome indirectness - follow up period <6 months)*

Hwang, 2012

Bibliographic Reference	Hwang, Chang Ho; Seong, Jin Wan; Son, Dae-Sik; Individual finger synchronized robot-assisted hand rehabilitation in subacute to chronic stroke: a prospective randomized clinical trial of efficacy; Clinical Rehabilitation; 2012; vol. 26 (no. 8); 696-704

Study details

Secondary publication of another included	No additional information.

study- see primary study for details	
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Mixed Average 6.5 (5.3) months after stroke.
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Not stated/unclear
Subgroup 8: Type of movement delivered by robotic device	Not stated/unclear

Study arms

Robot-assisted intervention (N = 9)
4 weeks (20 sessions) of active robot-assisted intervention (full-term intervention) group. The robot-assisted therapy included individual finger synchronisation (Amadeo, Tyromotion, Austria).

Early passive therapy (N = 5)
2weeks (10 sessions) of early passive therapy, followed by 2 weeks (10 sessions) of active robot-assisted intervention (the half term intervention) group. Data from the first 2 weeks of intervention were used.

Outcomes

Study timepoints
- Baseline
- 2 week (Post-intervention)

Dichotomous outcome

Outcome	Robot-assisted intervention, Baseline, N = 9	Robot-assisted intervention, 2 week, N = 9	Early passive therapy, Baseline, N = 8	Early passive therapy, 2 week, N = 8
Withdrawal for any reason As reported in Cochrane review. However, paper reports 2 drop outs in control group (1 did not receive allocated intervention and 1 was lost to follow-up within first 2 week period) No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Continuous outcomes

Outcome	Robot-assisted intervention, Baseline, N = 9	Robot-assisted intervention, 2 week, N = 9	Early passive therapy, Baseline, N = 8	Early passive therapy, 2 week, N = 6
Arm function (Fugl-Meyer) Change scores. FM scale used unclear. Values as reported in Cochrane review Mean (SD)	NR (NR)	3.5 (4.19)	NR (NR)	1.3 (4.32)
Arm muscle strength (scale unclear) Change scores. Values as reported in Cochrane review. Mean (SD)	NR (NR)	1.7 (7.04)	NR (NR)	1.3 (6.3)
Spasticity (Ashworth scale)- wrist Change scores. Scale range ?0-5 Mean (SD)	0.9 (0.3)	0.8 (0.9)	0.5 (0.2)	0.5 (0.5)
Spasticity (Ashworth scale)- elbow Change scores. Scale range ?0-5 Mean (SD)	1.2 (0.1)	1.2 (0.4)	1.4 (0.4)	1.3 (1)
Stroke-specific Patient Reported Outcome Measure (Stroke Impact Scale - hand motor subscale) Change scores. Scale range 12-60 Mean (SD)	38.8 (6)	47.6 (7.5)	48.7 (1.7)	47 (6.2)

Arm function (Fugl-Meyer) - Polarity - Higher values are better
Arm muscle strength (scale unclear) - Polarity - Higher values are better
Spasticity (Ashworth scale)- wrist - Polarity - Lower values are better

Spasticity (Ashworth scale)- elbow - Polarity - Lower values are better
Stroke-specific Patient Reported Outcome Measure (Stroke Impact Scale - hand motor subscale) - Polarity - Higher values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Spasticity(Ashworthscale)-elbow-MeanSD-Robot-assisted intervention-Early passive therapy-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-assisted intervention-Early passive therapy-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyer)-MeanSD-Robot-assisted intervention-Early passive therapy-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armmusclestrength(scaleunclear)-MeanSD-Robot-assisted intervention-Early passive therapy-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(Ashworthscale)-wrist-MeanSD-Robot-assisted intervention-Early passive therapy-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Stroke-specificPatientReportedOutcomeMeasure(StrokeImpactScale-handmotorsubscale)-MeanSD-Robot-assisted intervention-Early passive therapy-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Iwamoto, 2019

Bibliographic Reference	Iwamoto, Y.; Imura, T.; Suzukawa, T.; Fukuyama, H.; Ishii, T.; Taki, S.; Imada, N.; Shibukawa, M.; Inagawa, T.; Araki, H.; Araki, O.; Combination of Exoskeletal Upper Limb Robot and Occupational Therapy Improve Activities of Daily Living Function in Acute Stroke Patients; Journal of Stroke & Cerebrovascular Diseases; 2019; vol. 28 (no. 7); 2018-2025

Study details

Secondary publication of another included study- see primary study for details	NR
Other publications associated with this study included in review	NR
Trial name / registration number	NR
Study location	Japan
Study setting	Inpatients rehabilitation department of neurosurgical hospital
Study dates	NR
Sources of funding	NR
Inclusion criteria	Inclusion criteria were (1) first-time stroke, (2) Brunnstrom recovery stage (Br-stage) II to IV, and (3) study participant within 2 weeks after stroke onset.
Exclusion criteria	Patients were excluded if (1) the surface electrode could not be attached to the skin due to cutaneous disease or (2) they were not able to follow instructions.
Recruitment / selection of participants	NR
Intervention(s)	Hybrid Assistive Limb (HAL-SJ) HAL-SJ was attached to the elbow joint, and the patients were supported flexion and extension movement of the elbow joint. A surface electrode was attached to the patient on the muscle belly of the biceps brachii and triceps brachii muscles to record the EMG. Configuration parameters of HAL-SJ included assist gain (intensity

	of assist) and assist balance (balance between flexor muscle assist and extensor muscle assist), and the parameters were individually designed by the occupational therapists depending on the patient's symptoms. During A, the patients underwent robotic rehabilitation using HAL-SJ for 40 minutes per day and performed at least 200 movements (flexion and extension) of the elbow joint. Concomitant therapy -The total time of combination therapy during A and occupational therapy during B was equivalent. In the current Japanese medical system, the medical doctor prescribes a rehabilitation programme, and rehabilitation therapists (occupational therapist, physiotherapist, and speech therapist) design individually tailored exercise programmes for acute stroke patients for up to 3 hours per day.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Active assisted movement

Population subgroups	NR
Comparator	Occupational therapy included passive or active mobilization, task-specific training, and ADL training such as eating, grooming, dressing (upper and lower body), toileting, and bathing. Occupational therapy focusing on the patient's ADL function and the distribution of each programme was individually designed depending on the patient's symptoms.
Number of participants	12
Duration of follow-up	end of intervention
Indirectness	NR
Additional comments	NR

Study arms

Robotic Rehabilitation (N = 6)

Conventional therapy (N = 6)

Characteristics

Study-level characteristics

Characteristic	**Study (N = 12)**
Ethnicity Nominal	NR

Characteristic	Study (N = 12)
Comorbidities Nominal	NR
Severity Nominal	NR
Time after stroke Nominal	NR

Arm-level characteristics

Characteristic	Robotic Rehabilitation (N = 6)	Conventional therapy (N = 6)
% Female Nominal	16.7	50
Mean age (SD) Mean (SD)	62.33 (10.23)	59.67 (24.56)

Outcomes

Study timepoints

- Baseline
- 4 week

Continuous outcomes

Outcome	Robotic Rehabilitation, Baseline, N = 6	Robotic Rehabilitation, 4 week, N = 6	Conventional therapy, Baseline, N = 6	Conventional therapy, 4 week, N = 5
Acitvities of daily living (Barthel Index) 0-100, change score Mean (SD)	46.67 (21.6)	9.17 (5.97)	42.5 (19.69)	2.5 (4.52)
Arm strength (Motricity Index) change score Mean (SD)	42.83 (10.32)	2.75 (7.19)	49.5 (15.11)	1.67 (4.66)

Acitvities of daily living (Barthel Index) - Polarity - Higher values are better
Arm strength (Motricity Index) - Polarity - Higher values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Cross-over trial

Continuousoutcomes-Acitvitiesofdailyliving(BarthelIndex)-MeanSD-Robotic Rehabilitation-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(Due to randomisation, and deviation from intended intervention (assignment and adhering))*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armstrength(Gripstrength)-MeanSD-Robotic Rehabilitation-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(Due to randomisation, and deviation from intended intervention (assignment and adhering))*
Overall bias and Directness	Overall Directness	Directly applicable

Jiang, 2021

Bibliographic Reference	Jiang, S.; You, H.; Zhao, W.; Zhang, M.; Effects of short-term upper limb robot-assisted therapy on the rehabilitation of sub-acute stroke patients; Technology & Health Care; 2021; vol. 29 (no. 2); 295-303

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	No additional information.
Trial name / registration number	No additional information.
Study type	Randomised controlled trial (RCT)
Study location	China.

Study setting	Inpatient.
Study dates	No additional information.
Sources of funding	This work was supported by a fund from the Lanzhou Science and Technology Bureau (document number: 2016-2-59).
Inclusion criteria	First ischaemic or haemorrhagic stroke as confirmed by neuroimaging (CT or MRI); age of 35 to 85 years; less than 30 days since stroke; impaired upper limb motor function and unilateral hemiplegia; sufficient cognition to understand the purpose and follow the instructions of the study (Mini Mental State Examination at least 18); ability to participate in robot therapy (Brunnstrom assessment score 3-6); no visual problems.
Exclusion criteria	Drug abuse or epilepsy; painful arthritis of the elbow, wrist or finger joints; impaired cognition; former stroke; severe neuropsychologic impairments; severe spasticity (Ashworth 3-4).
Recruitment / selection of participants	People at the inpatient rehabilitation ward of the hospital.
Intervention(s)	Robot-assisted arm therapy N=23 In addition the robot therapy group received robot therapy (Armeo Spring) for 30 minutes twice a day, for 2 weeks. The difficulty was adjusted to the needs of each person. Concomitant therapy: All received conventional rehabilitation therapy for 30 minutes twice a day, for 2 weeks.
Subgroup 1: Severity	Moderate (or NIHSS 5-14)
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Mixed
Subgroup 4: Dose (hours per day)	<1 hour

Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Not stated/unclear
Population subgroups	No additional information.
Comparator	Usual care N=22 Conventional rehabilitation for 30 minutes twice a day, for 2 weeks. This included neurodevelopmental techniques, functional tasks and muscle strengthening. Concomitant therapy: All received conventional rehabilitation therapy for 30 minutes twice a day, for 2 weeks.
Number of participants	45
Duration of follow-up	2 weeks (post-intervention) and 1 month (this group will be included as ≥6 months but will be downgraded for indirectness as the time is less than 6 months).
Indirectness	Outcome indirectness - Outcomes at 16 weeks will be downgraded for indirectness as they were at a time point less than 6 months but after the post-intervention follow up.
Additional comments	No additional information.

Study arms

Robot-assisted arm therapy (N = 23)
In addition the robot therapy group received robot therapy (Armeo Spring) for 30 minutes twice a day, for 2 weeks. The difficulty was adjusted to the needs of each person. Concomitant therapy: All received conventional rehabilitation therapy for 30 minutes twice a day, for 2 weeks.

Usual care (N = 22)
Conventional rehabilitation for 30 minutes twice a day, for 2 weeks. This included neurodevelopmental techniques, functional tasks and muscle strengthening. Concomitant therapy: All received conventional rehabilitation therapy for 30 minutes twice a day, for 2 weeks.

Characteristics

Arm-level characteristics

Characteristic	Robot-assisted arm therapy (N = 23)	Usual care (N = 22)
% Female Sample size	n = 9 ; % = 39.1	n = 7 ; % = 31.8
Mean age (SD) (years) Mean (SD)	62.43 (11.29)	66 (11.51)
Ethnicity Sample size	n = NR ; % = NR	n = NR ; % = NR
Comorbidities Sample size	n = NR ; % = NR	n = NR ; % = NR

Characteristic	Robot-assisted arm therapy (N = 23)	Usual care (N = 22)
Diabetes Sample size	n = 10 ; % = 43.5	n = 12 ; % = 54.5
Hypertension Sample size	n = 16 ; % = 69.6	n = 14 ; % = 63.6
Drinking alcohol Sample size	n = 9 ; % = 39.1	n = 11 ; % = 50
Smoking Sample size	n = 8 ; % = 34.8	n = 4 ; % = 18.2
Severity NIHSS Mean (SD)	6.13 (1.79)	6.05 (1.79)
Time after stroke (days) Mean (SD)	20.09 (5.53)	19.41 (7.04)

Outcomes

Study timepoints

- Baseline
- 2 week (Post-intervention)
- 1 month (≥6 months outcomes from this group will be downgraded for indirectness)

Continuous outcomes

Outcome	Robot-assisted arm therapy, Baseline, N = 23	Robot-assisted arm therapy, 2 week, N = 23	Robot-assisted arm therapy, 1 month, N = 23	Usual care, Baseline, N = 22	Usual care, 2 week, N = 22	Usual care, 1 month, N = 22
Activities of daily living (functional independence measure) Scale range: 18-126. Final values. Mean (SD)	87.7 (16.71)	93.39 (15.99)	95.48 (15.85)	81.91 (11.82)	84.55 (12.7)	86.45 (13.25)
Arm function (Fugl-Meyer assessment) Scale range: 0-66. Final values. Mean (SD)	39.83 (8.53)	45.61 (8.83)	48.87 (8.63)	36.36 (7.25)	39.32 (8.17)	41.91 (7.71)
Arm muscle strength (Motricity Index) Scale range: 0-100. Final values. Mean (SD)	59.52 (10.32)	65.22 (9.31)	68.87 (8.64)	55.05 (8.65)	58.95 (9.33)	61.86 (9.13)
Spasticity (modified Ashworth scale) Calculated from individual patient data. Scale range: 0-5. Final values. Mean (SD)	1.22 (0.78)	1.13 (0.9)	1.09 (1.06)	1.27 (0.96)	1.32 (1.02)	1.14 (0.87)

Activities of daily living (functional independence measure) - Polarity - Higher values are better
Arm function (Fugl-Meyer assessment) - Polarity - Higher values are better

Arm muscle strength (Motricity Index) - Polarity - Higher values are better
Spasticity (modified Ashworth scale) - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Activitiesofdailyliving(functionalindependencemeasure)-MeanSD-Robot-assisted arm therapy-Usual care-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Activitiesofdailyliving(functionalindependencemeasure)-MeanSD-Robot-assisted arm therapy-Usual care-t1

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Partially applicable *(Outcome indirectness - Outcomes at 16 weeks will be downgraded for indirectness as they were at a time point less than 6 months but after the post-intervention follow up.)*

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-MeanSD-Robot-assisted arm therapy-Usual care-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-MeanSD-Robot-assisted arm therapy-Usual care-t1

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Partially applicable *(Outcome indirectness - Outcomes at 16 weeks will be downgraded for indirectness as they were at a time point less than 6 months but after the post-intervention follow up.)*

Continuousoutcomes-Armmusclestrength(MotricityIndex)-MeanSD-Robot-assisted arm therapy-Usual care-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armmusclestrength(MotricityIndex)-MeanSD-Robot-assisted arm therapy-Usual care-t1

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High

Section	Question	Answer
Overall bias and Directness	Overall Directness	Partially applicable *(Outcome indirectness - Outcomes at 16 weeks will be downgraded for indirectness as they were at a time point less than 6 months but after the post-intervention follow up.)*

Continuousoutcomes-Spasticity(modifiedAshworthscale)-MeanSD-Robot-assisted arm therapy-Usual care-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(modifiedAshworthscale)-MeanSD-Robot-assisted arm therapy-Usual care-t1

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Partially applicable *(Outcome indirectness - Outcomes at 16 weeks will be downgraded for indirectness as they were at a time point less than 6 months but after the post-intervention follow up.)*

Kahn et al.

Bibliographic Reference	Kahn, Leonard E.; Averbuch, Michele; Rymer, W. Zev; Reinkensmeyer, David J.; Comparison of robot-assisted reaching to free reaching in promoting recovery from chronic stroke; 39-44

Study details

Secondary publication of another included study- see primary study for details	Kahn et al. Robot-assisted reaching exercise promotes arm movement recovery in chronic hemiparetic stroke: a randomized controlled pilot study. Journal of neuroengineering and rehabilitation; 2006; vol. 3 (no. 1); 1-13
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.

Kahn, 2006

Bibliographic Reference	Kahn, Leonard E.; Zygman, Michele L.; Rymer, W. Zev; Reinkensmeyer, David J.; Robot-assisted reaching exercise promotes arm movement recovery in chronic hemiparetic stroke: a randomized controlled pilot study; Journal of neuroengineering and rehabilitation; 2006; vol. 3 (no. 1); 1-13

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review. Kahn L, Averbuch M, Rymer W, Reinkensmeyer J. Comparison of robot-assisted reaching to free reaching in promoting recovery from chronic stroke. In: Mokhtari M editor(s). *Integration of Assistive Technology in the Information Age*. Amsterdam: IOS Press, 2001:39-44.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	Not stated/unclear
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Not stated/unclear
Subgroup 8: Type of movement delivered by robotic device	Active assisted movement

Study arms

Robot active-assist training (N = 10)
Robot-guided active-assist arm training in an 8 week therapy programme involving 24 sessions, each lasting 45 minutes.

Free reaching training (N = 9)
'Free reaching training' that involved unconstrained, unassisted repetitive voluntary reaching in an 8 week therapy programme involving 24 sessions, each lasting 45 minutes.

Outcomes

Study timepoints
- Baseline
- 8 week (Post-intervention)

Dichotomous outcome

Outcome	Robot active-assist training, Baseline, N = 10	Robot active-assist training, 8 week, N = 10	Free reaching training, Baseline, N = 9	Free reaching training, 8 week, N = 9
Withdrawal for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot active-assist training-Free reaching training-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Kim, 2021

Bibliographic Reference	Kim, J. H.; Ko, M. H.; Park, J. W.; Lee, H. J.; Nam, K. Y.; Nam, Y. G.; Oh, C. H.; Park, J. H.; Kwon, B. S.; Efficacy of Electromechanically-Assisted Rehabilitation of Upper Limb Function in Post-Stroke Patients: A Randomized Controlled Study; Journal Of Rehabilitation Medicine Clinical Communications; 2021; vol. 4; 1000074

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	No additional information.
Trial name / registration number	CRIS registration number KCT0003525.

Study type	Randomised controlled trial (RCT)
Study location	Republic of Korea.
Study setting	Outpatient follow up.
Study dates	11 September 2018 to 19 March 2020.
Sources of funding	Supported by a grant of the Korea Health Technology R&D Project through the Korea Health Industry Development Institute (KHIDI), funded by the Ministry of Health & Welfare, Republic of Korea (grant number: HI15C1529). Device support from Man&Tel Co. Ltd, Gumi, Republic of Korea.
Inclusion criteria	Hemiplegia due to stroke; over 19 years; impaired upper limb dysfunction due to hemiplegia; ischaemic or haemorrhagic stroke confirmed by brain imaging; fair to good cognitive function in order to be able to follow instructions; ability to sit independently in a wheelchair or chair.
Exclusion criteria	Bilateral upper limb dysfunction; impaired upper limb dysfunction due to osteoarthritis or pain; severe spasticity; inability to maintain the treatment due to any aetiology; heart or lung disease etc.
Recruitment / selection of participants	No additional information.
Intervention(s)	Robot-assisted arm therapy N=23 Electromechanically-assisted upper limb training using Camillo. The training program for this device was chosen according to the person's preference and cognitive function. Both groups performed the therapeutic intervention for 30 minutes a day, 5 days a week for 4 weeks. Concomitant therapy: all people underwent additional therapy for activities of daily living for 30 minutes daily during the study period.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)

Subgroup 3: Region of upper limb trained	Not stated/unclear
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Not stated/unclear
Population subgroups	No additional information.
Comparator	Usual care N=24 Occupational therapist-assisted upper limb training using a conventional method including stretching and joint exercise for the major joints of the upper extremities, and performing tasks to improve muscle strength and upper extremity motions, tailored to the subject's ability. Concomitant therapy: all people underwent additional therapy for activities of daily living for 30 minutes daily during the study period.
Number of participants	47

Duration of follow-up	4 weeks (post-intervention).
Indirectness	No additional information.
Additional comments	No additional information.

Study arms

Robot-assisted arm therapy (N = 23)
Electromechanically-assisted upper limb training using Camillo. The training program for this device was chosen according to the person's preference and cognitive function. Both groups performed the therapeutic intervention for 30 minutes a day, 5 days a week for 4 weeks. Concomitant therapy: all people underwent additional therapy for activities of daily living for 30 minutes daily during the study period.

Usual care (N = 24)
Occupational therapist-assisted upper limb training using a conventional method including stretching and joint exercise for the major joints of the upper extremities, and performing tasks to improve muscle strength and upper extremity motions, tailored to the subject's ability. Concomitant therapy: all people underwent additional therapy for activities of daily living for 30 minutes daily during the study period.

Characteristics

Arm-level characteristics

Characteristic	Robot-assisted arm therapy (N = 23)	Usual care (N = 24)
% Female Sample size	n = 7 ; % = 43.8	n = 9 ; % = 56.3

Characteristic	Robot-assisted arm therapy (N = 23)	Usual care (N = 24)
Mean age (SD) (years) Mean (SD)	57.17 (15.12)	62.08 (12.42)
Ethnicity Sample size	n = NR ; % = NR	n = NR ; % = NR
Comorbidities Sample size	n = NR ; % = NR	n = NR ; % = NR
Severity Sample size	n = NR ; % = NR	n = NR ; % = NR
Time after stroke (days) Mean (SD)	342 (635.07)	813.67 (1225.81)

Outcomes

Study timepoints

- Baseline
- 4 week (Post-intervention)

Continuous outcomes

Outcome	Robot-assisted arm therapy, Baseline, N = 23	Robot-assisted arm therapy, 4 week, N = 23	Usual care, Baseline, N = 24	Usual care, 4 week, N = 24
Arm function (Fugl Meyer Assessment Upper Extremity Total score) Scale range: 0-66. Change scores. Mean (SD)	34.7 (24.27)	2.52 (5.48)	24.83 (21.71)	1.17 (4.18)
Arm muscle strength (Motricity Index) Scale range: 0-100. Change scores. Mean (SD)	55.78 (28.15)	5.74 (9.49)	38.38 (31.43)	0.54 (1.89)
Person/participant generic health-related quality of life (EQ-5D-5L) Scale range: -0.11-1. Change scores. Mean (SD)	0.53 (0.2)	0.01 (0.06)	0.28 (0.23)	0 (0.03)
Spasticity (modified Ashworth scale) Combination of values for shoulder, elbow and wrist. Scale range: 0-5. Change scores. Robot arm therapy - shoulder = -0.13 (0.38), elbow = -0.15 (0.38), wrist = -0.11 (0.34). Control: shoulder = 0.00 (0.29), elbow = 0.00 (0.29), wrist = -0.04 (0.20). Mean (SD)	0.72 (0.71)	-0.13 (0.37)	0.78 (0.8)	-0.013 (0.26)

Arm function (Fugl Meyer Assessment Upper Extremity Total score) - Polarity - Higher values are better
Arm muscle strength (Motricity Index) - Polarity - Higher values are better
Person/participant generic health-related quality of life (EQ-5D-5L) - Polarity - Higher values are better
Spasticity (modified Ashworth scale) - Polarity - Lower values are better

Dichotomous outcomes

Outcome	Robot-assisted arm therapy, Baseline, N = 23	Robot-assisted arm therapy, 4 week, N = 23	Usual care, Baseline, N = 24	Usual care, 4 week, N = 24
Withdrawal for any reason 10 withdrew from the control group, 5 from the experimental group due to simple withdrawal or incomplete evaluation No of events	n = NA ; % = NA	n = 5 ; % = 22	n = NA ; % = NA	n = 10 ; % = 42
Adverse events - Other reported adverse events No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Withdrawal for any reason - Polarity - Lower values are better
Adverse events - Other reported adverse events - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(FuglMeyerAssessmentUpperExtremityTotalscore)-MeanSD-Robot-assisted arm therapy-Usual care-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armmusclestrength(MotricityIndex)-MeanSD-Robot-assisted arm therapy-Usual care-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Person/participantgenerichealth-relatedqualityoflife(EQ-5D-5L)-MeanSD-Robot-assisted arm therapy-Usual care-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(modifiedAshworthscale)-MeanSD-Robot-assisted arm therapy-Usual care-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm therapy-Usual care-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Adverseevents-Otherreportedadverseevents-NoOfEvents-Robot-assisted arm therapy-Usual care-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Kim, 2019

Bibliographic Reference	Kim, M. S.; Kim, S. H.; Noh, S. E.; Bang, H. J.; Lee, K. M.; Robotic-Assisted Shoulder Rehabilitation Therapy Effectively Improved Poststroke Hemiplegic Shoulder Pain: A Randomized Controlled Trial; Archives of Physical Medicine & Rehabilitation; 2019; vol. 100 (no. 6); 1015-1022

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	No additional information.
Trial name / registration number	Clinical Trial Registration number: KCT0002696.

Study type	Randomised controlled trial (RCT)
Study location	Republic of Korea
Study setting	Outpatient follow up
Study dates	12 months starting in March 2016.
Sources of funding	Support by Wonkwang Institute of Clinical Medicine (2016-0669), Republic of Korea
Inclusion criteria	Subacute stroke patients who reported hemiplegic shoulder pain with a minimum visual analog scale of 3 points (0-10 scale).
Exclusion criteria	Significant cognitive impairment (Korean version of the Mini-Mental State Examination <15) or language deficits; preexisting shoulder pain prior to stroke; definite shoulder abnormalities in the affected limb, on radiographs; suspected complex regional pain syndrome, central pain or myofascial pain syndrome.
Recruitment / selection of participants	People were recruited consecutively from a single tertiary university hospital.
Intervention(s)	Robot-assisted arm training N=19 Robot-assisted shoulder rehabilitation therapy for 30 minutes per day, 5 times per week for a total of 20 sessions for 4 weeks. This involved achieving the maximal pain-tolerable range of motion of the shoulder joint, using the robot arm to increase that angle for approximately 10 seconds and then returning to the original position and then repeating this cycle every 5 minutes. Concomitant therapy: All people received usual care.
Subgroup 1: Severity	Moderate (or NIHSS 5-14)
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)

Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Not stated/unclear
Population subgroups	No additional information.
Comparator	Usual care N=19 Conventional rehabilitation only. Using patient-reported outcome measures exercises and reducing neurologic injury based on the Bobath approach and performed twice a day in both groups. Additional physical agent modalities, such as hot pack application, ultasound, and transcutaneous electrical nerve stimulation and analgesics were equally administered in both groups. Other occupational, language and cognitive therapies commonly performed in stroke rehabilitation settings were carried out in both groups during the study period. Concomitant therapy: All people received usual care.
Number of participants	38

Duration of follow-up	4 weeks (post-intervention), 8 weeks (4 weeks after cessation of intervention, will be included in the ≥6 months time point but outcomes will be downgraded for indirectness as the time point is <6 months).
Indirectness	Outcome indirectness - Outcomes at 8 weeks will be downgraded for indirectness as they were at a time point less than 6 months but after the post-intervention follow up.
Additional comments	Method of analysis unclear. Appears to be completers only.

Study arms

Robot-assisted arm training (N = 19)
Robot-assisted shoulder rehabilitation therapy for 30 minutes per day, 5 times per week for a total of 20 sessions for 4 weeks. This involved achieving the maximal pain-tolerable range of motion of the shoulder joint, using the robot arm to increase that angle for approximately 10 seconds and then returning to the original position and then repeating this cycle every 5 minutes. Concomitant therapy: All people received usual care.

Usual care (N = 19)
Conventional rehabilitation only. Using patient-reported outcome measures exercises and reducing neurologic injury based on the Bobath approach and performed twice a day in both groups. Additional physical agent modalities, such as hot pack application, ultasound, and transcutaneous electrical nerve stimulation and analgesics were equally administered in both groups. Other occupational, language and cognitive therapies commonly performed in stroke rehabilitation settings were carried out in both groups during the study period. Concomitant therapy: All people received usual care.

Characteristics

Arm-level characteristics

Characteristic	Robot-assisted arm training (N = 19)	Usual care (N = 19)
% Female Sample size	n = 7 ; % = 39	n = 7 ; % = 39
Mean age (SD) (years) Mean (SD)	65.9 (9.4)	64.7 (8.3)
Ethnicity Sample size	n = NR ; % = NR	n = NR ; % = NR
Comorbidities Sample size	n = NR ; % = NR	n = NR ; % = NR
Severity NIHSS Mean (SD)	8.8 (2.4)	9.6 (2.6)
Time after stroke (Months) Mean (SD)	3.2 (0.9)	3.3 (0.9)

Outcomes

Study timepoints

- Baseline
- 4 week (Post-intervention)

- 8 week (≥6 months - will be downgraded for indirectness due to being less than 6 months)

Continuous outcome

Outcome	Robot-assisted arm training, Baseline, N = 19	Robot-assisted arm training, 4 week, N = 19	Robot-assisted arm training, 8 week, N = 19	Usual care, Baseline, N = 19	Usual care, 4 week, N = 19	Usual care, 8 week, N = 19
Arm function (Korean-Shoulder Disability Questionnaire) Scale range: 0-100. Final values. Mean (SD)	96 (4)	68 (6)	65 (6)	96 (3)	83 (8)	82 (10)

Arm function (Korean-Shoulder Disability Questionnaire) - Polarity - Lower values are better

Dichotomous outcomes

Outcome	Robot-assisted arm training, Baseline, N = 19	Robot-assisted arm training, 4 week, N = 19	Robot-assisted arm training, 8 week, N = 19	Usual care, Baseline, N = 19	Usual care, 4 week, N = 19	Usual care, 8 week, N = 19
Withdrawal for any reason Intervention: 1 due to stroke recurrence. Control: 1 due to gastric cancer. No of events	n = NA ; % = NA	n = 1 ; % = 5	n = 1 ; % = 5	n = NA ; % = NA	n = 1 ; % = 5	n = 1 ; % = 5
Adverse events - Other reported adverse events Study states no adverse events.	n = NA ; % = NA	n = 0 ; % = 5	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0	n = 0 ; % = 0

Outcome	Robot-assisted arm training, Baseline, N = 19	Robot-assisted arm training, 4 week, N = 19	Robot-assisted arm training, 8 week, N = 19	Usual care, Baseline, N = 19	Usual care, 4 week, N = 19	Usual care, 8 week, N = 19
No of events						

Withdrawal for any reason - Polarity - Lower values are better
Adverse events - Other reported adverse events - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcome-Armfunction(Korean-ShoulderDisabilityQuestionnaire)-MeanSD-Robot-assisted arm training-Usual care-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcome-Armfunction(Korean-ShoulderDisabilityQuestionnaire)-MeanSD-Robot-assisted arm training-Usual care-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Partially applicable *(Outcome indirectness - Outcomes at 8 weeks will be downgraded for indirectness as they were at a time point less than 6 months but after the post-intervention follow up.)*

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm training-Usual care-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm training-Usual care-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Partially applicable *(Outcome indirectness - Outcomes at 8 weeks will be downgraded for indirectness as they were at a time point less than 6 months but after the post-intervention follow up.)*

Dichotomousoutcomes-Adverseevents-otheradverseevents-NoOfEvents-Robot-assisted arm training-Usual care-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Adverseevents-otheradverseevents-NoOfEvents-Robot-assisted arm training-Usual care-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Partially applicable *(Outcome indirectness - Outcomes at 8 weeks will be downgraded for indirectness as they were at a time point less than 6 months but after the post-intervention follow up.)*

Kutner, 2010

Bibliographic Reference	Kutner, Nancy G.; Zhang, Rebecca; Butler, Andrew J.; Wolf, Steven L.; Alberts, Jay L.; Quality-of-life change associated with robotic-assisted therapy to improve hand motor function in patients with subacute stroke: a randomized clinical trial; Physical therapy; 2010; vol. 90 (no. 4); 493-504

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)

Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Mixed 3-9 months
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	Not stated/unclear
Subgroup 5: Dose (days per week)	Not stated/unclear
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Active assisted movement

Study arms

Robotic assisted training (N = 10)
30 hours of repetitive task training plus 30 hours of robotic assisted training over 3 weeks.

Repetitive task training (N = 11)
60 hours of repetitive task training over 3 weeks.

Outcomes

Study timepoints

- Baseline
- 3 week (Post-intervention)
- 2 month (Post-intervention)

Continuous outcomes

Outcome	Robotic assisted training, Baseline, N = 10	Robotic assisted training, 3 week, N = 10	Robotic assisted training, 2 month, N = 10	Repetitive task training, Baseline, N = 7	Repetitive task training, 3 week, N = 7	Repetitive task training, 2 month, N = 7
Stroke-specific Patient Reported Outcome Measure (Stroke Impact Scale-ADL domain) Scale: unclear. Change scores. Values reported in the Cochrane review used. Mean (95% CI)	NR (NR to NR)	6.89 (0.18 to 13.61)	1.88 (-6.42 to 10.17)	NR (NR to NR)	8.49 (0.39 to 16.6)	7.53 (-2.35 to 17.4)
Stroke-specific Patient Reported Outcome Measure (Stroke Impact Scale-hand function domain) Scale: unclear. Change scores. Values reported in the Cochrane review used.	NR (NR to NR)	26.47 (14.69 to 38.26)	21.37 (7.31 to 35.44)	NR (NR to NR)	14.85 (0.64 to 29.06)	17.58 (0.84 to 34.22)

Outcome	Robotic assisted training, Baseline, N = 10	Robotic assisted training, 3 week, N = 10	Robotic assisted training, 2 month, N = 10	Repetitive task training, Baseline, N = 7	Repetitive task training, 3 week, N = 7	Repetitive task training, 2 month, N = 7
Mean (95% CI)						

Stroke-specific Patient Reported Outcome Measure (Stroke Impact Scale-ADL domain) - Polarity - Higher values are better
Stroke-specific Patient Reported Outcome Measure (Stroke Impact Scale-hand function domain) - Polarity - Higher values are better
ADL outcome: 3 week post-intervention results noted in Cochrane review were: 6.9 (10) for the intervention group and 8.5 (11.3) for the control group. [mean plus SD converted from mean plus 95% CI reported in study]. hand function outcome: 3 week post-intervention results noted in Cochrane review were: 26.5 (17.5) for the intervention group and 14.9 (19.9) for the control group. [mean plus SD converted from mean plus 95% CI reported in study].

Dichotomous outcome

Outcome	Robotic assisted training, Baseline, N = 11	Robotic assisted training, 3 week, N = 11	Robotic assisted training, 2 month, N = 11	Repetitive task training, Baseline, N = 10	Repetitive task training, 3 week, N = 10	Repetitive task training, 2 month, N = 10
Withdrawals for any reason 3 participants in the robot group did not receive the intervention due to transport difficulties. No of events	n = NA ; % = NA	n = 3 ; % = 27	n = NA ; % = NA	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA
Adverse events Narrative statement: no adverse events were reported. No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NR ; % = NR	n = NA ; % = NA	n = 0 ; % = 0	n = NR ; % = NR

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Stroke-specificPatientReportedOutcomeMeasure(StrokeImpactScale-ADLdomain)-MeanNineFivePercentCI-Robotic assisted training-Repetitive task training-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Stroke-specificPatientReportedOutcomeMeasure(StrokeImpactScale-ADLdomain)-MeanNineFivePercentCI-Robotic assisted training-Repetitive task training-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Continuousoutcomes-Stroke-specificPatientReportedOutcomeMeasure(StrokeImpactScale-handfunctiondomain)-MeanNineFivePercentCI-Robotic assisted training-Repetitive task training-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Stroke-specificPatientReportedOutcomeMeasure(StrokeImpactScale-handfunctiondomain)-MeanNineFivePercentCI-Robotic assisted training-Repetitive task training-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Dichotomousoutcome-Withdrawalsforanyreason-NoOfEvents-Robotic assisted training-Repetitive task training-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalsforanyreason-NoOfEvents-Robotic assisted training-Repetitive task training-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Lee, 2016

Bibliographic Reference	Lee, Kyeong Woo; Kim, Sang Beom; Lee, Jong Hwa; Lee, Sook Joung; Yoo, Seung Wan; Effect of upper extremity robot-assisted exercise on spasticity in stroke patients; Annals of rehabilitation medicine; 2016; vol. 40 (no. 6); 961

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised

Subgroup 8: Type of movement delivered by robotic device	Mixed

Study arms

Robot-assisted therapy (N = 29)
With the robot Neuro-X over 20 sessions (30 minutes per session, 2 sessions per day, 5 days a week for 2 weeks).

Conventional therapy (N = 29)
Conventional upper extremity rehabilitation exercise twice daily.

Outcomes

Study timepoints
- Baseline
- 2 week (Post-intervention)

Dichotomous outcome

Outcome	Robot-assisted therapy, Baseline, N = 29	Robot-assisted therapy, 2 week, N = 22	Conventional therapy, Baseline, N = 29	Conventional therapy, 2 week, N = 22
Withdrawal for any reason Robot group: 6 discharged early, 1 declined medical	n = NA ; % = NA	n = 7 ; % = 24	n = NA ; % = NA	n = 7 ; % = 24

Outcome	Robot-assisted therapy, Baseline, N = 29	Robot-assisted therapy, 2 week, N = 22	Conventional therapy, Baseline, N = 29	Conventional therapy, 2 week, N = 22
condition. Conventional group: 5 discharged early, 2 declined medical condition No of events				

Continuous outcomes

Outcome	Robot-assisted therapy, Baseline, N = 29	Robot-assisted therapy, 2 week, N = 22	Conventional therapy, Baseline, N = 29	Conventional therapy, 2 week, N = 22
Activities of daily living (Korean modified Barthel Index) Change scores reported at 2 weeks (baseline is total score). Values as reported in Cochrane review. Score 0-100 Mean (SD)	43.95 (19.2)	10 (7.1)	45.27 (13.87)	9.6 (6.5)
Arm function (Manual function Test) Change scores reported at 2 weeks (baseline is total score). Values as reported in Cochrane review. Score 0-32. Mean (SD)	6.77 (4.81)	1.6 (1.5)	6.32 (4.8)	1.2 (1.8)
Arm muscle strength (Manual Muscle Test) Change scores. Values as reported in Cochrane review. Score 0-5 Mean (SD)	NR (NR)	0.3 (0.5)	NR (NR)	0.2 (0.4)

Outcome	Robot-assisted therapy, Baseline, N = 29	Robot-assisted therapy, 2 week, N = 22	Conventional therapy, Baseline, N = 29	Conventional therapy, 2 week, N = 22
(Elbow flexor) Spasticity (modified Ashworth scale) Change scores reported at 2 weeks (baseline is total score). Score 0-5 Mean (SD)	1.91 (0.92)	-0.41 (0.5)	2.09 (0.61)	-0.23 (0.43)
(Shoulder adductor) Spasticity (modified Ashworth scale) Change scores reported at 2 weeks (baseline is total score). Score 0-5. Mean (SD)	1.77 (0.81)	-0.36 (0.49)	1.82 (0.73)	-0.23 (0.43)

Activities of daily living (Korean modified Barthel Index) - Polarity - Higher values are better
Arm function (Manual function Test) - Polarity - Higher values are better
Arm muscle strength (Manual Muscle Test) - Polarity - Higher values are better
(Elbow flexor) Spasticity (modified Ashworth scale) - Polarity - Lower values are better
(Shoulder adductor) Spasticity (modified Ashworth scale) - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-assisted therapy-Conventional therapy-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Activitiesofdailyliving(KoreanmodifiedBarthelIndex)-MeanSD-Robot-assisted therapy-Conventional therapy-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(ManualfunctionTest)-MeanSD-Robot-assisted therapy-Conventional therapy-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armmusclestrength(ManualMuscleTest)-MeanSD-Robot-assisted therapy-Conventional therapy-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-(Elbowflexor)Spasticity(modifiedAshworthscale)-MeanSD-Robot-assisted therapy-Conventional therapy-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-(Shoulderadductor)Spasticity(modifiedAshworthscale)-MeanSD-Robot-assisted therapy-Conventional therapy-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Lee, 2018

Bibliographic Reference	Lee, M. J.; Lee, J. H.; Lee, S. M.; Effects of robot-assisted therapy on upper extremity function and activities of daily living in hemiplegic patients: A single-blinded, randomized, controlled trial; Technology & Health Care; 2018; vol. 26 (no. 4); 659-666

Study details

Secondary publication of another included study- see primary study for details	NR

Other publications associated with this study included in review	NR
Trial name / registration number	NR
Study location	Korea
Study setting	rehabilitation hospital
Study dates	NR
Sources of funding	NR
Inclusion criteria	Patients were diagnosed with stroke induced hemiplegia occurring at least 6 months before study enrolment; patients were capable of communicating on their own with a score of > 21 points on the Korean version of the mini-mental state examination (MMSE-K); patients had a muscle tone of grade 2 or below on the Modified Ashworth scale in the hemiplegic upper extremity; patients had a minimally functional upper limb (FMA score >35).
Exclusion criteria	Patients with visual perception and cognitive deficits; patients with joint contracture or limited range of joint motion; patients who were unable to perform the exercise programme due to neurological or psychiatric problems.
Recruitment / selection of participants	Sixteen subjects were recruited to each group from rehabilitation centres belonging to the corkers compensation and welfare service.
Intervention(s)	In the experimental group he same treatment was applied as the control group for the same period of 30 mins of the REJOYCE robot treatment which led the use of the upper limb. The robotic device comprised of a notebook computer, a screen and a controller . the controller had 9 types of manipulation functions necessary t perform ADL such as: gross motor functions involving doorknobs, handles, jars, pouring a cup with water and fine motor functions involving keys and coins. Depending on the programmes settings the user could focus on training certain movements and strength. the degree of difficulty could be changed depending on the persons condition. 3 types of movement programme were applied for 10 mins each for a total of 30 mins.

	Concomitant therapy - Both groups received general occupational therapy consisting of 5, 30 min sessions per week for 8 weeks. The experimental group received a additional 30 min of robot assisted therapy, while the control group received an additional 30 min of general occupational therapy during each sessions over the same time period.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Mixed
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Active assisted movement
Population subgroups	NR
Comparator	Both groups received general occupational therapy consisting of 5, 30 min sessions per week for 8 weeks. The experimental group received a additional 30 min of robot assisted therapy, while the control group received an additional 30

	min of general occupational therapy during each sessions over the same time period. General occupational therapy comprised of stretching exercises, neurodevelopmental therapy, resistance exercise and fine motor training.
Number of participants	30
Duration of follow-up	8 weeks end of intervention
Indirectness	NR
Additional comments	NR

Study arms

Robot therapy (N = 15)

conventional therapy (N = 15)

Characteristics

Study-level characteristics

Characteristic	**Study (N = 30)**
Ethnicity Nominal	NR
Comorbidities Nominal	NR

Characteristic	Study (N = 30)
Severity Nominal	NR

Arm-level characteristics

Characteristic	Robot therapy (N = 15)	conventional therapy (N = 15)
% Female Nominal	46.7	26.7
Mean age (SD) Mean (SD)	52.07 (14.07)	50.27 (11.17)
Time after stroke Nominal	NR	NR
7-12 months Nominal	26.7	20
13-24 months Nominal	40	46.7
25 and above Nominal	33.3	33.3

Outcomes

Study timepoints

- Baseline
- 8 week

Continuous outcomes

Outcome	Robot therapy, Baseline, N = 15	Robot therapy, 8 week, N = 15	conventional therapy, Baseline, N = 15	conventional therapy, 8 week, N = 15
Activities of daily living (Modified Barthel Index) 0-100, change scores Mean (SD)	75.8 (10.31)	5.8 (5.73)	67.13 (15.14)	3.33 (4.95)
Arm function (Fugl Meyer UE) 0-66, change score Mean (SD)	51.87 (10.57)	8.2 (8.6)	50 (7.84)	2.33 (3.31)
Withdrawal for any reason No of events	n = 0 ; % = 0	n = 0 ; % = 0	n = 0 ; % = 0	n = 0 ; % = 0

Activities of daily living (Modified Barthel Index) - Polarity - Higher values are better
Arm function (Fugl Meyer UE) - Polarity - Higher values are better
Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot therapy-conventional therapy-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(FuglMeyerUE)-MeanSD-Robot therapy-conventional therapy-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Activitiesofdailyliving(ModifiedBarthelIndex)-MeanSD-Robot therapy-conventional therapy-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Lemmens, 2014

Bibliographic Reference	Lemmens, Ryanne J. M.; Timmermans, Annick A. A.; Janssen-Potten, Yvonne J. M.; Pulles, Sanne Antd; Geers, Richard P. J.; Bakx, Wilbert G. M.; Smeets, Rob J. E. M.; Seelen, Henk A. M.; Accelerometry measuring the outcome of robot-supported upper limb training in chronic stroke: a randomized controlled trial; PloS one; 2014; vol. 9 (no. 5); e96414

Study details

Secondary publication of another included study- see primary study for details	Timmermans et al. Effects of task-oriented robot training on arm function, activity, and quality of life in chronic stroke patients: a randomized controlled trial.mJournal of neuroengineering and rehabilitation; 2014; vol. 11 (no. 1); 1-12
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.

Lencioni, 2021

Bibliographic Reference	Lencioni, T.; Fornia, L.; Bowman, T.; Marzegan, A.; Caronni, A.; Turolla, A.; Jonsdottir, J.; Carpinella, I.; Ferrarin, M.; A randomized controlled trial on the effects induced by robot-assisted and usual-care rehabilitation on upper limb muscle synergies in post-stroke subjects; Scientific Reports; 2021; vol. 11 (no. 1); 5323

Study details

Secondary publication of another included study- see primary study for details	Carpinella, I. et al. Effects of robot therapy on upper body kinematics and arm function in persons post stroke: a pilot randomized controlled trial. J. Neuroeng. Rehabil. 17, 10 (2020).

Other publications associated with this study included in review	NR
Trial name / registration number	

Study arms

Robot therapy (N = 20)

Conventional therapy (N = 20)

Liao, 2012

Bibliographic Reference	Liao, Wan-wen; Wu, Ching-yi; Hsieh, Yu-wei; Lin, Keh-chung; Chang, Wan-ying; Effects of robot-assisted upper limb rehabilitation on daily function and real-world arm activity in patients with chronic stroke: a randomized controlled trial; Clinical rehabilitation; 2012; vol. 26 (no. 2); 111-120

Study details

Secondary publication of another included	Hsieh YW, Wu CY, Liao WW, Lin KC, Wu KY, Lee CY. Effects of treatment intensity in upper limb robot-assisted therapy for chronic stroke: a pilot randomized controlled trial. *Neurorehabilitation and Neural Repair* 2011;25(6):503-11.

study- see primary study for details	
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Not stated/unclear
Subgroup 8: Type of movement delivered by robotic device	Mixed

Study arms

Robot-assisted therapy (N = 10)
With Bi-Manu -Track over 4 weeks, 5 days a week for 90 to 105 minutes per session. After robot training, participants received 15 minutes of training in functional activities.

Active control therapy (N = 10)
Protocol-based occupational therapy techniques. The control group received the same amount of therapy hours as the treatment group; after the active control therapy session the participants also received 15 minutes of training in functional activities.

Outcomes

Study timepoints
- Baseline
- 4 week (Post-intervention)

Dichotomous outcome

Outcome	Robot-assisted therapy, Baseline, N = 10	Robot-assisted therapy, 4 week, N = 10	Active control therapy, Baseline, N = 10	Active control therapy, 4 week, N = 10
Withdrawal for any reason No of events	n = NR ; % = NR	n = 0 ; % = 0	n = NR ; % = NR	n = 0 ; % = 0

Continuous outcomes

Outcome	Robot-assisted therapy, Baseline, N = 10	Robot-assisted therapy, 4 week, N = 10	Active control therapy, Baseline, N = 10	Active control therapy, 4 week, N = 10
Activities of daily living (ABILHAND) Change scores. Scale range 0-69 Mean (SD)	0.99 (0.26)	0.3 (0.2)	0.92 (0.45)	0 (0.3)
Arm function (Fugl-Meyer assessment) Change scores. Scale range 0-66. Values as reported in Cochrane review. Mean (SD)	NR (NR)	6.3 (5.6)	NR (NR)	1.3 (7.9)

Activities of daily living (ABILHAND) - Polarity - Higher values are better
Arm function (Fugl-Meyer assessment) - Polarity - Higher values are better
Also reports Motor Activity Log (AOU and QOM separately), and FIM for ADL.

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-MeanSD-Robot-assisted therapy-Active control therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Activitiesofdailyliving(ABILHAND)-MeanSD-Robot-assisted therapy-Active control therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-assisted therapy-Active control therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Lin, 2022

Bibliographic Reference	Lin, Y; Li, QY; Qu, Q; Ding, L; Chen, Z; Huang, F; Hu, S; Deng, W; Guo, F; Wang, C; et, al.; Comparative Effectiveness of Robot-Assisted Training Versus Enhanced Upper Extremity Therapy on Upper and Lower Extremity for Stroke Survivors: a Multicentre Randomized Controlled Trial; Journal of rehabilitation medicine; 2022; jrm00314

Study details

Secondary publication of another included study- see primary study for details	No additional information.

Other publications associated with this study included in review	No additional information.
Trial name / registration number	ChiCTR2000038676
Study type	Randomised controlled trial (RCT)
Study location	China
Study setting	Outpatient follow up.
Study dates	May 2019 to July 2020.
Sources of funding	Supported by the National Key and Research Development Program of Ministry of Science and Technology of the People's Republic of China (grant numbers 2018YFC2002300 and 2018YFC2002301), the National Natural Science Foundation of China Major Research Programs (grant numbers 91948302 and 82021002) and Shanghai Municipal Health and Family Planning Commission (grant number 20194Y0509).
Inclusion criteria	Unilateral paresis with first ischaemic or haemorrhagic stroke confirmed by computed tomography or magnetic resonance imaging that occurred between 1 week and 2 years before enrollment; the ability to perform no or some active movements in the shoulder and/or elbow joints in the sitting position, allowing for trunk compensation if needed; the ability to understand and follow simple instructions.
Exclusion criteria	Bilateral impairment; multiple strokes; inability to sign informed consent; medical conditions that could interfere with training (severe auditory or visual impairments, orthopaedic contracture and severe cardiovascular disease).
Recruitment / selection of participants	No additional information.
Intervention(s)	Robot-assisted arm training N=86 Robot-assisted arm training using the FLEXO-Arm1 robot for 30 minutes, 5 days a week for 3 weeks. Training was provided by a physiotherapist. The robot exercise consisted of 2 types of movement patterns: teaching training and task-oriented training. This included 5 degrees of freedom: shoulder flexion-extension and adduction-abduction, horizontal and vertical elbow flexion-extension, and wrist flexion-extension. The teaching training included passive movements and was used for

	the first 10 minutes while the task-oriented training included active-assisted movements and was used for the second 20 minutes. Concomitant therapy: All people received conventional rehabilitation, 5 days a week for 3 weeks, divided into two 30 minute sessions of physiotherapy and occupational therapy.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Mixed
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Mixed
Population subgroups	No additional information.

Comparator	Any other intervention (task oriented training) N=86 Enhanced occupational therapy that was time matched to the robot arm training. Concomitant therapy: All people received conventional rehabilitation, 5 days a week for 3 weeks, divided into two 30 minute sessions of physiotherapy and occupational therapy.
Number of participants	172
Duration of follow-up	3 weeks (end of intervention)
Indirectness	No additional information.
Additional comments	Methods of analyses are intention to treat and per protocol analyses.

Study arms

Robot-assisted arm training (N = 86)
Robot-assisted arm training using the FLEXO-Arm1 robot for 30 minutes, 5 days a week for 3 weeks. Training was provided by a physiotherapist. The robot exercise consisted of 2 types of movement patterns: teaching training and task-oriented training. This included 5 degrees of freedom: shoulder flexion-extension and adduction-abduction, horizontal and vertical elbow flexion-extension, and wrist flexion-extension. The teaching training included passive movements and was used for the first 10 minutes while the task-oriented training included active-assisted movements and was used for the second 20 minutes. Concomitant therapy: All people received conventional rehabilitation, 5 days a week for 3 weeks, divided into two 30 minute sessions of physiotherapy and occupational therapy.

Any other intervention (task oriented training) (N = 86)
Enhanced occupational therapy that was time matched to the robot arm training. Concomitant therapy: All people received conventional rehabilitation, 5 days a week for 3 weeks, divided into two 30 minute sessions of physiotherapy and occupational therapy.

Characteristics

Arm-level characteristics

Characteristic	Robot-assisted arm training (N = 86)	Any other intervention (task oriented training) (N = 86)
% Female Sample size	n = 22 ; % = 26.8	n = 22 ; % = 25.6
Mean age (SD) (years) Mean (SD)	59.37 (10.96)	58.72 (12.89)
Ethnicity Sample size	n = NR ; % = NR	n = NR ; % = NR
Comorbidities Sample size	n = NR ; % = NR	n = NR ; % = NR
Severity Mean (SD)	NR (NR)	NR (NR)
Time after stroke (days) Mean (SD)	142.3 (162.84)	158.23 (178.2)

Outcomes

Study timepoints

- Baseline
- 3 week (End of intervention)

Continuous outcomes

Outcome	Robot-assisted arm training, Baseline, N = 82	Robot-assisted arm training, 3 week, N = 72	Any other intervention (task oriented training), Baseline, N = 86	Any other intervention (task oriented training), 3 week, N = 72
Arm function (Fugl-Meyer assessment- upper extremity) Scale range: 0-66. Change scores. Per protocol. Mean (SD)	31.23 (18.95)	7.01 (6.94)	25.69 (14.46)	5.63 (5.24)
Activities of daily living (Modified Barthel Index) Scale range: 0-100. Change scores. Mean (SD)	66.04 (23.47)	10.81 (9.98)	58.97 (24.19)	9.99 (10.72)

Arm function (Fugl-Meyer assessment- upper extremity) - Polarity - Higher values are better
Activities of daily living (Modified Barthel Index) - Polarity - Higher values are better

Continuous outcomes (mean difference)

Outcome	Robot-assisted arm training vs Any other intervention (task oriented training), Baseline, N2 = 72, N1 = 72	Robot-assisted arm training vs Any other intervention (task oriented training), 3 week, N2 = 72, N1 = 72
Arm function (Fugl-Meyer assessment- upper extremity) Scale range: 0-66. Change scores. Adjusted mean difference using the per-protocol set. Mean (95% CI)	NA (NA to NA)	1.33 (-0.71 to 3.37)

Arm function (Fugl-Meyer assessment- upper extremity) - Polarity - Higher values are better

Dichotomous outcomes

Outcome	Robot-assisted arm training, Baseline, N = 86	Robot-assisted arm training, 3 week, N = 86	Any other intervention (task oriented training), Baseline, N = 86	Any other intervention (task oriented training), 3 week, N = 86
Withdrawal for any reason Intervention: 4 did not receive the intervention due to covid-19, 1 lost to follow up, 1 adverse event, 3 withdrew consent, 1 discharge for covid 19, 4 discharged for personal reasons. Control: 1 selective operation, 1 adverse event, 2 withdrew consent, 2 discharged for covid-19, 9 discharged for personal reason No of events	n = NA ; % = NA	n = 14 ; % = 16	n = NA ; % = NA	n = 14 ; % = 16
Adverse events - other reported adverse events Each arm had 1 withdrawal due to adverse events - downgrade due to indirectness	n = NA ; % = NA	n = 1 ; % = 2	n = NA ; % = NA	n = 1 ; % = 2

Outcome	Robot-assisted arm training, Baseline, N = 86	Robot-assisted arm training, 3 week, N = 86	Any other intervention (task oriented training), Baseline, N = 86	Any other intervention (task oriented training), 3 week, N = 86
No of events				

Withdrawal for any reason - Polarity - Lower values are better
Adverse events - other reported adverse events - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Activitiesofdailyliving(ModifiedBarthelIndex)-MeanSD-Robot-assisted arm training-Any other intervention (task oriented training)-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes(meandifference)-Armfunction(FuglMeyerassessment-upperextremity)-MeanNineFivePercentCI-Robot-assisted arm training-Any other intervention (task oriented training)-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm training-Any other intervention (task oriented training)-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Adverseevents-otherreportedadverseevents-NoOfEvents-Robot-assisted arm training-Any other intervention (task oriented training)-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Partially applicable *(Outcome indirectness - withdrawal adverse events reported only (does not report any other adverse events))*

Linder, 2013

Bibliographic Reference	Linder, Susan M.; Rosenfeldt, Anson B.; Reiss, Aimee; Buchanan, Sharon; Sahu, Komal; Bay, Curtis R.; Wolf, Steven L.; Alberts, Jay L.; The home stroke rehabilitation and monitoring system trial: a randomized controlled trial; International journal of stroke; 2013; vol. 8 (no. 1); 46-53

Study details

Secondary publication of another included study- see primary study for details	Wolf et al. The HAAPI (Home Arm Assistance Progression Initiative) trial: a novel robotics delivery approach in stroke rehabilitation. Neurorehabilitation and neural repair; 2015; vol. 29 (no. 10); 958-968
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.

Lo, 2010

Bibliographic Reference	Lo, Albert C.; Guarino, Peter D.; Richards, Lorie G.; Haselkorn, Jodie K.; Wittenberg, George F.; Federman, Daniel G.; Ringer, Robert J.; Wagner, Todd H.; Krebs, Hermano I.; Volpe, Bruce T.; Robot-assisted therapy for long-term upper-limb impairment after stroke; New England Journal of Medicine; 2010; vol. 362 (no. 19); 1772-1783

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.

Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Mixed
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	Not stated/unclear
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Not stated/unclear

Study arms

Intensive robot-assisted therapy (N = 49)
Maximum of 36 sessions over 12 weeks.

Non-robot therapy (N = 78)
Intensive comparison therapy which matched the robot therapy in schedule and in form of intensity of movements. (n=50) Customary care (i.e. medical management , clinic visits needed and in some cases, rehabilitation services). (n=28) These groups were collapsed into one control group in analysis.

Outcomes

Study timepoints
- Baseline
- 12 week (Post-intervention)

Dichotomous outcome

Outcome	Intensive robot-assisted therapy, Baseline, N = 49	Intensive robot-assisted therapy, 12 week, N = 49	Non-robot therapy, Baseline, N = 78	Non-robot therapy, 12 week, N = 78
Withdrawal for any reason Values as reported in Cochrane review. Robot group: 3 withdrew consent, 1 lost to follow-up, 1 hospitalised. Comparison group: 3 died, 4 withdrew consent, 2 lost to follow-up, 1 hospitalised, 1 unable to travel. No of events	n = NA ; % = NA	n = 5 ; % = 10	n = NA ; % = NA	n = 11 ; % = 14
Adverse events Related to study therapy. Included pain/ stiffness,/ soreness, fatigue, swelling/ bruising, cut/ scratch/ irritation and numbness. No of events	n = NA ; % = NA	n = 12 ; % = 24	n = NA ; % = NA	n = 9 ; % = 18

Continuous outcomes

Outcome	Intensive robot-assisted therapy, Baseline, N = 49	Intensive robot-assisted therapy, 12 week, N = 49	Non-robot therapy, Baseline, N = 78	Non-robot therapy, 12 week, N = 78
Arm function (Fugl-Meyer assessment) Change scores. Scale 0-66. Values are those reported in Cochrane review. Mean (SD)	NA (NA)	3.9 (7.4)	NA (NA)	0 (6.4)
Spasticity (Ashworth MAS) Change scores. Scale 0-5. Values calculated from mean plus SE reported. Mean (SD)	NA (NA)	-0.07 (0.09)	NA (NA)	0.06 (0.5)
Stroke-specific Patient Reported Outcome Measure (Stroke Impact Scale) Change score. Scale range 0-100. Values are those reported in the Cochrane review. Mean (SD)	NA (NA)	6.3 (11.8)	NA (NA)	1.4 (12.1)

Arm function (Fugl-Meyer assessment) - Polarity - Higher values are better
Spasticity (Ashworth MAS) - Polarity - Lower values are better
Stroke-specific Patient Reported Outcome Measure (Stroke Impact Scale) - Polarity - Higher values are better
For spasticity outcome, values were calculated from means and SE reported. Values reported in paper: usual care: -0.04 (0.11), intensive comparison therapy: 0.12 (0.09)

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Intensive robot-assisted therapy-Non-robot therapy-t12

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Adverseevents-NoOfEvents-Intensive robot-assisted therapy-Non-robot therapy-t12

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-MeanSD-Intensive robot-assisted therapy-Non-robot therapy-t12

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(AshworthMAS)-MeanSD-Intensive robot-assisted therapy-Non-robot therapy-t12

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Stroke-specificPatientReportedOutcomeMeasure(StrokeImpactScale)-MeanSD-Intensive robot-assisted therapy-Non-robot therapy-t12

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Lum, 2002

Bibliographic Reference	Lum, Peter S.; Burgar, Charles G.; Shor, Peggy C.; Majmundar, Matra; Van der Loos, Machiel; Robot-assisted movement training compared with conventional therapy techniques for the rehabilitation of upper-limb motor function after stroke; Archives of physical medicine and rehabilitation; 2002; vol. 83 (no. 7); 952-959

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with	This study was included in the Cochrane review that this review was based on: 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

this study included in review	muscle strength after stroke. Cochrane Database of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review. Burgar C, Lum P, Shor P, Van der Loos H. Development of robots for rehabilitation therapy: the Palo Alto VA/Stanford experience. *Journal of Rehabilitation Research and Development* 2000;37(6):663-73. Burgar CG, Lum PS, Shor M, Loos HFM. Rehabilitation of upper limb dysfunction in chronic hemiplegia: robot-assisted movement versus conventional therapy. *Archives of Physical Medicine and Rehabilitation* 1999;80:1121.
Study type	Randomised controlled trial (RCT)
Sources of funding	
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Not stated/unclear
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	Not stated/unclear
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised

Subgroup 8: Type of movement delivered by robotic device	Mixed

Study arms

Robot therapy (N = 15)
Received bimanual and passive robot therapy by the MIME robot as per the control group.

Physiotherapy (N = 15)
Received 55 minutes of physiotherapy for the arm and 5 minutes of robot training for each of the 24 sessions over a 2 month period.

Outcomes

Study timepoints
- Baseline
- 2 month (Post-intervention)
- 6 month (Post-intervention.)

Dichotomous outcome

Outcome	Robot therapy, Baseline, N = 15	Robot therapy, 2 month, N = 15	Robot therapy, 6 month, N = 15	Physiotherapy, Baseline, N = 15	Physiotherapy, 2 month, N = 15	Physiotherapy, 6 month, N = 15
Withdrawal for any reason 2 dropped out because of medical	n = NA ; % = NA	n = 2 ; % = 13	n = NR ; % = NR	n = NA ; % = NA	n = 1 ; % = 8	n = NR ; % = NR

Outcome	Robot therapy, Baseline, N = 15	Robot therapy, 2 month, N = 15	Robot therapy, 6 month, N = 15	Physiotherapy, Baseline, N = 15	Physiotherapy, 2 month, N = 15	Physiotherapy, 6 month, N = 15
complications unrelated to the study, and 1 participant's data were not included in the analysis due late confirmation of ineligibility for the trial. Groups not reported. No of events						

Continuous outcomes

Outcome	Robot therapy, Baseline, N = 15	Robot therapy, 2 month, N = 13	Robot therapy, 6 month, N = 13	Physiotherapy, Baseline, N = 15	Physiotherapy, 2 month, N = 14	Physiotherapy, 6 month, N = 14
Activities of daily living (barthel index) Change scores. Scale 0-100. Mean (SE)	90.8 (2.6)	1.2 (1.2)	2.1 (1.3)	84.8 (3.3)	0 (0)	0.4 (0.4)
Arm function (Fugl-Meyer assessment)-proximal limb Change scores. Scale 0-42. Mean (SE)	NR (NR)	3.3 (0.7)	3.6 (1)	NR (NR)	1.6 (0.3)	2.8 (0.8)
Arm function (Fugl-Meyer assessment)-distal limb	NR (NR)	1.4 (0.5)	1.3 (0.4)	NR (NR)	1.5 (0.5)	2 (0.6)

Outcome	Robot therapy, Baseline, N = 15	Robot therapy, 2 month, N = 13	Robot therapy, 6 month, N = 13	Physiotherapy, Baseline, N = 15	Physiotherapy, 2 month, N = 14	Physiotherapy, 6 month, N = 14
Change scores. Scale 0-24. Mean (SE)						

Activities of daily living (barthel index) - Polarity - Higher values are better
Arm function (Fugl-Meyer assessment)- proximal limb - Polarity - Higher values are better
Arm function (Fugl-Meyer assessment)- distal limb - Polarity - Higher values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-distallimb-MeanSE-Robot therapy-Physiotherapy-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot therapy-Physiotherapy-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Activitiesofdailyliving(barthelindex)-MeanSE-Robot therapy-Physiotherapy-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Activitiesofdailyliving(barthelindex)-MeanSE-Robot therapy-Physiotherapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-proximallimb-MeanSE-Robot therapy-Physiotherapy-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-proximallimb-MeanSE-Robot therapy-Physiotherapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-distallimb-MeanSE-Robot therapy-Physiotherapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Lum, 2006

Bibliographic Reference	Lum, Peter S.; Burgar, Charles G.; Van der Loos, Machiel; Shor, Peggy C.; Majmundar, Matra; Yap, Ruth; MIME robotic device for upper-limb neurorehabilitation in subacute stroke subjects: A follow-up study; Journal of rehabilitation research & development; 2006; vol. 43 (no. 5)

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with	This study was included in the Cochrane review that this review was based on: 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

this study included in review	muscle strength after stroke. Cochrane Database of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months) 1-5 months
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	Not stated/unclear
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Not stated/unclear
Subgroup 8: Type of movement delivered by robotic device	Mixed

Study arms

Robot therapy (N = 24)
Group 1: robot unilateral group performed exercises with the MIME device that progressed from the easiest exercise modes (passive) to the most challenging (active-constrained); no bilateral exercise was performed. Group 2: robot-bilateral group practised that same

12 reaching movements as in group 1, but only in bilateral mode with the MIME device. Group 3: Robot-combined group spent approximately half the treatment time in unilateral mode (as in group p1) and the other half in the bilateral mode with the MIME device. The 3 groups were combined for analysis.

Conventional therapy (N = 6)
Received an equivalent intensity and duration of conventional therapy targeting proximal upper limb function based on neurodevelopmental treatment.

Outcomes

Study timepoints
- Baseline
- 4 week (Post-intervention)
- 6 month (Post-intervention)

Dichotomous outcomes

Outcome	Robot therapy, Baseline, N = 24	Robot therapy, 4 week, N = 24	Robot therapy, 6 month, N = 24	Conventional therapy, Baseline, N = 6	Conventional therapy, 4 week, N = 6	Conventional therapy, 6 month, N = 6
Withdrawal for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = 6 ; % = 25	n = NA ; % = NA	n = 0 ; % = 0	n = 1 ; % = 17

Continuous outcomes

Outcome	Robot therapy, Baseline, N = 24	Robot therapy, 4 week, N = 24	Robot therapy, 6 month, N = 18	Conventional therapy, Baseline, N = 6	Conventional therapy, 4 week, N = 6	Conventional therapy, 6 month, N = 5
Activities of daily living (functional independence measure) Change scores. Scale 0-63. Values at 4 weeks as reported in Cochrane review. Values at 6 months calculated from SEs reported. Mean (SD)	NA (NA)	2.9 (1.2)	4 (5.9)	NA (NA)	3.2 (1.4)	5.2 (3.8)
Arm function (Fugl-Meyer assessment- overall) Change scores. Scale 0-66. Values as reported in Cochrane review. Mean (SD)	NR (NR)	7 (1.8)	NR (NR)	NR (NR)	6.5 (2.5)	NR (NR)
Arm function (Fugl-Meyer assessment)- proximal limb Change scores. Scale 0-42. Calculated from SEs provided Mean (SD)	NA (NA)	NA (NA)	6.1 (4.3)	NA (NA)	NA (NA)	7.6 (2.7)
Arm function (Fugl-Meyer assessment)- distal limb Change scores. Scale 0-24. Calculated from SEs provided. Mean (SD)	NA (NA)	NA (NA)	5.3 (5.1)	NA (NA)	NA (NA)	6.2 (5.6)

Outcome	Robot therapy, Baseline, N = 24	Robot therapy, 4 week, N = 24	Robot therapy, 6 month, N = 18	Conventional therapy, Baseline, N = 6	Conventional therapy, 4 week, N = 6	Conventional therapy, 6 month, N = 5
Arm strength (Motor Power) Change scores. Scale 0-70. Values for 4 week outcomes as reported in Cochrane review. Values for 6 month outcomes calculated from SEs reported. Mean (SD)	NA (NA)	7.9 (7.5)	15.8 (7.9)	NA (NA)	9.3 (3.2)	14.2 (5.1)
Spasticity (Ashworth scale)- proximal Change scores. Scale 0-15. Calculated from SEs provided. Mean (SD)	NA (NA)	-0.04 (1.9)	-5.1 (2.4)	NA (NA)	-1.3 (1.7)	0.2 (1.8)
Spasticity (Ashworth scale)- distal Change scores. Scale 0-30. Calculated from SEs provided. Mean (SD)	NA (NA)	-0.38 (0.8)	-0.8 (1.6)	NA (NA)	0.7 (1.5)	0.8 (1.6)

Activities of daily living (functional independence measure) - Polarity - Higher values are better
Arm function (Fugl-Meyer assessment- overall) - Polarity - Higher values are better
Arm function (Fugl-Meyer assessment)- proximal limb - Polarity - Higher values are better
Arm function (Fugl-Meyer assessment)- distal limb - Polarity - Higher values are better
Arm strength (Motor Power) - Polarity - Higher values are better
Spasticity (Ashworth scale)- proximal - Polarity - Lower values are better
Spasticity (Ashworth scale)- distal - Polarity - Lower values are better
FIM outcome at 6 months: robot combined group: 2.8 (SE 2.4), robot unilateral group: 4.3 (SE 2.7), robot bilateral: 5 (SE 1.4), control group: 5.2 (SE 1.7). Proximal FM outcome at 6 months: robot combined group: 6 (SE 1.4), robot unilateral group: 7.3 (SE 2.0), robot bilateral: 4.4 (SE 1.3, control group: 7.6 (SE 1.2). Distal FM outcome at 6 months: robot combined group: 3 (SE 1), robot unilateral

group: 8.9 (SE 2.1), robot bilateral: 3 (SE 1.5), control group: 6.2 (SE 2.5). Motor Power outcome at 6 months: robot combined group: 17.2 (SE 2.1), robot unilateral group: 17.9 (SE 3.4), robot bilateral: 11.2 (SE 3.2), control group: 14.2 (SE 2.3). Proximal Ashworth outcome at 6 months: robot combined group: -0.2 (SE 0.5), robot unilateral group: 0.3 (SE 1.1), robot bilateral: -2 (SE 0.8), control group: 0.2 (SE 0.8). Distal Ashworth outcome at 6 months: robot combined group: -0.8(SE 0.6), robot unilateral group: -0.6 (SE 0.6), robot bilateral: -1.2 (SE 0.8), control group: 0.8 (SE 0.7).

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Activitiesofdailyliving(functionalindependencemeasure)-MeanSD-Robot therapy-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Activitiesofdailyliving(functionalindependencemeasure)-MeanSD-Robot therapy-Conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot therapy-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot therapy-Conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(FuglMeyerassessment-overall)-MeanSD-Robot therapy-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(FuglMeyerassessment-overall)-MeanSD-Robot therapy-Conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-proximallimb-MeanSD-Robot therapy-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-proximallimb-MeanSD-Robot therapy-Conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-distallimb-MeanSD-Robot therapy-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-distallimb-MeanSD-Robot therapy-Conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armstrength(MotorPower)-MeanSD-Robot therapy-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armstrength(MotorPower)-MeanSD-Robot therapy-Conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(Ashworthscale)-proximal-MeanSD-Robot therapy-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(Ashworthscale)-proximal-MeanSD-Robot therapy-Conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(Ashworthscale)-distal-MeanSD-Robot therapy-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(Ashworthscale)-distal-MeanSD-Robot therapy-Conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Ma, 2022

Bibliographic Reference	Ma, D; Li, X; Xu, Q; Yang, F; Feng, Y; Wang, W; Huang, J-J; Pei, Y-C; Pan, Y; Robot-Assisted Bimanual Training Improves Hand Function in Patients With Subacute Stroke: a Randomized Controlled Pilot Study; Frontiers in neurology; 2022; vol. 13

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	No additional information.
Trial name / registration number	ChiCTR1900023989.
Study type	Randomised controlled trial (RCT)
Study location	Taiwan.
Study setting	Inpatients.
Study dates	No additional information.
Sources of funding	Supported by Tsinghua University Precision Medicine Research Program (No. 10001020124), the Capital Health Research and Development of Special (No. 12021B2005) and Beijing Tsinghua Changgung Hospital Youth Start Fund (No. 12019C1008).
Inclusion criteria	First-ever and unilateral ischaemic or haemorrhagic cerebrovascular accident diagnosed by computed tomography or magnetic resonance imaging (MRI); people with subacute stroke with onset between 1 and 6 months; Brunnstrom stages of recovery ranging from 2 to 4; modified Ashworth spasticity score of the distal part of the upper limb <3.
Exclusion criteria	Mini-Mental State Examination score <24; sensory aphasia or mixed aphasia; hand dysfunction combined with a fracture of the upper limb or hand; severe neuralgia of the upper limb and hand; severe neuralgia of the upper limb and hand, affecting training (visual analog scale score >5).
Recruitment / selection of participants	Inpatients with stroke who had hemiplegic hand function from the Beijing Tsinghua Changgung Hospital.

Intervention(s)	Robot-assisted arm training N=13 Robot-assisted arm training for 60 minutes, 5 days a week for 4 weeks using an exoskeleton hand, a sensor glove and a control box (Mirror Hand). The robot can provide passive support or continuous active support to one finger or all fingers. The hand can provide mirror-guided movement, detecting the movement of the unaffected hand and replicating those movements. The exercise consisted of 5 minutes of continuous passive motion, followed by three minutes of sequential individual finger continuous passive motion, then the person actively moved the unaffected hand in the sensor glove to control the affected hand on the exoskeleton hand in a mirror symmetry pattern. Initially the program was conducted without objects for 15 minutes (such as grasping, single finger movement or opposite fingers) before task oriented training. Then the person was asked to manipulate objects and achieve a specific task with a triangular task (such as grasping and moving balls, grasping and moving wooden sticks, lifting and moving conical cylinders, pinching and moving wooden blocks, and moving pegs). Each task item was performed for 10-15 minutes. After training 30 minutes of regular control training was performed. Concomitant therapy: All people received 30 minutes of regular conventional therapy, 5 days a week for 4 weeks. This consisted of passive stretching, weight-bearing training, pain management, hand manipulation skills, dexterity training and task-specific activity training.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	≥5 days per week

Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Mixed
Population subgroups	No additional information.
Comparator	Any other intervention (usual care) N=13 60 minutes of one-on-one conventional therapy for unilateral hand functional training. Afterwards people had the same concomitant therapy. Concomitant therapy: All people received 30 minutes of regular conventional therapy, 5 days a week for 4 weeks. This consisted of passive stretching, weight-bearing training, pain management, hand manipulation skills, dexterity training and task-specific activity training.
Number of participants	26
Duration of follow-up	4 weeks (end of intervention).
Indirectness	No additional information.
Additional comments	Method of analysis unclear. Appears to be completers only.

Study arms

Robot-assisted arm training (N = 13)
Robot-assisted arm training for 60 minutes, 5 days a week for 4 weeks using an exoskeleton hand, a sensor glove and a control box (Mirror Hand). The robot can provide passive support or continuous active support to one finger or all fingers. The hand can provide mirror-guided movement, detecting the movement of the unaffected hand and replicating those movements. The exercise consisted of 5 minutes of continuous passive motion, followed by three minutes of sequential individual finger continuous passive motion, then the person actively moved the unaffected hand in the sensor glove to control the affected hand on the exoskeleton hand in a mirror symmetry pattern. Initially the program was conducted without objects for 15 minutes (such as grasping, single finger movement or opposite fingers) before task oriented training. Then the person was asked to manipulate objects and achieve a specific task with a triangular task (such as grasping and moving balls, grasping and moving wooden sticks, lifting and moving conical cylinders, pinching and moving wooden blocks, and moving pegs). Each task item was performed for 10-15 minutes. After training 30 minutes of regular control training was performed. Concomitant therapy: All people received 30 minutes of regular conventional therapy, 5 days a week for 4 weeks. This consisted of passive stretching, weight-bearing training, pain management, hand manipulation skills, dexterity training and task-specific activity training.

Any other intervention (usual care) (N = 13)
60 minutes of one-on-one conventional therapy for unilateral hand functional training. Afterwards people had the same concomitant therapy. Concomitant therapy: All people received 30 minutes of regular conventional therapy, 5 days a week for 4 weeks. This consisted of passive stretching, weight-bearing training, pain management, hand manipulation skills, dexterity training and task-specific activity training.

Characteristics

Arm-level characteristics

Characteristic	Robot-assisted arm training (N = 13)	Any other intervention (usual care) (N = 13)
% Female	n = 1 ; % = 10	n = 4 ; % = 44
Sample size		

Characteristic	Robot-assisted arm training (N = 13)	Any other intervention (usual care) (N = 13)
Mean age (SD) (years) Mean (SD)	59 (10.6)	56.44 (8.79)
Ethnicity Sample size	n = NR ; % = NR	n = NR ; % = NR
Comorbidities Sample size	n = NR ; % = NR	n = NR ; % = NR
Severity Mean (SD)	NR (NR)	NR (NR)
Time after stroke (Weeks) Mean (SD)	10 (5.85)	10.33 (6.24)

Only reports baseline characteristics for 10 people in the robot arm group, and 9 people in the control group.

Outcomes

Study timepoints

- Baseline
- 4 week (End of intervention)

Continuous outcome

Outcome	Robot-assisted arm training, Baseline, N = 10	Robot-assisted arm training, 4 week, N = 10	Any other intervention (usual care), Baseline, N = 9	Any other intervention (usual care), 4 week, N = 9
Arm function (Fugl-Meyer assessment- upper extremity) Scale range: 0-66. Final values. Mean (SD)	27.2 (17.03)	36.4 (16.87)	22.56 (17.17)	30.11 (20.95)

Arm function (Fugl-Meyer assessment- upper extremity) - Polarity - Higher values are better

Dichotomous outcome

Outcome	Robot-assisted arm training, Baseline, N = 13	Robot-assisted arm training, 4 week, N = 13	Any other intervention (usual care), Baseline, N = 13	Any other intervention (usual care), 4 week, N = 13
Withdrawal for any reason Intervention: 3 drop out. Control: 4 drop out. No of events	n = NA ; % = NA	n = 3 ; % = 23	n = NA ; % = NA	n = 4 ; % = 31

Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcome-Armfunction(Fugl-Meyerassessment-upperextremity)-MeanSD-Robot-assisted arm training-Any other intervention (usual care)-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm training-Any other intervention (usual care)-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Marganska, 2014

Bibliographic Reference	Marganska, V. K.; Blanco, J.; Campen, K.; Three-dimensional, task-specifi c robot therapy of the arm after stroke: a multicentre, parallel-group randomised tria; Lancet Neurol; 2014; vol. 13 (no. 2); 159-166

Study details

Secondary publication of another included	No additional information.

study- see primary study for details	
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Not stated/unclear
Subgroup 8: Type of movement delivered by robotic device	Not stated/unclear

Study arms

Robotic therapy (N = 39)
Robotic therapy with ARMin, each of 3 therapy modes (mobilisation, games, and training for activities of daily living) had to be done for at least 10 minutes. Therapy was given 3 times a week for a period of 8 weeks (sum of 24 sessions). Minimum session time (excluding time for preparation, diagnostics, and documentation) was 45 minutes.

Conventional therapy (N = 38)
Receiving common neurorehabilitation treatment given to participants after stroke in outpatient facilities, namely occupational therapy or physiotherapy. Therapists were asked to give regular therapy, usually including mobilisation, games, activities of daily living, or any combination of the 3. Therapy was given 3 times a week for a period of 8 weeks (sum of 24 sessions). Minimum session time (excluding time for preparation, diagnostics, and documentation) was 45 minutes.

Outcomes

Study timepoints
- Baseline
- 8 week (Post-intervention)

Dichotomous outcome

Outcome	Robotic therapy, Baseline, N = 39	Robotic therapy, 8 week, N = 39	Conventional therapy, Baseline, N = 38	Conventional therapy, 8 week, N = 38
Withdrawal for any reason In the robot group, 1 withdrew for medical reasons. In the conventional therapy group 1 withdrew for medical reasons and 2 refused therapy.	n = NA ; % = NA	n = 1 ; % = 3	n = NA ; % = NA	n = 3 ; % = 8

Outcome	Robotic therapy, Baseline, N = 39	Robotic therapy, 8 week, N = 39	Conventional therapy, Baseline, N = 38	Conventional therapy, 8 week, N = 38
No of events				

Continuous outcomes

Outcome	Robotic therapy, Baseline, N = 39	Robotic therapy, 8 week, N = 39	Conventional therapy, Baseline, N = 38	Conventional therapy, 8 week, N = 38
Arm function (Fugl-Meyer assessment- upper extremity) Change score. Scale range 0-66. Mean (SD)	20.2 (7.1)	3.3 (1.7)	20.7 (8.2)	2.5 (1.7)
Arm muscle strength ((Nm) Mean (SD)	10 (8)	1.4 (8)	11 (7.6)	2.6 (9.5)

Arm function (Fugl-Meyer assessment- upper extremity) - Polarity - Higher values are better
Arm muscle strength (- Polarity - Higher values are better
Also reports WMFT.

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(Fugl-Meyerassessment-upperextremity)-MeanSD-Robotic therapy-Conventional therapy-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to reporting of results)*

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armmusclestrength(-MeanSD-Robotic therapy-Conventional therapy-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robotic therapy-Conventional therapy-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Masiero, 2012

Bibliographic Reference	Masiero, S.; Armani, M.; Ferlini, G.; Chiasera, A.; Rosati, G.; Rossi, A.; A novel robot-assisted upper-limb rehabilitation program in acute management of post-stroke patients: a randomized controlled trial; Neurorehabilitation and Neural Repair; 2012; vol. 26 (no. 4); 401

Study details

Secondary publication of another included study- see primary study for details	Masiero S, Armani M, Rosati G. Upper-limb robot-assisted therapy in rehabilitation of acute stroke patients: focused review and results of new randomized controlled trial. *Journal of Rehabilitation Research and Development* 2011;48(4):355-66.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review. Masiero S, Armani M, Ferlini G, Rosati G, Rossi A. Randomized trial of a robotic assistive device for the upper extremity during early inpatient stroke rehabilitation. *Neurorehabilitation and Neural Repair* 2014;28(4):377-86. [MEDLINE: 964; 1552-6844]

Masiero, 2014

Bibliographic Reference	Masiero, Stefano; Armani, Mario; Ferlini, Gregorio; Rosati, Giulio; Rossi, Aldo; Randomized trial of a robotic assistive device for the upper extremity during early inpatient stroke rehabilitation; Neurorehabilitation and neural repair; 2014; vol. 28 (no. 4); 377-386

Study details

Secondary publication of another included	Masiero S, Armani M, Rosati G. Upper-limb robot-assisted therapy in rehabilitation of acute stroke patients: focused review and results of new randomized controlled trial. *Journal of Rehabilitation Research and Development* 2011;48(4):355-66.

study- see primary study for details	
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review. Masiero S, Armani M, Ferlini G, Chiasera A, Rosati G, Rossi A, et al. A novel robot-assisted upper-limb rehabilitation program in acute management of post-stroke patients: a randomized controlled trial. *Neurorehabilitation and Neural Repair* 2012;26(4):401. [MEDLINE: 177]

Masiero, 2011

Bibliographic Reference	Masiero, Stefano; Armani, Mario; Rosati, Giulio; Upper-limb robot-assisted therapy in rehabilitation of acute stroke patients: focused review and results of new randomized controlled trial; J Rehabil Res Dev; 2011; vol. 48 (no. 4); 355-366

Study details

Secondary publication of another included	No additional information.

study- see primary study for details	
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review. Masiero S, Armani M, Ferlini G, Rosati G, Rossi A. Randomized trial of a robotic assistive device for the upper extremity during early inpatient stroke rehabilitation. *Neurorehabilitation and Neural Repair* 2014;28(4):377-86. [MEDLINE: 964; 1552-6844] Masiero S, Armani M, Ferlini G, Chiasera A, Rosati G, Rossi A, et al. A novel robot-assisted upper-limb rehabilitation program in acute management of post-stroke patients: a randomized controlled trial. *Neurorehabilitation and Neural Repair* 2012;26(4):401. [MEDLINE: 177]
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Mixed Within 20 days of stroke.
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week

Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Not stated/unclear

Study arms

Robot training (N = 11)
Received robotic training with the NeReBot, twice a day for 20 minutes, and 40 minutes conventional training, 5 days a week for at least 5 weeks.

Conventional functional rehabilitation (N = 10)
80 minutes per day (including proprioceptive exercises, functional re-education, gait training, occupational therapy, and passive and active-assisted mobilisation of the hand and wrist) but without specifically exercising the proximal paretic arm.

Outcomes

Study timepoints
- Baseline
- 5 week (Post-intervention.)
- 3 month (Post-intervention.)

Dichotomous outcome

Outcome	Robot training, Baseline, N = 11	Robot training, 5 week, N = 11	Robot training, 3 month, N =	Conventional functional rehabilitation, Baseline, N = 10	Conventional functional rehabilitation, 5 week, N = 10	Conventional functional rehabilitation, 3 month, N = 10
Withdrawal for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NR ; % = NR	n = NA ; % = NA	n = 0 ; % = 0	n = NR ; % = NR

Continuous outcomes

Outcome	Robot training, Baseline, N = 11	Robot training, 5 week, N = 11	Robot training, 3 month, N = 11	Conventional functional rehabilitation, Baseline, N = 10	Conventional functional rehabilitation, 5 week, N = 10	Conventional functional rehabilitation, 3 month, N = 10
Activities of daily living (Frenchay Arm Test) Change scores. Scale range 0-5 Mean (SD)	NR (NR)	1.8 (1.4)	1.8 (1.4)	NR (NR)	1 (0.7)	0.25 (0.5)
Arm function (Fugl-Meyer assessment) Change scores. Scale range 0-66. Mean (SD)	NR (NR)	12.2 (8.3)	12.5 (8.9)	NR (NR)	13.9 (10.2)	14.21 (7.1)
Arm strength (MRC) Change score. Scale range 0-5. Values as reported in Cochrane review (appears to be average of MRC for each muscle group)	NR (NR)	0.8 (0.6)	NR (NR)	NR (NR)	1.5 (0.9)	NR (NR)

Outcome	Robot training, Baseline, N = 11	Robot training, 5 week, N = 11	Robot training, 3 month, N = 11	Conventional functional rehabilitation, Baseline, N = 10	Conventional functional rehabilitation, 5 week, N = 10	Conventional functional rehabilitation, 3 month, N = 10
Mean (SD)						
Spasticity (Ashworth MAS) Change scores. Scale range 0-5 Mean (SD)	NR (NR)	0.83 (0.28)	0.55 (0.8)	NR (NR)	0.5 (0.7)	0.75 (1.2)

Activities of daily living (Frenchay Arm Test) - Polarity - Higher values are better
Arm function (Fugl-Meyer assessment) - Polarity - Higher values are better
Arm strength (MRC) - Polarity - Higher values are better
Spasticity (Ashworth MAS) - Polarity - Lower values are better
Also reports FM-SE, FM-WH, Box and Block test. ADL: Frenchay Arm test used in Cochrane review and reported here, motor FIM also reported.

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Spasticity(AshworthMAS)-MeanSD-Robot training-Conventional functional rehabilitation-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot training-Conventional functional rehabilitation-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot training-Conventional functional rehabilitation-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Continuousoutcomes-Activitiesofdailyliving(FrenchayArmTest)-MeanSD-Robot training-Conventional functional rehabilitation-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Activitiesofdailyliving(FrenchayArmTest)-MeanSD-Robot training-Conventional functional rehabilitation-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns

Section	Question	Answer
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Continuousoutcomes-Armfunction(FugI-Meyerassessment)-MeanSD-Robot training-Conventional functional rehabilitation-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(FugI-Meyerassessment)-MeanSD-Robot training-Conventional functional rehabilitation-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Continuousoutcomes-Armstrength(MRC)-MeanSD-Robot training-Conventional functional rehabilitation-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armstrength(MRC)-MeanSD-Robot training-Conventional functional rehabilitation-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Continuousoutcomes-Spasticity(AshworthMAS)-MeanSD-Robot training-Conventional functional rehabilitation-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Masiero, 2007

Bibliographic Reference	Masiero, Stefano; Celia, Andrea; Rosati, Giulio; Armani, Mario; Robotic-assisted rehabilitation of the upper limb after acute stroke; Archives of physical medicine and rehabilitation; 2007; vol. 88 (no. 2); 142-149

Study details

Secondary publication of another included study- see primary study for details	No additional information.

Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Acute (72 hours - 7 days) ≤1 week of stroke onset.
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	<6 weeks at least 5 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Passive movement

Study arms

Robot assisted training (N = 17)
Received additional early sensorimotor robotic training with the NeReBot, robot training twice a day, 5 days a week for at least 5 weeks.

Non-robot therapy group (N = 18)
Received similar exposure to the robot (30 minutes twice per week) except that the exercises were performed with the unimpaired arm.

Outcomes

Study timepoints
- Baseline
- 5 week (Post-intervention)
- 8 month (Post-intervention)

Dichotomous outcomes

Outcome	Robot assisted training, Baseline, N = 17	Robot assisted training, 5 week, N = 17	Robot assisted training, 8 month, N = 17	Non-robot therapy group, Baseline, N = 18	Non-robot therapy group, 5 week, N = 18	Non-robot therapy group, 8 month, N = 18
Withdrawal for any reason 3 dropped out during the intervention and 2 died (groups not reported). No of events	n = NA ; % = NA	n = 2 ; % = 12	n = NR ; % = NR	n = NA ; % = NA	n = 3 ; % = 17	n = NR ; % = NR

Continuous outcomes

Outcome	Robot assisted training, Baseline, N = 17	Robot assisted training, 5 week, N = 17	Robot assisted training, 8 month, N = 17	Non-robot therapy group, Baseline, N = 18	Non-robot therapy group, 5 week, N = 18	Non-robot therapy group, 8 month, N = 18
Activities of daily living (functional independence measure) Change scores. Scale range 18-126. Mean (SD)	NR (NR)	32.6 (7.2)	46.2 (10.4)	NR (NR)	25.5 (10.5)	31.8 (14.6)
Arm function (Fugl Meyer Assessment) Change scores. Scale range 0-66. Values as reported in Cochrane review. Mean (SD)	NR (NR)	15.8 (8.1)	NR (NR)	NR (NR)	10.3 (12.1)	NR (NR)
Arm muscle strength (MRC) Change scores. Scale range 0-5. Values as reported in Cochrane review. Mean (SD)	NR (NR)	1.7 (1.2)	NR (NR)	NR (NR)	1.2 (1)	NR (NR)
Spasticity (MAS) Change scores. Scale range 0-5 Mean (SD)	NR (NR)	0.13 (1.4)	0.13 (1.4)	NR (NR)	0.13 (0.9)	0.88 (1.4)

Activities of daily living (functional independence measure) - Polarity - Higher values are better
Arm function (Fugl Meyer Assessment) - Polarity - Higher values are better

Arm muscle strength (MRC) - Polarity - Higher values are better
Spasticity (MAS) - Polarity - Lower values are better
Function outcome was reported separately for shoulder/ elbow and wrist/ hand. Strength outcome was reported separately for deltoid, biceps and wrist flexors.

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Activitiesofdailyliving(functionalindependencemeasure)-MeanSD-Robot assisted training-Non-robot therapy group-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot assisted training-Non-robot therapy group-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Activitiesofdailyliving(functionalindependencemeasure)-MeanSD-Robot assisted training-Non-robot therapy group-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(FuglMeyerAssessment)-MeanSD-Robot assisted training-Non-robot therapy group-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(FuglMeyerAssessment)-MeanSD-Robot assisted training-Non-robot therapy group-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armmusclestrength(MRC)-MeanSD-Robot assisted training-Non-robot therapy group-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armmusclestrength(MRC)-MeanSD-Robot assisted training-Non-robot therapy group-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(MAS)-MeanSD-Robot assisted training-Non-robot therapy group-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(MAS)-MeanSD-Robot assisted training-Non-robot therapy group-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Mayr, 2008

Bibliographic Reference	Mayr, A.; Kofler, M.; Saltuari, L.; ARMOR: an electromechanical robot for upper limb training following stroke. A prospective randomised controlled pilot study; Handchirurgie, Mikrochirurgie, Plastische Chirurgie: Organ der Deutschsprachigen Arbeitsgemeinschaft fur Handchirurgie: Organ der Deutschsprachigen Arbeitsgemeinschaft fur Mikrochirurgie der Peripheren Nerven und Gefasse: Organ der V..; 2008; vol. 40 (no. 1); 66-73

Study details

Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months) <3 months post stroke.
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	Not stated/unclear
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks

Subgroup 7: Level of supervision	Not stated/unclear
Subgroup 8: Type of movement delivered by robotic device	Not stated/unclear

Study arms

Robot-assisted therapy (N = 4)
group AB: the participants received over 2 weeks, t times per week robot-assisted therapy with the ARMOR device, then 2 weeks with no intervention, and then over 2 weeks, 5 times per week EMG-initiated functional electrical stimulation.

Functional Electrical Stimulation (N = 4)
group BA: the participants received 5 times per week over 2 weeks EMG-initiated functional electrical stimulation, then 2 weeks no intervention, and then 5 times per week over 2 weeks robot-assisted therapy.

Outcomes

Study timepoints
- Baseline
- 2 week (Post-intervention)

Dichotomous outcome

Outcome	Robot-assisted therapy, Baseline, N = 4	Robot-assisted therapy, 2 week, N = 4	Functional Electrical Stimulation, Baseline, N = 4	Functional Electrical Stimulation, 2 week, N = 4
Withdrawal for any reason Values as reported in Cochrane review No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Withdrawal for any reason - Polarity - Lower values are better

Continuous outcomes

Outcome	Robot-assisted therapy, Baseline, N = 4	Robot-assisted therapy, 2 week, N = 4	Functional Electrical Stimulation, Baseline, N = 4	Functional Electrical Stimulation, 2 week, N = 4
Arm function Chedoke-McMaster Stroke Assessment 15-105, change score Mean (SD)	NR (NR)	3 (2.9)	NR (NR)	1.3 (1.3)
Arm muscle strength (scale unclear) Values as reported in Cochrane review Mean (SD)	NR (NR)	3.6 (4.4)	NR (NR)	2.4 (4.2)

Arm function Chedoke-McMaster Stroke Assessment - Polarity - Higher values are better
Arm muscle strength (scale unclear) - Polarity - Higher values are better
Scales and ranges unclear as paper was not in English language. All information taken from Cochrane review.

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Cross-over trial

Continuousoutcomes-Armmusclestrength(scaleunclear)-MeanSD-Robot-assisted therapy-Functional Electrical Stimulation-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(Due to lack of allocation concealment and lack of assessor blinding.)*
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-assisted therapy-Functional Electrical Stimulation-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(Due to lack of allocation concealment and lack of assessor blinding.)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(scaleunclear)-MeanSD-Robot-assisted therapy-Functional Electrical Stimulation-t2

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(Due to lack of allocation concealment and lack of assessor blinding.)*
Overall bias and Directness	Overall Directness	Directly applicable

Mazzoleni et al.

Bibliographic Reference	Mazzoleni, Stefano; Buono, L.; Dario, P.; Posteraro, Federico; Upper limb robot-assisted therapy in subacute and chronic stroke patients: preliminary results on initial exposure based on kinematic measures; 265-269

Study details

Secondary publication of another included study- see primary study for details	Sale et al. Effects of upper limb robot-assisted therapy on motor recovery in subacute stroke patients. Journal of neuroengineering and rehabilitation; 2014; vol. 11 (no. 1); 1-8
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review. Sale et al. Recovery of hand function with robot-assisted therapy in acute stroke patients: a randomized-controlled trial. International Journal of Rehabilitation Research 2014;37(3): 236-42 Mazzoleni et al., 2014. Effects of upper limb robot-assisted therapy on motor recovery of subacute stroke patients: a kinematic approach. IEEE 1-5.

Mazzoleni et al.

Bibliographic Reference	Mazzoleni, Stefano; Carrozza, Maria Chiara; Sale, Patrizio; Franceschini, Marco; Posteraro, Federico; Tiboni, Micol; Effects of upper limb robot-assisted therapy on motor recovery of subacute stroke patients: a kinematic approach; 1-5

Study details

Secondary publication of another included study- see primary study for details	Sale et al. Effects of upper limb robot-assisted therapy on motor recovery in subacute stroke patients. Journal of neuroengineering and rehabilitation; 2014; vol. 11 (no. 1); 1-8
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858 Mazzoleni et al. Upper limb robot-assisted therapy in subacute and chronic stroke patients: preliminary results on initial exposure based on kinematic measures. 5th IEEE RAS and EMBS International Conference on Biomedical Robotics and Biomechatronics, BioRob; 12-15 August, 2014. 2014: 265-269 Sale et al. Recovery of hand function with robot-assisted therapy in acute stroke patients: a randomized-controlled trial. International Journal of Rehabilitation Research 2014;37(3): 236-42

McCabe, 2015

Bibliographic Reference	McCabe, Jessica; Monkiewicz, Michelle; Holcomb, John; Pundik, Svetlana; Daly, Janis J.; Comparison of robotics, functional electrical stimulation, and motor learning methods for treatment of persistent upper extremity dysfunction after stroke: a randomized controlled trial; Archives of physical medicine and rehabilitation; 2015; vol. 96 (no. 6); 981-990

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review. Daly JJ, Rogers J, McCabe J, Monkiewicz M, Burdsall R, Pundik S. Recovery of actual functional tasks in response to motor learning, robotics, and functional electrical stimulation. *Stroke* 2010;41(4):e355-6.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)

Subgroup 3: Region of upper limb trained	Proximal limb the robot therapy focused on the shoulder/ elbow area.
Subgroup 4: Dose (hours per day)	≥1 hour 5 hours per day
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised 1:3 supervision
Subgroup 8: Type of movement delivered by robotic device	Not stated/unclear

Study arms

Robot-assisted arm training (N = 12)
Motor Learning Programme in a 1:3 group paradigm for 3.5 hours per day + robotic-assisted arm training with the InMotion2 Shoulder-Elbow Robot 1.5 hours per day for 12 weeks.

Motor Learning Programme (N = 27)
Motor Learning Programme in a 1:3 group paradigm for 3.5 hours per day + functional electrical stimulation for1.5 hours per day for 12 weeks. Motor Learning Programme in a 1:3 group paradigm for 5 hours per day for 12 weeks. The 2 groups were combined for analysis.

Outcomes

Study timepoints

- Baseline
- 12 week

Dichotomous outcome

Outcome	Robot-assisted arm training, Baseline, N = 12	Robot-assisted arm training, 12 week, N = 12	Motor Learning Programme, Baseline, N = 27	Motor Learning Programme, 12 week, N = 27
Withdrawal for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Continuous outcomes

Outcome	Robot-assisted arm training, Baseline, N = 12	Robot-assisted arm training, 12 week, N = 12	Motor Learning Programme, Baseline, N = 27	Motor Learning Programme, 12 week, N = 27
Arm function (Fugl-Meyer) Change scores. Scale 0-66. Values as reported in the Cochrane review. Mean (SD)	NR (NR)	7.7 (3.8)	NR (NR)	9.4 (4.9)

Arm function (Fugl-Meyer) - Polarity - Higher values are better
Also reports AMAT. Distal and proximal FM scores also reported separately.

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(Fugl-Meyer)-MeanSD-Robot-assisted arm training-Motor Learning Programme-t12

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(comparison group included FES.)*

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm training-Motor Learning Programme-t12

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(comparison group included FES.)*

Orihuela-Espina, 2016

Bibliographic Reference	Orihuela-Espina, Felipe; Roldán, Giovana Femat; Sánchez-Villavicencio, Israel; Palafox, Lorena; Leder, Ronald; Sucar, Luis Enrique; Hernández-Franco, Jorge; Robot training for hand motor recovery in subacute stroke patients: a randomized controlled trial; Journal of Hand Therapy; 2016; vol. 29 (no. 1); 51-57

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Not stated/unclear
Subgroup 8: Type of movement	Mixed

delivered by robotic device	

Study arms

Robot therapy (N = 9)
Robot therapy with the Amadeo (Inc. Typromotion) for 40 sessions 5 times a week for about 60 minutes.

Occupational therapy (N = 9)
Classic occupational therapy 40 sessions 5 times a week for about 60 minutes.

Outcomes

Study timepoints
- Baseline
- 8 week (Post-intervention)

Continuous outcomes

Outcome	Robot therapy, Baseline, N = 9	Robot therapy, 8 week, N = 9	Occupational therapy, Baseline, N = 9	Occupational therapy, 8 week, N = 8
Arm function (total FMA) Change scores, scale 0-66 Mean (SD)	NR (NR)	5.7 (2.7)	NR (NR)	1.5 (2.3)

Outcome	Robot therapy, Baseline, N = 9	Robot therapy, 8 week, N = 9	Occupational therapy, Baseline, N = 9	Occupational therapy, 8 week, N = 8
Arm muscle strength (Motricity Index) Change scores. Scale 0-100 Mean (SD)	NR (NR)	12 (7.8)	NR (NR)	5.3 (6.6)

Arm function (total FMA) - Polarity - Higher values are better
Arm muscle strength (Motricity Index) - Polarity - Higher values are better

Dichotomous outcome

Outcome	Robot therapy, Baseline, N = 9	Robot therapy, 8 week, N = 9	Occupational therapy, Baseline, N = 9	Occupational therapy, 8 week, N = 9
Withdrawal for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(totalFMA)-MeanSD-Robot therapy-Occupational therapy-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to no details on randomisation and allocation concealment)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armmusclestrength(MotricityIndex)-MeanSD-Robot therapy-Occupational therapy-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to no details on randomisation and allocation concealment)*
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot therapy-Occupational therapy-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to no details on randomisation and allocation concealment)*
Overall bias and Directness	Overall Directness	Directly applicable

Padua, 2020

Bibliographic Reference

Padua, L.; Imbimbo, I.; Aprile, I.; Loreti, C.; Germanotta, M.; Coraci, D.; Piccinini, G.; Pazzaglia, C.; Santilli, C.; Cruciani, A.; Carrozza, M. C.; Pecchioli, C.; Loreti, S.; Lattanzi, S.; Cortellini, L.; Papadopoulou, D.; Liberti, G.; Panzera, F.; Mitrione, P.; Ruzzi, D.; Rinaldi, G.; Insalaco, S.; De Santis, F.; Spinelli, P.; Marsan, S.; Bastoni, I.; Pellegrino, A.; Petitti, T.; Montesano, A.; Castagna, A.; Grosso, C.; Ammenti, P.; Cattaneo, D.; Azzinnaro, L.; Barbieri, D.; Cassani, S.; Corrini, C.; Meotti, M.; Parelli, R.; Spedicato, A.; Zocchi, M.; Loffi, M.; Manenti, D.; Negri, L.; Gramatica, F.; Gower, V.; Galeri, S.; Noro, F.; Medici, L.; Garattini, R.; Bariselli, F.; Luli, M.; Ricca, M.; Negrini, S.; Diverio, M.; Giannini, E.; Gabrielli, A.; Deidda, B.; Gnetti, B.; Beatini, P.; Callegari, S.; Cabano, B.; Converti, F.; Pizzi, A.; Falsini, C.; Romanelli, A.; De Luca, G.; Vannetti, F.; Simoncini, E.; Martini, M.; Peccini, E.; Cecchi, F.; Avila, L.; Gabrielli, M. A.; Barilli, M.; Bertocchi, E.; Giannarelli, G.; Lerda, E.; Vasoli, M.; Rossi, P.; Marsili, V.; Tognoli, B.; Bertolini, A.; Vastola, G.; Speranza, G.; Colella, M.; Mosca, R.; Competiello, G.; Chiusano, A.; Della Vecchia, A.; Soriano, P.; Pagliarulo, M.; Remollino, V.; Langone, E.; Santarsiero, R.; Magliulo, M.; Araneo, G.; Galantucci, L.; Lioi, N.; Marrazzo, F.; Larocca, S.; Calia, R.; Benevento, S.; Toscano, O.; Lategana, M.; Cognitive reserve as a useful variable to address robotic or conventional upper limb rehabilitation treatment after stroke: a multicentre study of the Fondazione Don Carlo Gnocchi; European Journal of Neurology; 2020; vol. 27 (no. 2); 392-398

Study details

Secondary publication of another included study- see primary study for details	Aprile, Irene MD, PhD; Germanotta, Marco PhD; Cruciani, Arianna PT; Loreti, Simona MD; Pecchioli, Cristiano BS; Cecchi, Francesca MD; Montesano, Angelo MD; Galeri, Silvia MD; Diverio, Manuela MD; Falsini, Catuscia MD; Speranza, Gabriele MD; Langone, Emanuele MD; Papadopoulou, Dionysia PT; Padua, Luca MD, PhD; Carrozza, Maria Chiara PhD; for the FDG Robotic Rehabilitation Group Upper Limb Robotic Rehabilitation After Stroke: A Multicenter, Randomized Clinical Trial, Journal of Neurologic Physical Therapy: January 2020 - Volume 44 - Issue 1 - p 3-14doi: 10.1097/NPT.0000000000000295

Park, 2021

Bibliographic Reference	Park, J. H.; The effects of robot-assisted left-hand training on hemispatial neglect in older patients with chronic stroke: A pilot and randomized controlled trial; Medicine; 2021; vol. 100 (no. 9); e24781

Study details

Secondary publication of another included study- see primary study for details	Nr
Other publications associated with this study included in review	NR

Trial name / registration number	TCTR20200222005
Study location	South Korea
Study setting	rehabilitation hospital
Study dates	NR
Sources of funding	This work was supported by the Soonchunhyang University Research Fund. This work was supported by the Korea Institute for Advancement of Technology(KIAT) grant funded by the Korea Government(MOTIE) (P0012724, The Competency Development Program for Industry Specialist) This work was supported by the Soonchunhyang University Research Fund and the Korea Institute for Advancement of Technology(KIAT) grant funded by the Korea Government(MOTIE) (P0012724, The Competency Development Program for Industry Specialist). The proofreading of this manuscript were conducted by these funding sources. In addition, these funding sources were used to rent places and meals when having several meetings.
Inclusion criteria	The inclusion criteria were: (1) over 65 years of age, (2) right hemisphere stroke confirmed by a computed tomography scan or magnetic resonance imaging, (3) first-ever ischemic or haemorrhage stroke, (4) intact global cognitive function confirmed by the Korean version of Mini-Mental State Examination score ≥ 24, (5) time since stroke onset ≥ 6 months, and (6) the presence of hemispatial neglect diagnosed by performance on the Line Bisection Test and the Korean version of the Motor-free Visual Perception Test-Third Edition (MVPT-3).
Exclusion criteria	The exclusion criteria were: (1) any additional treatment for hemispatial neglect, (2) left upper limb sensory deficit or impairment, (3) visual impairment, (4) the modified Ashworth scale score for left-hand muscle tone ≥ 2, (5) below second-grade left hand muscle strength in a manual muscle test, (6) orthopaedic conditions involving the left upper limb, and (7) apraxia.
Recruitment / selection of participants	NR
Intervention(s)	The Robot therapy group performed 20 sessions (five days a week for four weeks) of robot-assisted hand training using the Amadeo Robotic device (Trymotion GmbH, Graz, Austria) (Figure 1). The end-effector based Amadeo Robot has five degrees of freedom and provides the motion of one or all five fingers through a passive rotational joint placed between the

	fingertip and an entity moves laterally (the thumb has two passive rotational joints). All five translational degrees of freedom are independent and almost entirely cover the fingers' workspace. The interface between the human hand and the machine is achieved via elastic bands or plasters and the wrist is restrained from movement by a Velcro strap. Each session lasted 30 minutes. The exercises were carried out according to a previous study as follow: (1) grasp and release training (digital joint flexion/extension exercise from the thumb to the fifth finger) for 15 minutes; and (2) count training (count a number sequence from one to five) for 15 minutes. The participant's hand motion was assisted by the robot and adjusted to the individual's level of function through the assistive therapy mode of the Amadeo robot. During the training, the participants in the EG received visual feedback of their hand movements via video animation presented on a monitor.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Not stated/unclear
Subgroup 8: Type of movement delivered by robotic device	Passive movement
Population subgroups	NR

Comparator	The control group received the 20 sessions of the conventional treatments that lasted 30 minutes each session for hemispatial neglect symptoms. These treatments included visual scanning training using a prism and vibration stimulation applied on the left neck extensors and a middle part of the left forearm. In addition, the participants in the CG learned the compensatory approach for ameliorating hemispatial neglect symptoms involving turning a head or trunk. Two dependent occupational therapists who had more than five years of experience conducted all sessions.
Number of participants	24
Duration of follow-up	4 weeks end of intervention
Indirectness	NR
Additional comments	NR

Study arms

robot-assisted left-hand training (N = 12)

conventional therapy (N = 12)

Characteristics

Study-level characteristics

Characteristic	**Study (N = 24)**
Ethnicity Nominal	NR

Characteristic	Study (N = 24)
Comorbidities Nominal	NR
Severity Nominal	NR

Arm-level characteristics

Characteristic	robot-assisted left-hand training (N = 12)	conventional therapy (N = 12)
% Female Nominal	41.7	50
Mean age (SD) months Mean (SD)	69.08 (4.71)	71.58 (3.17)
Time after stroke months Mean (SD)	9.5 (2.61)	9.08 (2.1)

Outcomes

Study timepoints

- Baseline
- 4 week

Dichotomous outcomes

Outcome	robot-assisted left-hand training, Baseline, N = 12	robot-assisted left-hand training, 4 week, N = 12	conventional therapy, Baseline, N = 12	conventional therapy, 4 week, N = 12
Withdrawal for any reason No of events	n = 0 ; % = 0	n = 0 ; % = 0	n = 0 ; % = 0	n = 0 ; % = 0

Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-robot-assisted left-hand training-conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Rabadi, 2008

Bibliographic Reference	Rabadi, M. H.; Galgano, M.; Lynch, D.; Akerman, M.; Lesser, M.; Volpe, B. T.; A pilot study of activity-based therapy in the arm motor recovery post stroke: a randomized controlled trial; Clinical Rehabilitation; 2008; vol. 22 (no. 12); 1071-1082

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months) < 4 weeks
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	Not stated/unclear
Subgroup 7: Level of supervision	Not stated/unclear
Subgroup 8: Type of movement	Mixed

delivered by robotic device	

Study arms

Robot-assissted arm training (N = 10)
Standard occupational and physical therapy for 3 hours per day plus 12 additional sessions of 40 minutes of robotic-assisted arm training with the MIT-Manus 5 days per week.

Non-robot arm training (N = 20)
Group 1: standard occupational and physical therapy for 3 hours per day plus 12 additional sessions of 40 minutes of occupational therapy 5 days per week. Group 2: standard occupational and physical therapy for 3 hours per day plus 12 additional sessions of 40 minutes of arm ergometry 5 days per week. The 2 groups were combined for analysis.

Outcomes

Study timepoints
- Baseline
- 3 week (Post-intervention, time point unclear)

Dichotomous outcome

Outcome	Robot-assissted arm training, Baseline, N = 10	Robot-assissted arm training, 3 week, N = 10	Non-robot arm training, Baseline, N = 20	Non-robot arm training, 3 week, N = 20
Withdrawal for any reason	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Outcome	Robot-assissted arm training, Baseline, N = 10	Robot-assissted arm training, 3 week, N = 10	Non-robot arm training, Baseline, N = 20	Non-robot arm training, 3 week, N = 20
No of events				

Continuous outcomes

Outcome	Robot-assissted arm training, Baseline, N = 10	Robot-assissted arm training, 3 week, N = 10	Non-robot arm training, Baseline, N = 20	Non-robot arm training, 3 week, N = 20
Activities of daily living (FIM, including motor and cognition subscale) Final values. Scale range 18-126.Values taken from Cochrane review Mean (SD)	NR (NR)	25.5 (7.2)	NR (NR)	28.3 (6.7)
Arm function (Fugl-Meyer assessment) Change scores. Scale 0-66. Values as reported in Cochrane review. Mean (SD)	NR (NR)	3.1 (8.1)	NR (NR)	3.9 (6.9)
Arm muscle strength (motor Power Scale) Change scores. Scale 0-70. Values as reported in Cochrane review Mean (SD)	NR (NR)	8.3 (7.9)	NR (NR)	1.2 (9.6)

Outcome	Robot-assissted arm training, Baseline, N = 10	Robot-assissted arm training, 3 week, N = 10	Non-robot arm training, Baseline, N = 20	Non-robot arm training, 3 week, N = 20
Spasticity (MAS) Final values. Scale range 0-5. Average calculated for 2 control groups. Mean (SD)	NR (NR)	2.73 (1.29)	NR (NR)	2.29 (1.53)

Activities of daily living (FIM, including motor and cognition subscale) - Polarity - Higher values are better
Arm function (Fugl-Meyer assessment) - Polarity - Higher values are better
Arm muscle strength (motor Power Scale) - Polarity - Higher values are better
Spasticity (MAS) - Polarity - Lower values are better
Also reports shoulder/ elbow and wrist/ hand subscales of FMA, ARAT. Spasticity outcome: OT group: 3.18 (1.4), arm ergometry group: 1.4 (1.07)

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Activitiesofdailyliving(FIM,includingmotorandcognitionsubscale)-MeanSD-Robot-assissted arm training-Non-robot arm training-t0

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-MeanSD-Robot-assissted arm training-Non-robot arm training-t0

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armmusclestrength(motorPowerScale)-MeanSD-Robot-assissted arm training-Non-robot arm training-t0

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(MAS)-MeanSD-Robot-assissted arm training-Non-robot arm training-t0

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-assissted arm training-Non-robot arm training-t0

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Ranzani, 2020

Bibliographic Reference	Ranzani, R.; Lambercy, O.; Metzger, J. C.; Califfi, A.; Regazzi, S.; Dinacci, D.; Petrillo, C.; Rossi, P.; Conti, F. M.; Gassert, R.; Neurocognitive robot-assisted rehabilitation of hand function: a randomized control trial on motor recovery in subacute stroke; Journal of Neuroengineering & Rehabilitation; 2020; vol. 17 (no. 1); 115

Study details

Secondary publication of another included study- see primary study for details	NA
Other publications associated with this study included in review	NA
Trial name / registration number	NCT02096445
Study location	Switzerland
Study setting	Rehabilitation centre
Study dates	April 2013 and March 2017
Sources of funding	This work was supported by the National Center of Competence in Research on Neural Plasticity and Repair of the Swiss National Science Foundation (NCCR Neuro), the ETH CHIRP1 Research Grant on Cortically-Driven Assistance Adaptation during Sensorimotor Training, the Olga Mayenfisch Stiftung, the ETH Zurich Foundation in collaboration with Hocoma AG, and the Clinica Hildebrand Centro di Riabilitazione Brissago, Switzerland.

Inclusion criteria	Subjects were enrolled in the study if they met the following inclusion criteria: age between 18 and 90 years old, first and only cerebrovascular event, subacute lesion (i.e., occurred not earlier than 6 weeks before recruitment), hemiparesis with arm motor deficit as assessed with a National Institutes of Health Stroke Scale (NIHS S ≥1.
Exclusion criteria	Subjects were excluded if they presented an altered state of consciousness, severe aphasia (Goodglass and Kaplan test < 1), severe cognitive deficits (Levels of Cognitive Functioning-Revised, LCF-R < 6), severe pathologies of the upper limb of traumatic or rheumatic nature, severe pain in the affected arm (≥5 on a visual analogue scale for pain (VASp)), or if they had active pacemakers and other active implants.
Recruitment / selection of participants	Study participants were recruited among inpatients undergoing an intensive interdisciplinary rehabilitation therapy program post stroke.
Intervention(s)	The neurocognitive therapy approach includes sensorimotor and cognitive aspects, all fundamental during the execution of complex tasks and activities of daily life. Focusing on haptic and postural perception, often without vision, subjects are asked to explore objects (e.g. sponges, sticks, springs), discriminate their properties and perceive relative differences. A robotic device is an ideal tool to perform such exercises, as a wide range of haptic stimuli can easily and accurately be rendered in a repeatable and well-controlled manner. The robotic device used in this study can haptically reproduce the same objects and, thereby, motor, sensory and cognitive tasks used in conventional therapy. The objects are rendered via the robotic handles by generating appropriate forces during hand opening/closing and forearm pronosupination, while they are displayed on a screen. Similarly, each 45-min session of robot-assisted therapy included three exercises (selected each day following a predefined plan common to all participants) consisting of up to 30 task repetitions with the robot (each involving multiple movements and interpretation of sensory information), in a maximum of 15 min per exercise. The exercise type, number of task repetitions per exercise and the maximum exercise duration were selected based on pilot tests on subjects with stroke [29] to precisely match therapy type and dose typically performed in conventional therapy. In each exercise, the difficulty level was initially adapted to the subject according to a baseline robotic assessment and continuously updated at the end of each session depending on the subject’s performance. An experienced physio- or occupational therapist supervised all the sessions. The tasks were executed either passively (i.e., guided by the therapist/robot) when they only required sensory perception (e.g. of object length or forearm orientation), or actively by the subject (against the resistance of the object/robot) when they required active object manipulation (e.g., stiffness identification).

	Concomitant therapy- In both groups, all the conventional neurocognitive therapy sessions included two or three exercises depending on the session duration (i.e., 30 or 45 min), as typically done in the standard clinical setting. The exercises were performed with the help of the therapist, who progressively adapted the assistance and difficulty level of the exercise (e.g., number of objects, object length or stiffness) depending on his/her evaluation of the subject's ability
Subgroup 1: Severity	Mild (or NIHSS 1-5)
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement	Mixed

delivered by robotic device	
Population subgroups	NA
Comparator	In both groups, all the conventional neurocognitive therapy sessions included two or three exercises depending on the session duration (i.e., 30 or 45 min), as typically done in the standard clinical setting. The exercises were performed with the help of the therapist, who progressively adapted the assistance and difficulty level of the exercise (e.g., number of objects, object length or stiffness) depending on his/her evaluation of the subject's ability
Number of participants	33
Duration of follow-up	post intervention (4 weeks)
Indirectness	NR
Additional comments	NR

Study arms

robot-assisted neurocognitive therapy (N = 17)

conventional neurocognitive therapy (N = 16)

Characteristics

Study-level characteristics

Characteristic	Study (N = 33)
Ethnicity Nominal	NR
Comorbidities Nominal	NR

Arm-level characteristics

Characteristic	robot-assisted neurocognitive therapy (N = 17)	conventional neurocognitive therapy (N = 16)
% Female Nominal	28.6	38.4
Mean age (SD) Mean (SD)	70 (12.79)	67.46 (11.39)
Severity Mean (SD)	1.36 (0.75)	1.69 (1.03)
Time after stroke weeks Mean (SD)	3.14 (1.51)	3.08 (1.32)

Outcomes

Study timepoints

- Baseline
- 4 week (post intervention)
- 32 week

Continuous outcomes

Outcome	robot-assisted neurocognitive therapy, Baseline, N = 17	robot-assisted neurocognitive therapy, 4 week, N = 14	robot-assisted neurocognitive therapy, 32 week, N = 14	conventional neurocognitive therapy, Baseline, N = 16	conventional neurocognitive therapy, 4 week, N = 13	conventional neurocognitive therapy, 32 week, N = 13
Arm function (Fugl Meyer UE) 0-66, change scores Mean (SD)	50.14 (12.5)	7.14 (5.72)	8.64 (7.42)	50.85 (15)	6.85 (5.34)	8.08 (8.32)
Spasticity (Ashworth MAS) 0-4, change score Mean (SD)	1.29 (1.77)	0.07 (2.37)	-0.21 (2.36)	2.15 (2.94)	-1.54 (2.91)	-1.31 (3.12)

Arm function (Fugl Meyer UE) - Polarity - Higher values are better
Spasticity (Ashworth MAS) - Polarity - Lower values are better

Dichotomous outcomes

Outcome	robot-assisted neurocognitive therapy, Baseline, N = 17	robot-assisted neurocognitive therapy, 4 week, N = 17	robot-assisted neurocognitive therapy, 32 week, N = 17	conventional neurocognitive therapy, Baseline, N = 16	conventional neurocognitive therapy, 4 week, N = 16	conventional neurocognitive therapy, 32 week, N = 16
Withdrawal for any reason intervention reasons = 1 fatigue, 1 unrelated renal failure, 1 lack of motivation. Reasons control = 1 cognitive deficits, 1 lack of motivation No of events	n = 0 ; % = 0	n = 3 ; % = 17.6	n = 5 ; % = 29.4	n = 0 ; % = 0	n = 2 ; % = 12.5	n = 5 ; % = 31.3

Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(FuglMeyerUE)-MeanSD-robot-assisted neurocognitive therapy-conventional neurocognitive therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-robot-assisted neurocognitive therapy-conventional neurocognitive therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(AshworthMAS)-MeanSD-robot-assisted neurocognitive therapy-conventional neurocognitive therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(AshworthMAS)-MeanSD-robot-assisted neurocognitive therapy-conventional neurocognitive therapy-t32

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(FuglMeyerUE)-MeanSD-robot-assisted neurocognitive therapy-conventional neurocognitive therapy-t32

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-robot-assisted neurocognitive therapy-conventional neurocognitive therapy-t32

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

Remy-Neris, 2021

Bibliographic Reference	Remy-Neris, O.; Le Jeannic, A.; Dion, A.; Medee, B.; Nowak, E.; Poiroux, E.; Durand-Zaleski, I.; Team*, R. E. M. Investigative; Additional, Mechanized Upper Limb Self-Rehabilitation in Patients With Subacute Stroke: The REM-AVC Randomized Trial; Stroke; 2021; vol. 52 (no. 6); 1938-1947

Study details

Secondary publication of another included	NR

study- see primary study for details	
Other publications associated with this study included in review	NR
Trial name / registration number	NCT01383512
Study location	France
Study setting	21 inpatient rehabilitation centres
Study dates	June 2011 to December 2016
Sources of funding	This study was supported by the French Ministry of Health: EMREM_AVC CHU BREST 20 220.
Inclusion criteria	The inclusion criteria were as follows: aged 18 to 81 years old, diagnosis of hemorrhagic or ischemic middle cerebral artery stroke 3 weeks to 3 months previously, and an FMA UE8 score between 10 and 40 points.
Exclusion criteria	Exclusion criteria were as follows: pain in the affected shoulder >3/10 on a visual analogue scale, a Boston Diagnostic Aphasia Examination9 score ≤3 points, fatigue or visual impairment that would prevent participation in an additional daily hour of therapy, and an inability to sit independently.
Recruitment / selection of participants	Patients were enrolled by an allocated physician at each site via a secure, web-based, centralized data entry system that ensured all inclusion and exclusion criteria were respected.
Intervention(s)	The ArmeoSpring exoskeleton device (Hocoma, Inc, Zurich, Switzerland) was used for the gravity-supported, games-based self-rehabilitation, following the response to a call to tender. This is a mechanized, nonactuated exoskeleton that supports the weight of the arm by means of springs. It records joint angles and the position of the end effector (handheld by the user) in real time. It is designed to train shoulder and elbow movements, pronation and supination, and grip-release through participation in games displayed on a screen. The games are conceived to challenge movement distance or speed or a combination of both. The workspace required for the games is personalized for each user (by the therapist) as the maximum space in which they can actively reach the limits of the virtual environment.

	A therapist was present during the first 4 sessions; for the remaining sessions, the therapist set the patient up in the device, adjusted the device parameters, and programmed the exercises, but the participant then trained independently. concomitant therapy- The study involved usual rehabilitation for all participants, followed by an additional daily hour of self-rehabilitation (two 30-minute sessions) consisting of either gravity-supported, games-based training using an exoskeleton (for the Exo group) or basic stretching and active exercises (for the control group) over a period of 4 weeks. This dose of self-rehabilitation was chosen according to therapist's opinions of the amount feasible in the context of multidisciplinary rehabilitation and post stroke fatigue. Participating therapists (physiotherapists and occupational therapists) received specific training in the use of the device for the purposes of the study and in the control self-rehabilitation during a 2-day training program. Performance of self-rehabilitation was encouraged by the therapist in charge of each patient who recorded attendance and session duration. All participants underwent the usual rehabilitation provided in each center, 5 days per week. UL rehabilitation time was standardized across centers to a maximum of 1.5 hours per day during the trial.
Subgroup 1: Severity	Moderate (or NIHSS 5-14)
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks

Subgroup 7: Level of supervision	Unsupervised
Subgroup 8: Type of movement delivered by robotic device	Active assisted movement
Population subgroups	NR
Comparator	The control group performed their self-rehabilitation in the rehabilitation room. A 2×2-m instruction poster with written and photographic instructions of stretches and active exercises was fixed to a wall (Data Supplement). Participants were instructed to perform 10 minutes of stretching (5-second stretches of the main muscles that shorten after stroke) and 20 minutes of active exercises (10 repetitions of each exercise) that involved simple movements of the UL joints through range and no functional exercises. Exercises involving range of motion could be progressed in terms of distance and height, but no formal method of progression was determined. A therapist was present throughout the first 4 sessions: for the remaining sessions, they checked the participant's attendance, recommended exercises to be performed, provided encouragement to continue if the patient stopped exercising, but did not supervise the exercise program.
Number of participants	215
Duration of follow-up	End of intervention
Indirectness	NR
Additional comments	NR

Study arms

Robot therapy with Armeo Spring (N = 107)

Conventional therapy (N = 108)

Characteristics

Study-level characteristics

Characteristic	Study (N = 215)
Ethnicity Nominal	NR
Comorbidities Nominal	NR

Arm-level characteristics

Characteristic	Robot therapy with Armeo Spring (N = 107)	Conventional therapy (N = 108)
% Female Nominal	37.38	32.41
Mean age (SD) Mean (SD)	58.08 (14.05)	58.53 (13.27)
Severity NIHSS Mean (SD)	5.04 (2.36)	5.4 (2.45)

Characteristic	Robot therapy with Armeo Spring (N = 107)	Conventional therapy (N = 108)
Time after stroke days Mean (SD)	55.67 (21.6)	53.93 (22.68)

Outcomes

Study timepoints

- Baseline
- 30 day (post intervention)
- 12 month

continuous outcomes

Outcome	Robot therapy with Armeo Spring, Baseline, N = 107	Robot therapy with Armeo Spring, 30 day, N = 105	Robot therapy with Armeo Spring, 12 month, N = 97	Conventional therapy, Baseline, N = 108	Conventional therapy, 30 day, N = 103	Conventional therapy, 12 month, N = 97
Arm function (Fugel myer UE) 0-66, change score Mean (SD)	25.87 (9.01)	13.32 (9.03)	23.44 (11.09)	26.36 (9.96)	11.78 (8.84)	22.41 (10.53)
person/particpant health related quality of life (EQ5D)	53.43 (20.17)	NR (NR)	14.41 (19.86)	50.13 (19.82)	NR (NR)	19.08 (22.8)

Outcome	Robot therapy with Armeo Spring, Baseline, N = 107	Robot therapy with Armeo Spring, 30 day, N = 105	Robot therapy with Armeo Spring, 12 month, N = 97	Conventional therapy, Baseline, N = 108	Conventional therapy, 30 day, N = 103	Conventional therapy, 12 month, N = 97
0-100 (change score) from 0-12 months FU Mean (SD)						
Stroke-specific Patient Reported Outcome Measure (Stroke Impact Scale-hand function domain) 0-100, change score Mean (SD)	12.19 (20.54)	14.79 (24.41)	37.8 (31.22)	7.24 (12.58)	14.99 (21.43)	35.27 (32.24)
Activties of daily living (functional independence measure) 13-91, change score Mean (SD)	98.35 (17.67)	10.81 (9.38)	18.51 (13.3)	99.95 (16.7)	10.68 (10.02)	18.65 (14.75)

Arm function (Fugel myer UE) - Polarity - Higher values are better
person/particpant health related quality of life (EQ5D) - Polarity - Higher values are better
Stroke-specific Patient Reported Outcome Measure (Stroke Impact Scale-hand function domain) - Polarity - Higher values are better
Activties of daily living (functional independence measure) - Polarity - Higher values are better

Dichotomous outcomes

Outcome	Robot therapy with Armeo Spring, Baseline, N = 107	Robot therapy with Armeo Spring, 30 day, N = 107	Robot therapy with Armeo Spring, 12 month, N = 107	Conventional therapy, Baseline, N = 108	Conventional therapy, 30 day, N = 108	Conventional therapy, 12 month, N = 108
Adverse events (injuries and pain) No of events	n = 0 ; % = 0	n = 45 ; % = 42.1	n = NR ; % = NR	n = 0 ; % = 0	n = 59 ; % = 54.6	n = NR ; % = NR
Other reported adverse events serious events No of events	n = 0 ; % = 0	n = 4 ; % = 3.7	n = NR ; % = NR	n = 0 ; % = 0	n = 5 ; % = 4.6	n = NR ; % = NR
Withdrawal for any reason No of events	n = 0 ; % = 0	n = 1 ; % = 0.9	n = 3 ; % = 2.8	n = 0 ; % = 0	n = 4 ; % = 3.7	n = 3 ; % = 2.8

Adverse events (injuries and pain) - Polarity - Lower values are better
Other reported adverse events - Polarity - Lower values are better
Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

continuousoutcomes-Stroke-specificPatientReportedOutcomeMeasure(StrokeImpactScale-handfunctiondomain)-MeanSD-Robot therapy with Armeo Spring-Conventional therapy-t30

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to measurement of the outcome no blinding)*
Overall bias and Directness	Overall Directness	Directly applicable

continuousoutcomes-Activtiesofdailyliving(functionalindependencemeasure)-MeanSD-Robot therapy with Armeo Spring-Conventional therapy-t30

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

continuousoutcomes-Armfunction(FugelmyerUE)-MeanSD-Robot therapy with Armeo Spring-Conventional therapy-t30

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Adverseevents(injuriesandpain)-NoOfEvents-Robot therapy with Armeo Spring-Conventional therapy-t30

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Otherreportedadverseevents-NoOfEvents-Robot therapy with Armeo Spring-Conventional therapy-t30

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot therapy with Armeo Spring-Conventional therapy-t30

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

continuousoutcomes-Armfunction(FugelmyerUE)-MeanSD-Robot therapy with Armeo Spring-Conventional therapy-t12

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

continuousoutcomes-person/particpanthealthrelatedqualityoflife(EQ5D)-MeanSD-Robot therapy with Armeo Spring-Conventional therapy-t12

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to measurement of outcome no blinding and reporting only at 12 months)*
Overall bias and Directness	Overall Directness	Directly applicable

continuousoutcomes-Stroke-specificPatientReportedOutcomeMeasure(StrokeImpactScale-handfunctiondomain)-MeanSD-Robot therapy with Armeo Spring-Conventional therapy-t12

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to measurement of the outcome no blinding)*
Overall bias and Directness	Overall Directness	Directly applicable

continuousoutcomes-Activtiesofdailyliving(functionalindependencemeasure)-MeanSD-Robot therapy with Armeo Spring-Conventional therapy-t12

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot therapy with Armeo Spring-Conventional therapy-t12

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Rodgers, 2019

Bibliographic Reference	Rodgers, H.; Bosomworth, H.; Krebs, H. I.; van Wijck, F.; Howel, D.; Wilson, N.; Aird, L.; Alvarado, N.; Andole, S.; Cohen, D. L.; Dawson, J.; Fernandez-Garcia, C.; Finch, T.; Ford, G. A.; Francis, R.; Hogg, S.; Hughes, N.; Price, C. I.; Ternent, L.; Turner, D. L.; Vale, L.; Wilkes, S.; Shaw, L.; Robot assisted training for the upper limb after stroke (RATULS): a multicentre randomised controlled trial; Lancet; 2019; vol. 394 (no. 10192); 51-62

Study details

Secondary publication of another included study- see primary study for details	NR
Other publications associated with this study included in review	Rodgers H, Bosomworth H, Krebs HI, van Wijck F, Howel D, Wilson N, Finch T, Alvarado N, Ternent L, Fernandez-Garcia C, Aird L, Andole S, Cohen DL, Dawson J, Ford GA, Francis R, Hogg S, Hughes N, Price CI, Turner DL, Vale L, Wilkes S, Shaw L. Robot-assisted training compared with an enhanced upper limb therapy programme and with usual care for upper limb functional limitation after stroke: the RATULS three-group RCT. Health Technol Assess. 2020 Oct;24(54):1-232. doi: 10.3310/hta24540. PMID: 33140719; PMCID: PMC7682262.

	Fernandez-Garcia C, Ternent L, Homer TM, Rodgers H, Bosomworth H, Shaw L, Aird L, Andole S, Cohen D, Dawson J, Finch T, Ford G, Francis R, Hogg S, Hughes N, Krebs HI, Price C, Turner D, Van Wijck F, Wilkes S, Wilson N, Vale L. Economic evaluation of robot-assisted training versus an enhanced upper limb therapy programme or usual care for patients with moderate or severe upper limb functional limitation due to stroke: results from the RATULS randomised controlled trial. BMJ Open. 2021 May 25;11(5):e042081. doi: 10.1136/bmjopen-2020-042081. PMID: 34035087; PMCID: PMC8154983.
Trial name / registration number	ISRCTN69371850.
Study location	UK
Study setting	Four National Health Service (NHS) centres in the UK. Each centre comprised a stroke service in an NHS hospital with an MIT-Manus robotic gym system (InMotion commercial version, Interactive Motion Technologies, Watertown, MA, USA), plus stroke services in adjacent NHS Trusts and community services.
Study dates	Between April 14, 2014, and April 30, 2018
Sources of funding	National Institute for Health Research Health Technology Assessment Programme.
Inclusion criteria	Study participants were adults (age ≥18 years) with moderate or severe upper limb functional limitation (Action Research Arm Test [ARAT] score 0–39) 9 as a result of first-ever stroke that had occurred between 1 week and 5 years before randomisation.
Exclusion criteria	Exclusion criteria were other notable impairment in the upper limb affected by stroke; other diagnosis that might interfere with rehabilitation or outcome assessments; previous use of the robotic gym system or other arm rehabilitation robot; participation in another upper limb rehabilitation trial; and previous enrolment in this study. Participants were recruited from stroke units, outpatient clinics, day hospitals, community rehabilitation services, local stroke clubs, and primary care.
Recruitment / selection of participants	Randomisation was done through a central independent web-based service hosted by Newcastle University Clinical Trials Unit. Participants were randomly assigned 1:1:1 to receive robot-assisted training, an EULT programme, or usual care using permuted block sequences stratified according to centre, time since stroke, and severity of upper limb functional limitation (ARAT score).9 The sequences were prepared by an independent statistician before the start of enrolment.
Intervention(s)	The robot-assisted training programme integrated training with all three modules of the MIT-Manus robotic gym (shoulder–elbow module, wrist module, hand module integrated on to the shoulder–elbow module). The MIT-Manus robotic gym recorded data on the robot-assisted training sessions content.

	Concomitant therapy - Robot-assisted training and EULT programmes were delivered at the same frequency and duration: 45 min of face-to-face therapy, three times per week for 12 weeks. The same therapists and therapy assistants delivered both interventions at each centre. Robot-assisted training and EULT were delivered in addition to usual post-stroke care.
Subgroup 1: Severity	Moderate (or NIHSS 5-14)
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Active assisted movement

Population subgroups	NR
Comparator	The 2 control groups have been combined for the purposes of this review in align with the Cochrane review. EULT - The EULT programme was designed to reflect best practice using repetitive functional task practice to work towards participant-centred goals. Therapists recorded data on the content of EULT sessions. Robot-assisted training and EULT programmes were delivered at the same frequency and duration: 45 min of face-to-face therapy, three times per week for 12 weeks. Usual care - Participants assigned to usual care received usual NHS care, which was provided by their local clinical service. The English national quality standard is that patients with stroke should be offered a minimum of 45 min of each appropriate therapy that is required, for a minimum of 5 days per week, at a level that enables the patient to meet their rehabilitation goals for as long as they are continuing to benefit from therapy and as long as they are able to tolerate it.
Number of participants	770
Duration of follow-up	3 months
Indirectness	NR
Additional comments	NR

Study arms

Robot assisted training (N = 257)

Enhanced UL therapy and usual care (N = 513)

Characteristics

Study-level characteristics

Characteristic	Study (N = 770)
Ethnicity Nominal	NR
Comorbidities Nominal	NR

Arm-level characteristics

Characteristic	Robot assisted training (N = 257)	Enhanced UL therapy and usual care (N = 513)
% Female Nominal	39	39.1
Mean age (SD) Mean (SD)	59.9 (13.5)	60.9 (13.5)
Severity NIHSS Mean (SD)	5.6 (3.2)	5.7 (3.2)

Characteristic	Robot assisted training (N = 257)	Enhanced UL therapy and usual care (N = 513)
Time after stroke days Median (IQR)	233 (102 to 549)	NR (NR to NR)

Outcomes

Study timepoints

- Baseline
- 3 month
- 6 month

Continuous ouctomes

Outcome	Robot assisted training, Baseline, N = 257	Robot assisted training, 3 month, N = 232	Robot assisted training, 6 month, N = 221	Enhanced UL therapy and usual care, Baseline, N = 513	Enhanced UL therapy and usual care, 3 month, N = 437	Enhanced UL therapy and usual care, 6 month, N = 404
Activties of dailiy living (Barthel index) 0-100, final values Mean (SD)	14.5 (3.8)	15.5 (3.4)	15.6 (3.4)	14.4 (4)	15.3 (3.6)	15.7 (3.6)
Arm function (Fugl Meyer UE) 0-126, final values	68.9 (16.5)	76.6 (22.1)	78.2 (22.8)	69 (18)	76.1 (23.2)	78.7 (23.7)

Outcome	Robot assisted training, Baseline, N = 257	Robot assisted training, 3 month, N = 232	Robot assisted training, 6 month, N = 221	Enhanced UL therapy and usual care, Baseline, N = 513	Enhanced UL therapy and usual care, 3 month, N = 437	Enhanced UL therapy and usual care, 6 month, N = 404
Mean (SD)						
Stroke-specific Patient Reported Outcome Measure (Stroke Impact Scale hand function) 0-100, final value. intervention N = 213, control N = 395 Mean (SD)	NR (NR)	15.5 (24.4)	15.7 (25.2)	NR (NR)	18.1 (25.9)	16.8 (25.1)
Stroke-specific Patient Reported Outcome Measure (Stroke Impact Scale - mobility) 0-100, final value intervention N = 213, control N = 395 Mean (SD)	NR (NR)	61.6 (25.1)	61.7 (24.8)	NR (NR)	63.9 (24)	63.4 (23.8)
Stroke-specific Patient Reported Outcome Measure (Stroke Impact Scale ADLs) 0-100, final value intervention N = 213, control N = 395 Mean (SD)	NR (NR)	50.8 (22.5)	50.4 (22.3)	NR (NR)	53.5 (21)	52.2 (22)
Stroke-specific Patient Reported Outcome Measure (Stroke Impact Scalesocial	NR (NR)	47.7 (24.7)	47 (25.9)	NR (NR)	49.6 (23.4)	50 (24.1)

Outcome	Robot assisted training, Baseline, N = 257	Robot assisted training, 3 month, N = 232	Robot assisted training, 6 month, N = 221	Enhanced UL therapy and usual care, Baseline, N = 513	Enhanced UL therapy and usual care, 3 month, N = 437	Enhanced UL therapy and usual care, 6 month, N = 404
participation) 0-100, final values. intervention N = 210, control N = 394 Mean (SD)						
Person/participant generic health related quality of life (EQ5D)) 0-1, final values Mean (SD)	0.36 (0.26)	0.45 (0.27)	0.46 (0.29)	0.38 (0.26)	0.45 (0.27)	0.5 (0.3)

Activties of dailiy living (Barthel index) - Polarity - Higher values are better
Arm function (Fugl Meyer UE) - Polarity - Higher values are better
Stroke-specific Patient Reported Outcome Measure (Stroke Impact Scale hand function) - Polarity - Higher values are better
Stroke-specific Patient Reported Outcome Measure (Stroke Impact Scale - mobility) - Polarity - Higher values are better
Stroke-specific Patient Reported Outcome Measure (Stroke Impact Scale ADLs) - Polarity - Higher values are better
Stroke-specific Patient Reported Outcome Measure (Stroke Impact Scalesocial participation) - Polarity - Higher values are better
Person/participant generic health related quality of life (EQ5D)) - Polarity - Higher values are better

dichotomous outcomes

Outcome	Robot assisted training, Baseline, N = 257	Robot assisted training, 3 month, N = 257	Robot assisted training, 6 month, N = 257	Enhanced UL therapy and usual care, Baseline, N = 513	Enhanced UL therapy and usual care, 3 month, N = 513	Enhanced UL therapy and usual care, 6 month, N = 513
withdrawal due to any reason No of events	n = 0 ; % = 0	n = 18 ; % = 7	n = 11 ; % = 4.2	n = 0 ; % = 0	n = 44 ; % = 8.57	n = 38 ; % = 7.4
adverse events (cardiovascular) intervention N = 233, control N = 443, 6 months intervention = 223, control = 412 No of events	n = 0 ; % = 0	n = 5 ; % = 1.9	n = 2 ; % = 0.9	n = 0 ; % = 0	n = 2 ; % = 0.4	n = 2 ; % = 0.5
Adverse events general 3 months- intervention N = 233, control N = 443, 6 months intervention = 223, control = 412 No of events	n = 0 ; % = 0	n = 46 ; % = 19.7	n = 44 ; % = 19.7	n = 0 ; % = 0	n = 78 ; % = 17.6	n = 84 ; % = 20.4

withdrawal due to any reason - Polarity - Lower values are better
adverse events (cardiovascular) - Polarity - Lower values are better
Adverse events general - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

dichotomousoutcomes-withdrawalduetoanyreason-NoOfEvents-Robot assisted training-Enhanced UL therapy and usual care-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousouctomes-Activtiesofdailiyliving(Barthelindex)-MeanSD-Robot assisted training-Enhanced UL therapy and usual care-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousouctomes-Armfunction(FuglMeyerUE)-MeanSD-Robot assisted training-Enhanced UL therapy and usual care-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousouctomes-Stroke-specificPatientReportedOutcomeMeasure(StrokeImpactScalehandfunction)-MeanSD-Robot assisted training-Enhanced UL therapy and usual care-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to measurement of the outcome as no blinding and self reported outcome)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousouctomes-Stroke-specificPatientReportedOutcomeMeasure(StrokeImpactScalesocialparticipation)-MeanSD-Robot assisted training-Enhanced UL therapy and usual care-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to measurement of the outcome as no blinding and self reported outcome)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousouctomes-Stroke-specificPatientReportedOutcomeMeasure(StrokeImpactScaleADLs)-MeanSD-Robot assisted training-Enhanced UL therapy and usual care-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to measurement of the outcome as no blinding and self reported outcome)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousouctomes-Stroke-specificPatientReportedOutcomeMeasure(StrokeImpactScale-mobility)-MeanSD-Robot assisted training-Enhanced UL therapy and usual care-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to measurement of the outcome as no blinding and self reported outcome)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousouctomes-Person/participantgenerichealthrelatedqualityoflife(EQ5D))-MeanSD-Robot assisted training-Enhanced UL therapy and usual care-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to measurement of the outcome as no blinding and self reported outcome)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousouctomes-Person/participantgenerichealthrelatedqualityoflife(EQ5D))-MeanSD-Robot assisted training-Enhanced UL therapy and usual care-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to measurement of the outcome as no blinding and self reported outcome)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousouctomes-Stroke-specificPatientReportedOutcomeMeasure(StrokeImpactScalesocialparticipation)-MeanSD-Robot assisted training-Enhanced UL therapy and usual care-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to measurement of the outcome as no blinding and self reported outcome)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousouctomes-Stroke-specificPatientReportedOutcomeMeasure(StrokeImpactScaleADLs)-MeanSD-Robot assisted training-Enhanced UL therapy and usual care-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to measurement of the outcome as no blinding and self reported outcome)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousouctomes-Stroke-specificPatientReportedOutcomeMeasure(StrokeImpactScale-mobility)-MeanSD-Robot assisted training-Enhanced UL therapy and usual care-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to measurement of the outcome as no blinding and self reported outcome)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousouctomes-Stroke-specificPatientReportedOutcomeMeasure(StrokeImpactScalehandfunction)-MeanSD-Robot assisted training-Enhanced UL therapy and usual care-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to measurement of the outcome as no blinding and self reported outcome)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousouctomes-Armfunction(FuglMeyerUE)-MeanSD-Robot assisted training-Enhanced UL therapy and usual care-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousouctomes-Activtiesofdailiyliving(Barthelindex)-MeanSD-Robot assisted training-Enhanced UL therapy and usual care-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

dichotomousoutcomes-Adverseeventsgeneral-NoOfEvents-Robot assisted training-Enhanced UL therapy and usual care-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

dichotomousoutcomes-Adverseeventsgeneral-NoOfEvents-Robot assisted training-Enhanced UL therapy and usual care-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

dichotomousoutcomes-adverseevents(cardiovascular)-NoOfEvents-Robot assisted training-Enhanced UL therapy and usual care-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

dichotomousoutcomes-adverseevents(cardiovascular)-NoOfEvents-Robot assisted training-Enhanced UL therapy and usual care-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

dichotomousoutcomes-withdrawalduetoanyreason-NoOfEvents-Robot assisted training-Enhanced UL therapy and usual care-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Rodgers, 2020

Bibliographic Reference	Rodgers, H.; Bosomworth, H.; Krebs, H. I.; van Wijck, F.; Howel, D.; Wilson, N.; Finch, T.; Alvarado, N.; Ternent, L.; Fernandez-Garcia, C.; Aird, L.; Andole, S.; Cohen, D. L.; Dawson, J.; Ford, G. A.; Francis, R.; Hogg, S.; Hughes, N.; Price, C. I.; Turner, D. L.; Vale, L.; Wilkes, S.; Shaw, L.; Robot-assisted training compared with an enhanced upper limb therapy programme and with usual care for upper limb functional limitation after stroke: the RATULS three-group RCT; Health Technology Assessment (Winchester, England); 2020; vol. 24 (no. 54); 1-232

Study details

Secondary publication of another included study- see primary study for details	Rodgers H, Bosomworth H, Krebs HI, van Wijck F, Howel D, Wilson N, Aird L, Alvarado N, Andole S, Cohen DL, Dawson J, Fernandez-Garcia C, Finch T, Ford GA, Francis R, Hogg S, Hughes N, Price CI, Ternent L, Turner DL, Vale L, Wilkes S, Shaw L. Robot assisted training for the upper limb after stroke (RATULS): a multicentre randomised controlled trial. Lancet. 2019 Jul 6;394(10192):51-62. doi: 10.1016/S0140-6736(19)31055-4. Epub 2019 May 22. PMID: 31128926; PMCID: PMC6620612.
Other publications associated with this study included in review	Fernandez-Garcia C, Ternent L, Homer TM, Rodgers H, Bosomworth H, Shaw L, Aird L, Andole S, Cohen D, Dawson J, Finch T, Ford G, Francis R, Hogg S, Hughes N, Krebs HI, Price C, Turner D, Van Wijck F, Wilkes S, Wilson N, Vale L. Economic evaluation of robot-assisted training versus an enhanced upper limb therapy programme or usual care for patients with moderate or severe upper limb functional limitation due to stroke: results from the RATULS randomised controlled trial. BMJ Open. 2021 May 25;11(5):e042081. doi: 10.1136/bmjopen-2020-042081. PMID: 34035087; PMCID: PMC8154983.

Sale, 2014

Bibliographic Reference	Sale, Patrizio; Franceschini, Marco; Mazzoleni, Stefano; Palma, Enzo; Agosti, Maurizio; Posteraro, Federico; Effects of upper limb robot-assisted therapy on motor recovery in subacute stroke patients; Journal of neuroengineering and rehabilitation; 2014; vol. 11 (no. 1); 1-8

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review. Mazzoleni S, Buono L, Dario P, Posteraro F. Upper limb robot-assisted therapy in subacute and chronic stroke patients: preliminary results on initial exposure based on kinematic measures. 5th IEEE RAS and EMBS International Conference on Biomedical Robotics and Biomechatronics, BioRob; 12-15 August, 2014. 2014:265-9. [MEDLINE: 4006; 21551774]

	Sale P, Mazzoleni S, Lombardi V, Galafate D, Massimiani MP, Posteraro F, et al. Recovery of hand function with robot-assisted therapy in acute stroke patients: a randomized-controlled trial. *International Journal of Rehabilitation Research* 2014;37(3):236-42. [MEDLINE: 4901; 03425282]
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Not stated/unclear
Subgroup 8: Type of movement delivered by robotic device	Active assisted movement

Study arms

Robot-assisted therapy (N = 26)
30 sessions of robot-assisted therapy (5 days a week for 6 weeks).

Conventional rehabilitative treatment (N = 27)
30 sessions (5 days a week for 6 weeks)

Outcomes

Study timepoints
- Baseline
- 6 week (Post-intervention)

Dichotomous outcome

Outcome	Robot-assisted therapy, Baseline, N = 26	Robot-assisted therapy, 6 week, N = 26	Conventional rehabilitative treatment, Baseline, N = 27	Conventional rehabilitative treatment, 6 week, N = 27
Withdrawal for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Continuous outcomes

Outcome	Robot-assisted therapy, Baseline, N = 26	Robot-assisted therapy, 6 week, N = 26	Conventional rehabilitative treatment, Baseline, N = 27	Conventional rehabilitative treatment, 6 week, N = 27
Arm function (Fugl-Meyer assessment) Change scores. Scale range 0-66. Values as reported in Cochrane review. Mean (SD)	26.81 (11.43)	8.7 (7.5)	20.33 (16.01)	3.6 (10.7)
Arm muscle strength (Motricity Index) Change scores. Scale range 0-100. Values as reported in Cochrane review. Mean (SD)	43.88 (24.77)	13.9 (15.5)	30.3 (33.38)	9.3 (21.7)
Spasticity (MAS)- shoulder Final values. Scale range 0-5 Mean (SD)	1.15 (1.16)	0.73 (1.08)	1.19 (1)	1.15 (1.17)
Spasticity (MAS)- elbow Final values. Scale range 0-5 Mean (SD)	1.12 (1.07)	0.73 (0.96)	0.85 (0.91)	0.93 (0.96)

Arm function (Fugl-Meyer assessment) - Polarity - Higher values are better
Arm muscle strength (Motricity Index) - Polarity - Higher values are better
Spasticity (MAS)- shoulder - Polarity - Lower values are better
Spasticity (MAS)- elbow - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Spasticity(MAS)-elbow-MeanSD-Robot-assisted therapy-Conventional rehabilitative treatment-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(MAS)-shoulder-MeanSD-Robot-assisted therapy-Conventional rehabilitative treatment-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armmusclestrength(MotricityIndex)-MeanSD-Robot-assisted therapy-Conventional rehabilitative treatment-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-MeanSD-Robot-assisted therapy-Conventional rehabilitative treatment-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-assisted therapy-Conventional rehabilitative treatment-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Sale, 2014

Bibliographic Reference	Sale, Patrizio; Mazzoleni, Stefano; Lombardi, Valentina; Galafate, Daniele; Massimiani, Maria P.; Posteraro, Federico; Damiani, Carlo; Franceschini, Marco; Recovery of hand function with robot-assisted therapy in acute stroke patients: a randomized-controlled trial; International journal of rehabilitation research; 2014; vol. 37 (no. 3); 236-242

Study details

Secondary publication of another included study- see primary study for details	Sale et al. Effects of upper limb robot-assisted therapy on motor recovery in subacute stroke patients. J Neuroeng Rehabil. 2014; 11: 104.

Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 8: Type of movement delivered by robotic device	Active assisted movement

Singh, 2021

Bibliographic Reference	Singh, N.; Saini, M.; Kumar, N.; Srivastava, M. V. P.; Mehndiratta, A.; Evidence of neuroplasticity with robotic hand exoskeleton for post-stroke rehabilitation: a randomized controlled trial; Journal of Neuroengineering & Rehabilitation; 2021; vol. 18 (no. 1); 76

Study details

Secondary publication of another included study- see primary study for details	NR
Trial name / registration number	ISRCTN95291802
Study location	India
Study setting	outpatient clinic
Study dates	July-2016 to January-2019
Sources of funding	This work was financially supported by SERB, DST India (YSS/2015/000697) and IIT Delhi, MFIRP (Project no. AI-19).
Inclusion criteria	Patients were enrolled based on inclusion-criteria, age 18–70 years, having ischemic / hemorrhagic stroke within 3–24 months, Mini-Mental Scale (MMS)=24–30; Brunnstrom stage (BS)=3–5; Modifed Ashworth Scale (MAS)=1, 1+, 2
Exclusion criteria	Patients with contra-indication to Transcranial Magnetic Stimulation (TMS), no detectable Electromyogram (EMG) activity and any other progressive neurological or cognitive disorders were excluded from the study.
Recruitment / selection of participants	More than 300 patients (n>300) were screened in the out-patient clinic of the Department of Neurology, AIIMS, New-Delhi over three years from July-2016 to January-2019. Stroke diagnosis was established clinically in all the patients
Intervention(s)	An electromechanical robotic-exoskeleton was developed for rehabilitation of wrist-joint and fingers-joint. Stages of motion sequence were: wrist at the neutral position, finger extension (baseline position) → wrist extension finger flexion (final

	position) → back to wrist flexion, finger extension (towards baseline position); with a constant speed (28 degrees/second) for all the patients. All sessions were given at the hospital set-up under the supervision of an expert clinician. Each 45 min robotic-therapy session consisted of approximately 250 trials of 10 s each, excluding the setup time, breaks, donning and doing of the exoskeleton or consultation which was an additional 10–15 min. Patients were advised to take 5 min break for rest in between the therapy-session if there is a feeling of pain or fatigue, this time was then added to the total therapy time, keeping the active therapy session to 45 min consistently. Robot therapy sessions were conducted for 45 min per day for 5 days a week for 4 weeks. Patient hands were stabilized in the exoskeleton device with the velcro straps in the neutral position and therapy required to extend the wrist in a neutral position only (with no ulnar/radial deviation). The device is actively initiated by Electromyogram (EMG) activity of EDC muscle with robot motion-triggered only if the EMG thresholds (set with the consensus of the therapist at the time of first therapy sitting) are crossed and it provides an interactive adaptive performance visual biofeedback in real-time. At baseline position, the patient tries to extend the wrist voluntarily for the first three seconds after the green LED cue. If the EMG crosses the predefined threshold, the exoskeleton will be triggered for an assisted wrist extension and finger flexion movement. Once it reaches the final position, the exoskeleton then assists the patient's hand back to the baseline position, wrist flexion with finger extension.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks

Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Active assisted movement
Population subgroups	NR
Comparator	The conventional therapy session was conducted for 45 min per day for 5 days a week for 4 weeks. The type of activity, intensity and frequency was based on the baseline clinical presentation of the patient as reflected by clinical scales (MAS, FMA, BI, BS, and Range of motion).
Number of participants	23
Duration of follow-up	post intervention (4 weeks)
Indirectness	NR
Additional comments	NR

Study arms

Robotic-therapy Group (N = 13)

Conventional therapy (N = 14)

Characteristics

Study-level characteristics

Characteristic	Study (N = 23)
Ethnicity Nominal	NR
Comorbidities Nominal	NR
Severity Nominal	NR

Arm-level characteristics

Characteristic	Robotic-therapy Group (N = 13)	Conventional therapy (N = 14)
% Female Nominal	NR	NR
Mean age (SD) Mean (SD)	41.1 (12.8)	42.7 (9.3)
Time after stroke months Mean (SD)	13.8 (9.1)	10.3 (5)

Outcomes

Study timepoints

- Baseline
- 4 week

Continuous outcomes

Outcome	Robotic-therapy Group, Baseline, N = 13	Robotic-therapy Group, 4 week, N = 12	Conventional therapy, Baseline, N = 14	Conventional therapy, 4 week, N = 11
Activities of daily living (barthel index) 0-100, final value Mean (SD)	74.1 (12.4)	89.1 (7.9)	69.5 (12.9)	82.7 (14.3)
Arm function (Fugl Meyer UE) 0-66, final value Mean (SD)	36 (7.7)	50.2 (6.5)	37.4 (9.1)	45.4 (9.7)
Spastcity outcome - Modified ashworth scale 0-4, final value Mean (SD)	1.75 (0.2)	1.29 (0.2)	1.86 (0.5)	1.59 (0.6)

Activities of daily living (barthel index) - Polarity - Higher values are better
Arm function (Fugl Meyer UE) - Polarity - Higher values are better
Spastcity outcome - Modified ashworth scale - Polarity - Lower values are better

Dichotomous outcomes

Outcome	Robotic-therapy Group, Baseline, N = 13	Robotic-therapy Group, 4 week, N = 13	Conventional therapy, Baseline, N = 14	Conventional therapy, 4 week, N = 14
withdrawal due to any reason No of events	n = 0 ; % = 0	n = 1 ; % = 7.6	n = 0 ; % = 0	n = 3 ; % = 21.4

withdrawal due to any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Activitiesofdailyliving(barthelindex)-MeanSD-Robotic-therapy Group-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to missing outcome data)*
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-withdrawalduetoanyreason-NoOfEvents-Robotic-therapy Group-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to missing outcome data)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(FuglMeyerUE)-MeanSD-Robotic-therapy Group-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to missing outcome data)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spastcityoutcome-Modifiedashworthscale-MeanSD-Robotic-therapy Group-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to missing outcome data)*
Overall bias and Directness	Overall Directness	Directly applicable

Straudi, 2020

Bibliographic Reference	Straudi, S.; Baroni, A.; Mele, S.; Craighero, L.; Manfredini, F.; Lamberti, N.; Maietti, E.; Basaglia, N.; Effects of a Robot-Assisted Arm Training Plus Hand Functional Electrical Stimulation on Recovery After Stroke: A Randomized Clinical Trial; Archives of Physical Medicine & Rehabilitation; 2020; vol. 101 (no. 2); 309-316

Study details

Secondary publication of another included study- see primary study for details	NR

Other publications associated with this study included in review	NR
Trial name / registration number	(NCT02267798)
Study location	italy
Study setting	Inpatient Rehabilitation University Hospital
Study dates	NR
Sources of funding	NR
Inclusion criteria	Inclusion criteria were: males and females, aged 18-80 years with diagnosis of first, single unilateral ischemic stroke verified by brain imaging <8 weeks. To be enrolled in the study patients had to have an upper limb motor impairment defined by an upper extremity score >11 and <55 on the Fugl-Meyer Assessment (FMA-UE).
Exclusion criteria	Patients were excluded if they presented with neurological conditions in addition to stroke that may affect motor function, other medical conditions likely to interfere with the ability to safely complete the study protocol, impaired cognitive functioning (score <21 on the Mini Mental Status Examination), or severe upper-limb pain defined as >7 on the Visual Analogue Scale.
Recruitment / selection of participants	NR
Intervention(s)	The experimental group received 1 hour and 40 minutes of hand FES+ RAT for each session (5 times/week over 6 weeks). Specifically, a 40 minute-session of hand FES was delivered through a battery-powered programmable stimulator and a forearm-wrist-hand orthosis containing 5 electrodes positioned to provide reliable activation of the following muscles: extensor digitorum communis, extensor pollicis brevis, flexor pollicis longus, flexor digitorum superficialis, and thenar muscles (H200, Bioness, CA). The intensity of stimulation was set to a level that provided comfortable and consistent activation of the extensor and flexor muscles to achieve whole hand opening and functional grasping. Participants were instructed to coordinate their actions with the pre-timed stimulation patterns programmed in the device so as to synchronize the user's intention with FES assistance. Although the stimulation cycles were fixed, participants needed to engage actively in the tasks to produce the synergistic muscle actions throughout the upper limb required for effective task performance. The therapist set up activities to involve each subject in functional exercises specific to their personal needs, such as

	reaching, grasping, holding and releasing or daily activities with upper limb engagement. The voluntary contraction during electrical stimulation increases motor cortical excitability in the agonist muscle. After FES training, patients received 60 minutes of RAT with an end-effector device (Reo Therapy System, Motorika Medical Ltd, Israel) which focused on repetitive tasks that incorporate multidirectional reaching actions. In this robot-assisted therapy a robot manipulator applied forces to the paretic arm during goal-directed movements. During the session the patient's affected hand was placed on or strapped onto a robotic arm and she/he was instructed to either actively reach predefined reach points, or to be guided while the robotic arm led the arm towards these reach points. Concomitant therapy - addition to arm rehabilitation, all patients received multidisciplinary rehabilitation based on an individualized approach.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Mixed
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement	Active assisted movement

delivered by robotic device	
Population subgroups	NR
Comparator	the control group received 1 hour and 40 minutes of conventional therapy (5 times/week over 6 weeks). The control group received the same time of conventional arm therapy (100 minutes). Specific exercises for the affected upper limb included active, passive and sensory exercises or functional tasks.
Number of participants	40
Duration of follow-up	end of treatment - 6 weeks
Indirectness	NR

Study arms

Robot-assisted arm therapy and hand 11 functional electrical stimulation (N = 20)

intensive conventional therapy (N = 20)

Characteristics

Study-level characteristics

Characteristic	**Study (N = 39)**
Ethnicity Nominal	NR

Characteristic	Study (N = 39)
Comorbidities Nominal	NR
Severity Nominal	NR

Arm-level characteristics

Characteristic	Robot-assisted arm therapy and hand 11 functional electrical stimulation (N = 20)	intensive conventional therapy (N = 20)
% Female Nominal	36.8	40
Mean age (SD) Mean (SD)	NR (NR)	NR (NR)
Mean age (SD) Median (IQR)	68 (56 to 71)	68 (58.5 to 73)
Time after stroke Median (IQR)	39 (21 to 62)	32.5 (20 to 51)

Outcomes

Study timepoints

- Baseline
- 6 week

dichotomous outcomes

Outcome	Robot-assisted arm therapy and hand 11 functional electrical stimulation, Baseline, N = 20	Robot-assisted arm therapy and hand 11 functional electrical stimulation, 6 week, N = 20	intensive conventional therapy, Baseline, N = 20	intensive conventional therapy, 6 week, N = 20
Withdrawal for any reason Medical complications unrelated to interventions No of events	n = 0 ; % = 0	n = 1 ; % = 5	n = 0 ; % = 0	n = 0 ; % = 0

Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm therapy and hand 11 functional electrical stimulation-intensive conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(due to analysis used and bias due to deviations from the intended interventions)*

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Susanto, 2015

Bibliographic Reference	Susanto, Evan A.; Tong, Raymond K. Y.; Ockenfeld, Corinna; Ho, Newmen S. K.; Efficacy of robot-assisted fingers training in chronic stroke survivors: a pilot randomized-controlled trial; Journal of neuroengineering and rehabilitation; 2015; vol. 12 (no. 1); 1-9

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear

Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	Not stated/unclear
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Passive movement

Study arms

Robot-assisted group (N = 9)
Hand exoskeleton robot-assisted training for10 1 hour sessions. Duration 5 weeks.

Non-assisted group (N = 10)
20 1 hour sessions for 5 weeks.

Outcomes

Study timepoints

- Baseline
- 5 week (Post-intervention)
- 6 month (Post-intervention.)

Dichotomous outcome

Outcome	Robot-assisted group, Baseline, N = 9	Robot-assisted group, 5 week, N = 9	Robot-assisted group, 6 month, N = 9	Non-assisted group, Baseline, N = 10	Non-assisted group, 5 week, N = 10	Non-assisted group, 6 month, N = 10
Withdrawal for any reason 1 lost to follow-up in control group due to relocation No of events	n = NA ; % = NA	n = 0 ; % = 0	n = 0 ; % = 0	n = NA ; % = NA	n = 1 ; % = 10	n = 1 ; % = 10

Continuous outcome

Outcome	Robot-assisted group, Baseline, N = 9	Robot-assisted group, 5 week, N = 9	Robot-assisted group, 6 month, N = 9	Non-assisted group, Baseline, N = 10	Non-assisted group, 5 week, N = 10	Non-assisted group, 6 month, N = 10
Arm function (Fugl-Meyer assessment) Change scores. Scale rang 0-66. Mean (SD)	31.89 (11.98)	5.1 (6.6)	6.1 (10.9)	34.6 (8.16)	5.7 (4.4)	2.7 (4.4)

Arm function (Fugl-Meyer assessment) - Polarity - Higher values are better

Also reports FMA-SE, FMA-WH, Wolf motor function test and ARAT.

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-assisted group-Non-assisted group-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-assisted group-Non-assisted group-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcome-Armfunction(Fugl-Meyerassessment)-MeanSD-Robot-assisted group-Non-assisted group-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcome-Armfunction(Fugl-Meyerassessment)-MeanSD-Robot-assisted group-Non-assisted group-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Takahashi, 2016

Bibliographic Reference	Takahashi, Kayoko; Domen, Kazuhisa; Sakamoto, Tomosaburo; Toshima, Masahiko; Otaka, Yohei; Seto, Makiko; Irie, Katsumi; Haga, Bin; Takebayashi, Takashi; Hachisuka, Kenji; Efficacy of upper extremity robotic therapy in subacute poststroke hemiplegia: an exploratory randomized trial; Stroke; 2016; vol. 47 (no. 5); 1385-1388

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear

Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised Therapist supervised both groups from a distance.
Subgroup 8: Type of movement delivered by robotic device	Passive movement

Study arms

Robot therapy (N = 30)
40 minutes of standard therapy plus robot therapy with ReoGo for 40 additional minutes, 7 times a week for 6 weeks.

Self-training (N = 30)
40 minutes of standard therapy plus therapist-directed self-training for 40 additional minutes, 7 times a week for 6 weeks.

Outcomes

Study timepoints

- Baseline
- 6 week (Post-intervention.)

Dichotomous outcomes

Outcome	Robot therapy, Baseline, N = 30	Robot therapy, 6 week, N = 30	Self-training, Baseline, N = 30	Self-training, 6 week, N = 30
Withdrawal for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0
Adverse events Deemed to be related to the study therapy. No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0

Continuous outcomes

Outcome	Robot therapy, Baseline, N = 30	Robot therapy, 6 week, N = 30	Self-training, Baseline, N = 30	Self-training, 6 week, N = 26
Activities of daily living (Functional Independence measure, physical items) Change scores. Scale range 13-91 Mean (SD)	61.1 (14.8)	12.6 (7.7)	62.2 (15.9)	15.1 (11)
Arm function (Fugl-Meyer assessment) Change scores. Scale range 0-66	29.1 (16.3)	9.5 (7.9)	31.8 (15.4)	6.9 (8.8)

Outcome	Robot therapy, Baseline, N = 30	Robot therapy, 6 week, N = 30	Self-training, Baseline, N = 30	Self-training, 6 week, N = 26
Mean (SD)				
Arm strength (Motricity Index) Change scores. Scale range ?0-100 Mean (SD)	55.73 (17.41)	6.5 (11)	54.54 (18.46)	8.4 (13.7)
Spasticity (MAS) Change scores. Scale 0-5 Mean (SD)	3.63 (2.25)	-0.1 (2.26)	3.71 (1.67)	-0.4 (1.66)

Activities of daily living (Functional Independence measure, physical items) - Polarity - Higher values are better
Arm function (Fugl-Meyer assessment) - Polarity - Higher values are better
Arm strength (Motricity Index) - Polarity - Higher values are better
Spasticity (MAS) - Polarity - Lower values are better
Also reports other functional outcomes: WMFT, FM proximal upper extremity, FM flexor synergy, Motor Activity Log, simple test for evaluating hand function and range of motion test.

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Activitiesofdailyliving(FunctionalIndependencemeasure,physicalitems)-MeanSD-Robot therapy-Self-training-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(MAS)-MeanSD-Robot therapy-Self-training-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armstrength(MotricityIndex)-MeanSD-Robot therapy-Self-training-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(Fugl-Meyerassessment)-MeanSD-Robot therapy-Self-training-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot therapy-Self-training-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Adverseevents-NoOfEvents-Robot therapy-Self-training-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Takebayashi, 2022

Bibliographic Reference	Takebayashi, T; Takahashi, K; Amano, S; Gosho, M; Sakai, M; Hashimoto, K; Hachisuka, K; Uchiyama, Y; Domen, K; Robot-Assisted Training as Self-Training for Upper-Limb Hemiplegia in Chronic Stroke: a Randomized Controlled Trial; Stroke; 2022; vol. 53 (no. 7); 2182-2191

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	No additional information.
Trial name / registration number	UMIN000022509.

Study type	Randomised controlled trial (RCT)
Study location	Japan.
Study setting	Outpatient follow up.
Study dates	November 29, 2016 to November 12, 2018.
Sources of funding	Funded by Teijin Pharma Limited.
Inclusion criteria	20-80 years old; upper-limb hemiplegia/hemiparesis due to a clinically first ever supratentorial stroke that occurred at least 6 months before the start of the study and were undergoing outpatient or ambulatory rehabilitation therapy to treat upper-limb dysfunction; Fugl-Meyer Assessment score <44; upper-limb distal function of 1b or above on the Stroke Impairment Assessment Set; a score no more than 2 on the Modified Ashworth Scale.
Exclusion criteria	Diagnosis with multiple strokes or cerebellar/brain stem strokes; extreme upper-limb pain; upper-limb function improvement without therapy; people with neuromuscular diseases; malignant tumours; balance or gait disturbances; other serious uncontrolled diseases, including cardiac, renal or hepatic diseases; peopel with serious aphasia or cognitive dysfunction (score of 24 points or less on the Mini-Mental State Examination); people with a history of robot-assisted upper-limb training or constraint induced movement training for upper-limb hemiplegia or who received a botulinum toxin injection within 16 weeks before enrollment; any person deemed ineligible by the investigator during the study.
Recruitment / selection of participants	People receiving outpatient rehabilitation at one of 25 hospitals or clinics throughout Japan.
Intervention(s)	Robot-assisted arm training N=87 Two groups combined. Group 1 (n=44) participated in 20 minutes of therapist-led occupational therapy and 40 minutes of robot self-training using the ReoGo-J device, group 2 (n=43) participated in 40 minutes of robot self-training using the ReoGo-J device then 20-minutes of therapist-led constraint induced movement therapy based on practice with the affected hand (shaping), task practice and behavioural practice of everyday functions with the affected hand. The ReoGo-J device mainly enabled movements of the shoulder, elbow and forearm and allowed for multiple tasks such as reaching, abduction and external rotation matched to the person's functional level. It could be set to a passive or active-assistive mode. The accuracy of performance could be assessed through visual feedback through a monitor available to the person participating in the therapy. In total 1 hour sessions of therapy were delivered 3 days a week for 10 weeks.

	Concomitant therapy: No additional information.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Unsupervised
Subgroup 8: Type of movement delivered by robotic device	Mixed
Population subgroups	No additional information.
Comparator	Any other intervention N=42 40 minutes of self-training, including sanding, placing, stretching and repetitive reaching, grasping and releasing practice to target the shoulder, elbow and forearm followed by 20 minutes of therapist-led occupational therapy. In total 1 hour sessions of therapy were delivered 3 days a week for 10 weeks.

	Concomitant therapy: No additional information.
Number of participants	129
Duration of follow-up	10 weeks (end of intervention)
Indirectness	No additional information.
Additional comments	Intention to treat and per-protocol analysis.

Study arms

Robot-assisted arm training (N = 87)
Two groups combined. Group 1 (n=44) participated in 20 minutes of therapist-led occupational therapy and 40 minutes of robot self-training using the ReoGo-J device, group 2 (n=43) participated in 40 minutes of robot self-training using the ReoGo-J device then 20-minutes of therapist-led constraint induced movement therapy based on practice with the affected hand (shaping), task practice and behavioural practice of everyday functions with the affected hand. The ReoGo-J device mainly enabled movements of the shoulder, elbow and forearm and allowed for multiple tasks such as reaching, abduction and external rotation matched to the person's functional level. It could be set to a passive or active-assistive mode. The accuracy of performance could be assessed through visual feedback through a monitor available to the person participating in the therapy. In total 1 hour sessions of therapy were delivered 3 days a week for 10 weeks. Concomitant therapy: No additional information.

Any other intervention (N = 42)
40 minutes of self-training, including sanding, placing, stretching and repetitive reaching, grasping and releasing practice to target the shoulder, elbow and forearm followed by 20 minutes of therapist-led occupational therapy. In total 1 hour sessions of therapy were delivered 3 days a week for 10 weeks. Concomitant therapy: No additional information.

Characteristics

Arm-level characteristics

Characteristic	Robot-assisted arm training (N = 87)	Any other intervention (N = 42)
% Female Sample size	n = 18 ; % = 21	n = 10 ; % = 27
Mean age (SD) (years) Mean (SD)	60 (12)	58 (10)
Ethnicity Sample size	n = NR ; % = NR	n = NR ; % = NR
Comorbidities Sample size	n = NR ; % = NR	n = NR ; % = NR
Severity Mean (SD)	NR (NR)	NR (NR)
Time after stroke (Months) Mean (SD)	37.7 (56.7)	34.3 (37.8)

Reports baseline characteristics for 84 people in the intervention arm, and 37 people in the control arm.

Outcomes

Study timepoints

- Baseline
- 10 week (End of intervention)

Continuous outcomes

Outcome	Robot-assisted arm training, Baseline, N = 81	Robot-assisted arm training, 10 week, N = 81	Any other intervention, Baseline, N = 36	Any other intervention, 10 week, N = 36
Arm function (Fugl-Meyer assessment - upper extremity) Scale range: 0-66. Change scores. Using the full available set of data. Values for robot training groups combined. Robot training and usual care = 2.52 (0.59). Robot training and constraint training = 2.19 (0.61). Mean (SD)	26.2 (9.8)	2.36 (0.62)	25 (9)	1.49 (0.64)
Arm muscle strength (Motricity Index) Scale range: 0-99. Change scores. Using the full available set of data. Values for robot training groups combined. Robot training and usual care = 8.37 (1.79). Robot training and constraint training = 5.51 (1.87). Mean (SD)	NR (NR)	6.99 (2.32)	NR (NR)	5.28 (1.95)
Spasticity (modified Ashworth scale) Scale range: 0-4. Change scores. Using the full available set of data. Values for robot training groups combined. Robot training and usual care = -0.35 (0.63). Robot training and constraint training = -1.13 (0.66). Mean (SD)	NR (NR)	-0.73 (0.75)	NR (NR)	0.07 (0.69)
Stroke-specific Patient-Reported Outcome Measures (Stroke Impact Scale) Scale range: 0-100. Change scores. Using the full available set of data.	NA (NA)	NA (NA)	NA (NA)	NA (NA)

Outcome	Robot-assisted arm training, Baseline, N = 81	Robot-assisted arm training, 10 week, N = 81	Any other intervention, Baseline, N = 36	Any other intervention, 10 week, N = 36
Mean (SD)				
SIS Strength Values for robot training groups combined. Robot training and usual care = 6.29 (1.89). Robot training and constraint training = 9.60 (1.99). Mean (SD)	NA (NA)	7.88 (2.55)	NA (NA)	4.43 (2.06)
SIS Memory Values for robot training groups combined. Robot training and usual care = 0.23 (1.52). Robot training and constraint training = 3.06 (1.59). Mean (SD)	NA (NA)	1.59 (2.1)	NA (NA)	1.4 (1.67)
SIS Emotion Values for robot training groups combined. Robot training and usual care = -0.71 (1.65). Robot training and constraint training = -0.20 (1.74). Mean (SD)	NA (NA)	-0.46 (1.71)	NA (NA)	0.78 (1.81)
SIS Communication Values for robot training groups combined. Robot training and usual care = 0.71 (1.45). Robot training and constraint training = 0.62 (1.53). Mean (SD)	NA (NA)	0.67 (1.49)	NA (NA)	0.99 (1.6)
SIS Activities of Daily Living Values for robot training groups combined. Robot training and	NA (NA)	3.52 (1.76)	NA (NA)	0.52 (1.76)

Outcome	Robot-assisted arm training, Baseline, N = 81	Robot-assisted arm training, 10 week, N = 81	Any other intervention, Baseline, N = 36	Any other intervention, 10 week, N = 36
usual care = 2.94 (1.61). Robot training and constraint training = 4.14 (1.69). Mean (SD)				
SIS Mobility Values for robot training groups combined. Robot training and usual care = 2.93 (1.70). Robot training and constraint training = 2.54 (1.79). Mean (SD)	NA (NA)	2.74 (1.76)	NA (NA)	0.5 (1.86)
SIS Hand Function Values for robot training groups combined. Robot training and usual care = 10.33 (2.43). Robot training and constraint training = 8.26 (2.55). Mean (SD)	NA (NA)	9.33 (2.7)	NA (NA)	3.06 (2.65)
SIS Social Participation Values for robot training groups combined. Robot training and usual care = 8.77 (2.98). Robot training and constraint training = 8.10 (3.13). Mean (SD)	NA (NA)	8.45 (3.07)	NA (NA)	1.37 (3.23)
SIS Stroke Recovery Values for robot training groups combined. Robot training and usual care = 8.33 (2.14). Robot training and constraint training = 8.77 (2.24). Mean (SD)	NA (NA)	8.54 (2.2)	NA (NA)	7.43 (2.35)

Outcome	Robot-assisted arm training, Baseline, N = 81	Robot-assisted arm training, 10 week, N = 81	Any other intervention, Baseline, N = 36	Any other intervention, 10 week, N = 36
SIS Physical Domain Values for robot training groups combined. Robot training and usual care = 5.50 (1.25). Robot training and constraint training = 6.13 (1.31). Mean (SD)	NA (NA)	5.8 (1.32)	NA (NA)	2.28 (1.36)

Arm function (Fugl-Meyer assessment - upper extremity) - Polarity - Higher values are better
Arm muscle strength (Motricity Index) - Polarity - Higher values are better
Spasticity (modified Ashworth scale) - Polarity - Lower values are better
Stroke-specific Patient-Reported Outcome Measures (Stroke Impact Scale) - Polarity - Higher values are better

Dichotomous outcomes

Outcome	Robot-assisted arm training, Baseline, N = 87	Robot-assisted arm training, 10 week, N = 87	Any other intervention, Baseline, N = 42	Any other intervention, 10 week, N = 42
Withdrawal for any reason Robot therapy: 4 did not receive the intervention over 80%, 1 endpoint exceeded 1 week post intervention, 2 discontinued without efficacy data, 1 later turned out to be the same patient. Control: 1 later turned out to be the same patient. 2 withdrew consent. 1 did not receive the intervention, 1 discontinued without efficacy data, 1 did not receive the intervention over 80%. No of events	n = NA ; % = NA	n = 8 ; % = 9	n = NA ; % = NA	n = 6 ; % = 14
Adverse events - injuries and pain (back pain, pain in extremity, medical device site pain, fall, skin abrasion)	n = NA ; % = NA	n = 8 ; % = 9	n = NA ; % = NA	n = 0 ; % = 0

Outcome	Robot-assisted arm training, Baseline, N = 87	Robot-assisted arm training, 10 week, N = 87	Any other intervention, Baseline, N = 42	Any other intervention, 10 week, N = 42
Intervention: 4 back pain, 1 pain in extremity, 1 medical device site pain, 1 fall, 1 skin abrasion. Control: No events. No of events				

Withdrawal for any reason - Polarity - Lower values are better
Adverse events - injuries and pain (back pain, pain in extremity, medical device site pain, fall, skin abrasion) - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(Fugl-Meyerassessment-upperextremity)-MeanSD-Robot-assisted arm training-Any other intervention-t10

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armmusclestrength(MotricityIndex)-MeanSD-Robot-assisted arm training-Any other intervention-t10

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(modifiedAshworthscale)-MeanSD-Robot-assisted arm training-Any other intervention-t10

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Stroke-specificPatient-ReportedOutcomeMeasures(StrokeImpactScale)-SISStrength-MeanSD-Robot-assisted arm training-Any other intervention-t10

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Stroke-specificPatient-ReportedOutcomeMeasures(StrokeImpactScale)-SISMemory-MeanSD-Robot-assisted arm training-Any other intervention-t10

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Stroke-specificPatient-ReportedOutcomeMeasures(StrokeImpactScale)-SISEmotion-MeanSD-Robot-assisted arm training-Any other intervention-t10

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Stroke-specificPatient-ReportedOutcomeMeasures(StrokeImpactScale)-SISCommunication-MeanSD-Robot-assisted arm training-Any other intervention-t10

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Stroke-specificPatient-ReportedOutcomeMeasures(StrokeImpactScale)-SISActivitiesofDailyLiving-MeanSD-Robot-assisted arm training-Any other intervention-t10

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Stroke-specificPatient-ReportedOutcomeMeasures(StrokeImpactScale)-SISMobility-MeanSD-Robot-assisted arm training-Any other intervention-t10

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Stroke-specificPatient-ReportedOutcomeMeasures(StrokeImpactScale)-SISHandFunction-MeanSD-Robot-assisted arm training-Any other intervention-t10

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Stroke-specificPatient-ReportedOutcomeMeasures(StrokeImpactScale)-SISSocialParticipation-MeanSD-Robot-assisted arm training-Any other intervention-t10

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Stroke-specificPatient-ReportedOutcomeMeasures(StrokeImpactScale)-SISStrokeRecovery-MeanSD-Robot-assisted arm training-Any other intervention-t10

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Stroke-specificPatient-ReportedOutcomeMeasures(StrokeImpactScale)-SISPhysicalDomain-MeanSD-Robot-assisted arm training-Any other intervention-t10

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot-assisted arm training-Any other intervention-t10

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Adverseevents-injuriesandpain(backpain,paininextremity,medicaldevicesitepain,fall,skinabrasion)-NoOfEvents-Robot-assisted arm training-Any other intervention-t10

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Taravati, 2021

Bibliographic Reference	Taravati, S.; Capaci, K.; Uzumcugil, H.; Tanigor, G.; Evaluation of an upper limb robotic rehabilitation program on motor functions, quality of life, cognition, and emotional status in patients with stroke: a randomized controlled study; Neurological Sciences; 2021; vol. 11; 11

Study details

Secondary publication of another included study- see primary study for details	NR
Other publications associated with this study included in review	NR
Trial name / registration number	NCT 04393480
Study location	Turkey

Study setting	rehabilitation hospital
Study dates	April 2016 - April 2019
Sources of funding	NR
Inclusion criteria	Single stroke. being an adult, duration of 4 to 30 months after stroke, a score of 16 or higher in mini mental state test, upper extremity Brunsstrom stage 2 or more, a fluent speaker in Turkish.
Exclusion criteria	Severe Apraxia, skin ulcers, multiple strokes, severe decompensated comorbidities, cardiac pacemakers, severe neuropsychological impairments, neglect syndrome, spasticity in the upper extremities greater than 3 on the MAS, severe joint contracted, a history of botulinum toxin injection in their upper extremity, and history of dose changes in drugs for spasticity in the last 3 months were excluded.
Recruitment / selection of participants	patients who were admitted to the Physical medicine and rehabilitation department of the institution between April 2016-April 2019 were included in the study if they fulfilled the inclusion criteria.
Intervention(s)	ReoGo-Motorika upper extremity rehabilitation system is a robotics-cased mobile rehabilitation system with a computerised touch screen. It is used to treat both active, passive and advanced functional patients with motor limitations. Continuous passive movement, active-assisted movement and active resistant movement are the most common movement types of the device. Robotic therapy is carried out under the supervision of a physiotherapist who controls the device. The patients in the study groups were instructed to use their arm and hand movements to reach virtual targets in the screen in front of them. The system helped then to levitate their affected arm against gravity. The study group had hand-arm robotic assisted therapy for 30-45 min, 5 days a week for 4 weeks. Concomitant therapy - conventional therapy was carried out by the same team of physiotherapists who were blinded to both groups. The control group received only conventional therapy for 5 days a week and 4 weeks, while the study groups received the same amount of conventional therapy in addition to rehabilitation with the robotic rehabilitation.
Subgroup 1: Severity	Not stated/unclear

Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Mixed
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Active assisted movement
Population subgroups	NR
Comparator	The control group received only conventional therapy carried out by a physiotherapist and consisted of ROM exercises, muscle strengthening, balance ad mobility training, exercises for improving activities of daily living, neurophysiological exercises, bed movements, sitting and transfer training, gait training, proprioceptive exercises, balance exercises, occupational therapy (60 mins daily), and cognitive rehabilitation b y an experienced psychologist given to those with cognitive impairment (45 min/twice week). Conventional physiotherapy was provided for 5 days a week and for 4 weeks.
Number of participants	45

Duration of follow-up	4 weeks end of intervention
Indirectness	NR
Additional comments	NR

Study arms

Robot therapy (N = 22)

conventional therapy (N = 23)

Characteristics

Study-level characteristics

Characteristic	**Study (N = 45)**
Ethnicity Nominal	NR
Comorbidities Nominal	NR
Severity Nominal	NR

Arm-level characteristics

Characteristic	Robot therapy (N = 22)	conventional therapy (N = 23)
% Female Nominal	17.65	30
Mean age (SD) Mean (SD)	50.94 (17.2)	55.75 (11.61)
Time after stroke Mean (SD)	10.94 (8.02)	12.65 (8.42)

Outcomes

Study timepoints

- Baseline
- 4 week

Continuous outcomes

Outcome	Robot therapy, Baseline, N = 22	Robot therapy, 4 week, N = 17	conventional therapy, Baseline, N = 23	conventional therapy, 4 week, N = 20
Activties of daily living (functional independence measure) 18-126, final value Mean (SD)	86.06 (26.2)	96.47 (23.55)	83.6 (23.7)	93.15 (21.99)

Outcome	Robot therapy, Baseline, N = 22	Robot therapy, 4 week, N = 17	conventional therapy, Baseline, N = 23	conventional therapy, 4 week, N = 20
Arm function (Fugl Meyer UE) 0-66, final value Mean (SD)	19 (10.46)	24.24 (10.02)	21.05 (10.85)	23.35 (10.01)
Arm strength (hand grip strength unclear measurement ?(N)) (Newtons) Mean (SD)	9.59 (9.49)	12.82 (12.41)	7.95 (9.25)	11 (12.98)
Stroke specific quality of life scale (SS-QOL) 49-245, final value Mean (SD)	118.65 (28.53)	138.59 (34.3)	133.75 (27.72)	140.8 (30.72)
Spastcity outcome - Modified ashworth scale total Mean (SD)	0.78 (0.84)	0.52 (0.7)	0.81 (0.83)	0.68 (0.78)

Activties of daily living (functional independence measure) - Polarity - Higher values are better
Arm function (Fugl Meyer UE) - Polarity - Higher values are better
Arm strength (hand grip strength unclear measurement ?(N)) - Polarity - Higher values are better
Stroke specific quality of life scale (SS-QOL) - Polarity - Higher values are better
Spastcity outcome - Modified ashworth scale total - Polarity - Lower values are better

Dichotomous outcomes

Outcome	Robot therapy, Baseline, N = 22	Robot therapy, 4 week, N = 22	conventional therapy, Baseline, N = 23	conventional therapy, 4 week, N = 23
Withdrawal for any reason intervention reasons = 1 pneumonia, 2 general health disorder, 1 tumor reoccurrence, 1 withdrawn. Control reasons = 1 general health disorder, 2 withdrawn No of events	n = 0 ; % = 0	n = 5 ; % = 22.7	n = 0 ; % = 0	n = 3 ; % = 13

Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Activtiesofdailyliving(functionalindependencemeasure)-MeanSD-Robot therapy-conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to effect of assignment to intervention, measurement of outcome, and missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot therapy-conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to effect of assignment to intervention and missing data)*

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armstrength(handgripstrengthunclearmeasurement?(N))-MeanSD-Robot therapy-conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to effect of assignment to intervention and missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(FuglMeyerUE)-MeanSD-Robot therapy-conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to effect of assignment to intervention and missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Strokespecificqualityoflifescale(SS-QOL)-MeanSD-Robot therapy-conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to effect of assignment to intervention and missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spastcityoutcome-Modifiedashworthscaletotal-MeanSD-Robot therapy-conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to effect of assignment to intervention and missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

Taveggia, 2016

Bibliographic Reference	Taveggia, Giovanni; Borboni, Alberto; Salvi, Lorena; Mulé, Chiara; Fogliaresi, Stefania; Villafañe, Jorge H.; Casale, Roberto; Efficacy of robot-assisted rehabilitation for the functional recovery of the upper limb in post-stroke patients: a randomized controlled study; European journal of physical and rehabilitation medicine; 2016; vol. 52 (no. 6); 767-773

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear

Subgroup 2: Time after stroke at the start of the trial	Mixed 0.5-12 months post-stroke.
Subgroup 3: Region of upper limb trained	Not stated/unclear
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Not stated/unclear
Subgroup 8: Type of movement delivered by robotic device	Passive movement

Study arms

Robot therapy (N = 27)
Robot therapy with the Armeo Spring for 30 minutes per session, 5 times per week for 6 weeks.

Physical rehabilitation therapy (N = 27)
According to the Bobath concept for 30 minutes per session, 5 times a week for 6 weeks.

Outcomes

Study timepoints

- Baseline
- 6 week (Immediately post-intervention)
- 12 week (6 weeks post-intervention.)

Dichotomous outcomes

Outcome	Robot therapy, Baseline, N = 27	Robot therapy, 6 week, N = 27	Robot therapy, 12 week, N = 27	Physical rehabilitation therapy, Baseline, N = 27	Physical rehabilitation therapy, 6 week, N = 27	Physical rehabilitation therapy, 12 week, N = 27
Withdrawal for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = 13 ; % = 52	n = NA ; % = NA	n = 0 ; % = 0	n = 14 ; % = 48
Adverse events Narrative statement No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NR ; % = NR	n = NA ; % = NA	n = 0 ; % = 0	n = NR ; % = NR

Continuous outcomes

Outcome	Robot therapy, Baseline, N = 27	Robot therapy, 6 week, N = 27	Robot therapy, 12 week, N = 27	Physical rehabilitation therapy, Baseline, N = 27	Physical rehabilitation therapy, 6 week, N = 27	Physical rehabilitation therapy, 12 week, N = 27
Activities of daily living (functional	94.7 (22.1)	13.4 (20.9)	21.4 (17.9)	92.9 (20.7)	4.4 (21.2)	6.3 (20.4)

Outcome	Robot therapy, Baseline, N = 27	Robot therapy, 6 week, N = 27	Robot therapy, 12 week, N = 27	Physical rehabilitation therapy, Baseline, N = 27	Physical rehabilitation therapy, 6 week, N = 27	Physical rehabilitation therapy, 12 week, N = 27
independence measure) Scale range 0-126. Mean (SD)						
Arm muscle strength (Motricity Index) Change scores. Scale range 0-100 Mean (SD)	37 (19.3)	17.7 (20.8)	43.5 (21.7)	39.2 (15.6)	11.4 (16)	5.6 (16.1)
Spasticity (Ashworth MAS) Change scores. Scale range 0-5 Mean (SD)	5.6 (1.3)	-1.6 (1.5)	-1.6 (1.5)	5.4 (1.5)	-1 (1.6)	-1.4 (1.6)

Activities of daily living (functional independence measure) - Polarity - Higher values are better
Arm muscle strength (Motricity Index) - Polarity - Higher values are better
Spasticity (Ashworth MAS) - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot therapy-Physical rehabilitation therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Adverseevents-NoOfEvents-Robot therapy-Physical rehabilitation therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Activitiesofdailyliving(functionalindependencemeasure)-MeanSD-Robot therapy-Physical rehabilitation therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armmusclestrength(MotricityIndex)-MeanSD-Robot therapy-Physical rehabilitation therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(AshworthMAS)-MeanSD-Robot therapy-Physical rehabilitation therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(AshworthMAS)-MeanSD-Robot therapy-Physical rehabilitation therapy-t12

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Continuousoutcomes-Armmusclestrength(MotricityIndex)-MeanSD-Robot therapy-Physical rehabilitation therapy-t12

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Continuousoutcomes-Activitiesofdailyliving(functionalindependencemeasure)-MeanSD-Robot therapy-Physical rehabilitation therapy-t12

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot therapy-Physical rehabilitation therapy-t12

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Partially applicable *(Follow up <6 months)*

Timmermans, 2014

Bibliographic Reference	Timmermans, Annick A. A.; Lemmens, Ryanne J. M.; Monfrance, Maurice; Geers, Richard P. J.; Bakx, Wilbert; Smeets, Rob J. E. M.; Seelen, Henk A. M.; Effects of task-oriented robot training on arm function, activity, and quality of life in chronic stroke patients: a randomized controlled trial; Journal of neuroengineering and rehabilitation; 2014; vol. 11 (no. 1); 1-12

Study details

Secondary publication of another included	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.

study- see primary study for details	
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review. Lemmens RJM, Timmermans AAA, Janssen-Potten YJM, Pulles SANT, Geers RPJ, Bakx WGM, et al. Accelerometry measuring the outcome of robot-supported upper limb training in chronic stroke: a randomized controlled trial. *PLOS One* 2014;9(5):e96414.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Not stated/unclear

Subgroup 8: Type of movement delivered by robotic device	Mixed

Study arms

Robot-assisted training (N = 11)
With end-effector robot HapticMaster 4 times/ week, twice a day for 30 minutes (separated by 0.5 hour to 1 hour of rest).

Arm-hand training programme (N = 11)
4 times/ week, twice a day for 30 minutes (separated by 0.5 hour to 1 hour of rest).

Outcomes

Study timepoints
- Baseline
- 8 week (Post-intervention)
- 6 month (Post-intervention (6 months after the end of the intervention))

Dichotomous outcome

Outcome	Robot-assisted training, Baseline, N = 11	Robot-assisted training, 8 week, N = 11	Robot-assisted training, 6 month, N = 11	Arm-hand training programme, Baseline, N = 11	Arm-hand training programme, 8 week, N = 11	Arm-hand training programme, 6 month, N = 11
Withdrawal for any reason No of events	n = NA ; % = NA	n = 0 ; % = 0	n = 0 ; % = 0	n = NA ; % = NA	n = 0 ; % = 0	n = 0 ; % = 0
Adverse events One patient in the experimental group fainted briefly once. No relationship with the intervention was found. No adverse effects of the study were found. No of events	n = NA ; % = NA	n = 0 ; % = 0	n = NR ; % = NR	n = NA ; % = NA	n = 0 ; % = 0	n = NR ; % = NR

Continuous outcomes

Outcome	Robot-assisted training, Baseline, N = 11	Robot-assisted training, 8 week, N = 11	Robot-assisted training, 6 month, N = 11	Arm-hand training programme, Baseline, N = 11	Arm-hand training programme, 8 week, N = 11	Arm-hand training programme, 6 month, N = 11
Person/ participant generic health-related quality if life (EQ-5D) VAS scale, range 0-100, change scores. Values as reported in Cochrane review.	65 (63 to 85)	80 (70 to 80)	74 (70 to 80)	70 (64 to 75)	78 (68 to 90)	75 (60 to 80)

Outcome	Robot-assisted training, Baseline, N = 11	Robot-assisted training, 8 week, N = 11	Robot-assisted training, 6 month, N = 11	Arm-hand training programme, Baseline, N = 11	Arm-hand training programme, 8 week, N = 11	Arm-hand training programme, 6 month, N = 11
Median (IQR)						
Arm function (FMMA) Change scores, scale 0-66. Values as reported in Cochrane review. Mean (SD)	NR (NR)	1.6 (10.8)	NR (NR)	NR (NR)	3.5 (32.7)	NR (NR)
Arm function (FMMA) Final values, scale 0-66. Median (IQR)	50 (39 to 58)	55 (46 to 56)	52 (43 to 59)	53 (47 to 57)	54 (51 to 59)	53 (50.7 to 59.5)

Person/ participant generic health-related quality if life (EQ-5D) - Polarity - Higher values are better
Arm function (FMMA) - Polarity - Higher values are better
Arm function (FMMA) - Polarity - Higher values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Dichotomousoutcome-Withdrawalforanyreason-NoOfEvents-Robot-assisted training-Arm-hand training programme-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Person/participantgenerichealth-relatedqualityiflife(EQ-5D)-MedianIQR-Robot-assisted training-Arm-hand training programme-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Person/participantgenerichealth-relatedqualityiflife(EQ-5D)-MedianIQR-Robot-assisted training-Arm-hand training programme-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(FMMA)-MeanSD-Robot-assisted training-Arm-hand training programme-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(FMMA)-MeanSD-Robot-assisted training-Arm-hand training programme-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(FMMA)-MedianIQR-Robot-assisted training-Arm-hand training programme-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(FMMA)-MedianIQR-Robot-assisted training-Arm-hand training programme-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Tomić, 2017

Bibliographic Reference	Tomić, Tijana J. Dimkić; Savić, Andrej M.; Vidaković, Aleksandra S.; Rodić, Sindi Z.; Isaković, Milica S.; Rodríguez-de-Pablo, Cristina; Keller, Thierry; Konstantinović, Ljubica M.; ArmAssist robotic system versus matched conventional therapy for poststroke upper limb rehabilitation: a randomized clinical trial; BioMed research international; 2017; vol. 2017

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Not stated/unclear
Subgroup 8: Type of movement delivered by robotic device	Active assisted movement

Study arms

Robot therapy (N = 13)
Additional robot therapy with the ArmAssist (AA) for 30 minutes administered over 15 sessions each lasting 30 minutes, scheduled 5 days per week (Monday to Friday) for 3 weeks

Additional occupational therapy (N = 13)
Additional occupational therapy for 30 minutes that was matched in its structure and amount to the AA training as close as possible and administered over 15 sessions each lasting 30 minutes, scheduled 5 days per week (Monday to Friday) for 3 weeks

Outcomes

Study timepoints
- Baseline
- 3 week (at the end of intervention)

Continuous and dichotomous outcomes

Outcome	Robot therapy, Baseline, N = 13	Robot therapy, 3 week, N = 13	Additional occupational therapy, Baseline, N = 13	Additional occupational therapy, 3 week, N = 13
Activites of daily living (Barthel Index) 0-100, change score Mean (SD)	65 (26.1)	21.2 (24.8)	65.4 (19.8)	13.1 (10.7)

Outcome	Robot therapy, Baseline, N = 13	Robot therapy, 3 week, N = 13	Additional occupational therapy, Baseline, N = 13	Additional occupational therapy, 3 week, N = 13
Arm function (Fugl meyer assessment- UE) 0-66, change score Mean (SD)	26.5 (7.7)	18 (9.4)	26.6 (7.5)	7.5 (5.5)
Withdrawal for any reason No of events	n = 0 ; % = 0	n = 0 ; % = 0	n = 0 ; % = 0	n = 0 ; % = 0

Activites of daily living (Barthel Index) - Polarity - Higher values are better
Arm function (Fugl meyer assessment- UE) - Polarity - Higher values are better
Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

continuousoutcomes-acitivitesofdailyliving-barthelindex-MeanSD-Robot therapy-Additional occupational therapy-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

continuousoutcomes-Armfunction(FuglmeyerassessmentUE)-MeanSD-Robot therapy-Additional occupational therapy-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

continuousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot therapy-Additional occupational therapy-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Valles, 2016

Bibliographic Reference	Valles, Karla Bustamante; Montes, Sandra; de Jesus Madrigal, Maria; Burciaga, Adan; Martínez, María Elena; Johnson, Michelle J.; Technology-assisted stroke rehabilitation in Mexico: a pilot randomized trial comparing traditional therapy to circuit training in a Robot/technology-assisted therapy gym; Journal of neuroengineering and rehabilitation; 2016; vol. 13 (no. 1); 1-15

Study details

Secondary publication of another included study- see primary study for details	No additional information.

Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear Mean 23 points FMA upper extremity.
Subgroup 2: Time after stroke at the start of the trial	Not stated/unclear Not described, but inclusion criteria says a minimum of 6 months post stroke.
Subgroup 3: Region of upper limb trained	Mixed
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	Not stated/unclear
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Mixed

Study arms

Robot therapy (N = 13)
24 2 hour therapy sessions over a 6-8 week period.

Standard rehabilitation therapy (N = 14)
24 2 hour therapy sessions over a 6-8 week period.

Outcomes

Study timepoints
- Baseline
- 8 week (Post-intervention)

Continuous outcomes

Outcome	Robot therapy, Baseline, N = 10	Robot therapy, 8 week, N = 10	Standard rehabilitation therapy, Baseline, N = 10	Standard rehabilitation therapy, 8 week, N = 10
Arm function (Fugi-Meyer assessment) Scale range: 0-66. Change scores. Values reported in the Cochrane review used. Mean (SD)	23 (12.59)	4.6 (3.89)	22 (19.17)	5.1 (4.72)

Arm function (Fugi-Meyer assessment) - Polarity - Higher values are better
Also reports Rancho los Amigos functional test and Box and block test.

Dichotomous outcome

Outcome	Robot therapy, Baseline, N = 13	Robot therapy, 8 week, N = 13	Standard rehabilitation therapy, Baseline, N = 14	Standard rehabilitation therapy, 8 week, N = 14
Withdrawal for any reason Robot group: 3 (2 did not receive allocated intervention due to illness unrelated to the study, 1 discontinued intervention due to pathological depression). Traditional therapy group: 4 (1 did not receive the allocated intervention due to a lack of interest in the assigned therapy, 1 was lost to follow-up due to personal reasons, 2 discontined intervention due to illness and personal reasons). No of events	n = NA ; % = NA	n = 3 ; % = 23	n = NA ; % = NA	n = 4 ; % = 30

Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Dichotomousoutcome-Withdrawalduetoadverseevents-NoOfEvents-Robot therapy-Standard rehabilitation therapy-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Function(FM),changescore-MeanSD-Robot therapy-Standard rehabilitation therapy-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Vanoglio, 2017

Bibliographic Reference	Vanoglio, Fabio; Bernocchi, Palmira; Mulè, Chiara; Garofali, Francesca; Mora, Chiara; Taveggia, Giovanni; Scalvini, Simonetta; Luisa, Alberto; Feasibility and efficacy of a robotic device for hand rehabilitation in hemiplegic stroke patients: a randomized pilot controlled study; Clinical rehabilitation; 2017; vol. 31 (no. 3); 351-360

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)

Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Passive movement

Study arms

Robot therapy (N = 15)
Robot therapy with the Gloreha Professional (Idrogenet, Lumezzane, Italy) consisted of a total of 30 sessions, lasting 40 minutes per day, for 5 days per week

passive arm therapy (N = 15)
passive arm therapy for 30 sessions, lasting 40 minutes per day, for 5 days per week

Outcomes

Study timepoints

- Baseline
- 30 day (end of intervention)

Continuous outcomes

Outcome	Robot therapy, Baseline, N = 15	Robot therapy, 30 day, N = 14	passive arm therapy, Baseline, N = 15	passive arm therapy, 30 day, N = 13
Arm function (Quick DASH) 19-95, change score Mean (SD)	59.7 (24.2)	15.7 (18.99)	65.6 (11.5)	0.43 (7.45)
Arm strength (Motricity Index) 0-100, change score Mean (SD)	37.4 (26.5)	23 (17.94)	28.1 (29.8)	5.2 (10.21)
Withdrawal for any reason No of events	n = 0 ; % = 0	n = 1 ; % = 6.6	n = 0 ; % = 0	n = 2 ; % = 13.3

Arm function (Quick DASH) - Polarity - Lower values are better
Arm strength (Motricity Index) - Polarity - Higher values are better
Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot therapy-passive arm therapy-t30

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armstrength(MotricityIndex)-MeanSD-Robot therapy-passive arm therapy-t30

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(QuickDASH)-MeanSD-Robot therapy-passive arm therapy-t30

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Villafañe, 2018

Bibliographic Reference	Villafañe, Jorge H.; Taveggia, Giovanni; Galeri, Silvia; Bissolotti, Luciano; Mullè, Chiara; Imperio, Grace; Valdes, Kristin; Borboni, Alberto; Negrini, Stefano; Efficacy of short-term robot-assisted rehabilitation in patients with hand paralysis after stroke: a randomized clinical trial; Hand; 2018; vol. 13 (no. 1); 95-102

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Subgroup 1: Severity	Moderate (or NIHSS 5-14)
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Distal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement	Passive movement

delivered by robotic device	

Study arms

Robot therapy (N = 16)
Robot therapy with the hand Gloreha for 30 minutes for 3 days per week

Usual care (N = 16)
Physical and occupational arm therapy for 30 minutes 3 days per week

Outcomes

Study timepoints
- Baseline
- 3 week

Continuous outcomes

Outcome	Robot therapy, Baseline, N = 16	Robot therapy, 3 week, N = 16	Usual care, Baseline, N = 16	Usual care, 3 week, N = 16
Activties of daily living (Barthel Index) 0-100, change scores Mean (SD)	36.6 (21)	22.8 (2.4)	35.3 (23.6)	21.6 (2.4)

Outcome	Robot therapy, Baseline, N = 16	Robot therapy, 3 week, N = 16	Usual care, Baseline, N = 16	Usual care, 3 week, N = 16
Arm function (quickDASH) 0-100, change score Mean (SD)	68 (11)	9.9 (1.9)	61.2 (15.3)	9.1 (1.9)
Arm muscle strength (Motricity Index) 0-100, change scores Mean (SD)	30.6 (21.2)	24.4 (2.6)	36.3 (37.4)	14.9 (2.6)

Activties of daily living (Barthel Index) - Polarity - Higher values are better
Arm function (quickDASH) - Polarity - Higher values are better
Arm muscle strength (Motricity Index) - Polarity - Higher values are better

Dichotomous ouctomes

Outcome	Robot therapy, Baseline, N = 16	Robot therapy, 3 week, N = 16	Usual care, Baseline, N = 16	Usual care, 3 week, N = 16
Withdrawal for any reason No of events	n = 0 ; % = 0	n = 0 ; % = 0	n = 0 ; % = 0	n = 0 ; % = 0

Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Dichotomousouctomes-Withdrawalforanyreason-NoOfEvents-Robot therapy-Usual care-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuosoutcomes-Armmusclestrength(MotricityIndex)-MeanSD-Robot therapy-Usual care-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuosoutcomes-Activtiesofdailyliving(BarthelIndex)-MeanSD-Robot therapy-Usual care-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuosoutcomes-Armfunction(quickDASH)-MeanSD-Robot therapy-Usual care-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High

Section	Question	Answer
Overall bias and Directness	Overall Directness	Directly applicable

Volpe, 2000

Bibliographic Reference	Volpe, B. T.; Krebs, H. I.; Hogan, N.; Edelstein, L.; Diels, C.; Aisen, M.; A novel approach to stroke rehabilitation: robot-aided sensorimotor stimulation; Neurology; 2000; vol. 54 (no. 10); 1938-1944

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review. Fasoli SE, Krebs HI, Ferraro M, Hogan N, Volpe BT. Does shorter rehabilitation limit potential recovery poststroke?. *Neurorehabilitation and Neural Repair* 2004;18:88-94.
Subgroup 1: Severity	Not stated/unclear

Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Mixed
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Active assisted movement

Study arms

Robot assisted arm training (N = 30)
The treatment group used the MIT-Manus device for arm training for 1 hour per day, 5 days a week (for at least 25 sessions)

Placebo (N = 26)
The control group had similar initial exposure to the robot with the exception that half the tasks were performed with the unimpaired arm, and when the participant could not perform the task with the affected limb, the unimpaired limb was used to complete the task or the technician assisted the movement. The robot never actively moved the limbs of participants in the control group. Participants were exposed to the robot 1 hour per week

Outcomes

Study timepoints

- Baseline
- 5 week (post treatment)

Continuous outcomes

Outcome	Robot assisted arm training, Baseline, N = 30	Robot assisted arm training, 5 week, N = 30	Placebo, Baseline, N = 26	Placebo, 5 week, N = 26
Actvities of daily living (FIM - motor and cognition score) change score Mean (SD)	30.5 (4)	9.1 (3.3)	21.5 (5)	4.4 (2)
Arm function (FMA) 0-24, change score Mean (SD)	0 (0)	6 (3.5)	0 (0)	4 (1.7)
Arm strength (motor power score) change score, scale range unclear based on Cochrane information Mean (SD)	NR (NR)	4.1 (1.4)	NR (NR)	1.7 (1.7)

Actvities of daily living (FIM - motor and cognition score) - Polarity - Higher values are better
Arm function (FMA) - Polarity - Higher values are better
Arm strength (motor power score) - Polarity - Higher values are better

Dichotomous outcomes

Outcome	Robot assisted arm training, Baseline, N = 30	Robot assisted arm training, 5 week, N = 30	Placebo, Baseline, N = 26	Placebo, 5 week, N = 26
Withdrawal for any reason No of events	n = 0 ; % = 0	n = 0 ; % = 0	n = 0 ; % = 0	n = 0 ; % = 0

Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Actvitiesofdailyliving(Motricityindex-motor)-MeanSD-Robot assisted arm training-Placebo-t0

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to randomisation and missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(FMwristhand)-MeanSD-Robot assisted arm training-Placebo-t0

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to randomisation and missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armstrength(motorpowerscore)-MeanSD-Robot assisted arm training-Placebo-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to randomisation and missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Robot assisted arm training-Placebo-t5

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(due to randomisation and missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

Volpe, 2008

Bibliographic Reference	Volpe, Bruce T.; Lynch, Daniel; Rykman-Berland, Avrielle; Ferraro, Mark; Galgano, Michael; Hogan, Neville; Krebs, Hermano I.; Intensive sensorimotor arm training mediated by therapist or robot improves hemiparesis in patients with chronic stroke; Neurorehabilitation and neural repair; 2008; vol. 22 (no. 3); 305-310

Study details

Secondary publication of another included study- see primary study for details	No additional information.

Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Severe (or NIHSS 15-24) NIHSS 17 (SEM = 1)
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months) Mean 35-40 months
Subgroup 3: Region of upper limb trained	Mixed
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Passive movement
Indirectness	Time period in trial 'at discharge'. The period is poorly defined and is not necessarily the end of intervention. Therefore, outcomes will be downgraded for indirectness.

Study arms

Robot assisted arm training (N = 11)
Robotic training with the InMotion2 robot (the commercial version of MIT-Manus). All participants had an identical number of treatment sessions, and the sessions were of the same duration (1 hour per session, 3 times a week for 6 weeks).

Conventional therapy (N = 10)
Intensive movement protocol with a trained physiotherapist. All participants had an identical number of treatment sessions, and the sessions were of the same duration (1 hour per session, 3 times a week for 6 weeks).

Outcomes

Study timepoints
- Baseline
- 6 week (Time period in trial 'at discharge'. The period is poorly defined and is not necessarily the end of intervention. Therefore, outcomes will be downgraded for indirectness.)

Continuous outcomes

Outcome	Robot assisted arm training, Baseline, N = 11	Robot assisted arm training, 6 week, N = 11	Conventional therapy, Baseline, N = 10	Conventional therapy, 6 week, N = 10
Arm function (Fugl Meyer Assessment) Scale range: 0-66. Final values. Mean (SE)	NR (NR)	NR (NR)	NR (NR)	NR (NR)
Fugl Meyer Shoulder/elbow Scale range: 0-42. Final values.	12.79 (1.6)	15.73 (2)	11.43 (1)	15.1 (1.7)

Outcome	Robot assisted arm training, Baseline, N = 11	Robot assisted arm training, 6 week, N = 11	Conventional therapy, Baseline, N = 10	Conventional therapy, 6 week, N = 10
Mean (SE)				
Fugl Meyer Wrist/hand Scale range: 0-24. Final values. Mean (SE)	2.45 (1.3)	3.73 (2)	1.6 (0.8)	2.6 (0.9)
Spasticity (Ashworth scale) Scale range: Unclear. Final values. Mean (SE)	8.18 (1.4)	6.27 (1)	7.4 (1.5)	6 (1.3)
Stroke-specific Patient Reported Outcome Measures (Stroke Impact Scale) Scale range: 0-100. Final values. Mean (SE)	63.9 (3.1)	67.1 (2.4)	64.7 (2.3)	65.5 (2.4)

Arm function (Fugl Meyer Assessment) - Polarity - Higher values are better
Spasticity (Ashworth scale) - Polarity - Lower values are better
Stroke-specific Patient Reported Outcome Measures (Stroke Impact Scale) - Polarity - Higher values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(FuglMeyerAssessment)-FuglMeyerShoulder/elbow-MeanSE-Robot assisted arm training-Conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(FuglMeyerAssessment)-FuglMeyerWrist/hand-MeanSE-Robot assisted arm training-Conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Spasticity(Ashworthscale)-MeanSE-Robot assisted arm training-Conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Stroke-specificPatientReportedOutcomeMeasures(StrokeImpactScale)-MeanSE-Robot assisted arm training-Conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Wolf, 2015

Bibliographic Reference	Wolf, Steven L.; Sahu, Komal; Bay, R. Curtis; Buchanan, Sharon; Reiss, Aimee; Linder, Susan; Rosenfeldt, Anson; Alberts, Jay; The HAAPI (Home Arm Assistance Progression Initiative) trial: a novel robotics delivery approach in stroke rehabilitation; Neurorehabilitation and neural repair; 2015; vol. 29 (no. 10); 958-968

Study details

Secondary publication of another included study- see primary study for details	NR
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.

	Linder SM, Rosenfeldt AB, Reiss A, Buchanan S, Sahu K, Bay CR, et al. The home stroke rehabilitation and monitoring system trial: a randomized controlled trial. *International Journal of Stroke* 2013;8(1):46-53.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Mixed
Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Active assisted movement

Study arms

Robot assisted arm therapy (N = 51)
Robot therapy with the Hand Mentor Pro (Kinetic Muscles Incs) for 60 minutes over a 8 (to 12) weeks period

Conventional therapy (N = 48)
Home exercises for the arm therapy for 60 minutes over a 8 (to 12) weeks period

Outcomes

Study timepoints
- Baseline
- 8 week (8-12 weeks. End of intervention.)

Continuous outcomes

Outcome	Robot assisted arm therapy, Baseline, N = 51	Robot assisted arm therapy, 8 week, N = 47	Conventional therapy, Baseline, N = 48	Conventional therapy, 8 week, N = 45
Arm function (Fugl Meyer Assessment) Scale range: 0-66. Final values. Reported proximal and distal subscales, total scale used. Mean (95% CI)	34.1 (24.2 to 44)	43.4 (30.8 to 56)	33.3 (23.6 to 43)	42.9 (30.4 to 55.3)

Arm function (Fugl Meyer Assessment) - Polarity - Higher values are better

Dichotomous outcomes

Outcome	Robot assisted arm therapy, Baseline, N = 51	Robot assisted arm therapy, 8 week, N = 51	Conventional therapy, Baseline, N = 48	Conventional therapy, 8 week, N = 48
Discontinuation for any reason Robot: 2 no show for end of trial, 1 noncompliant, 1	n = NA ; % = NA	n = 4 ; % = 7.8	n = NA ; % = NA	n = 3 ; % = 6.3

Outcome	Robot assisted arm therapy, Baseline, N = 51	Robot assisted arm therapy, 8 week, N = 51	Conventional therapy, Baseline, N = 48	Conventional therapy, 8 week, N = 48
withdrew. Control: 1 recurrent stroke, 1 got insurance approval for traditional therapy, 1 no show for end of trial. No of events				

Discontinuation for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(FuglMeyerAssessment)-MeanNineFivePercentCI-Robot assisted arm therapy-Conventional therapy-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Discontinuationforanyreason-NoOfEvents-Robot assisted arm therapy-Conventional therapy-t8

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns
Overall bias and Directness	Overall Directness	Directly applicable

Wu et al.

Bibliographic Reference	Wu, Ching-yi; Chen, Ming-De; Chen, Yu-ting; Wu, Li-Ling; Lin, Keh-chung; Unilateral and Bilateral Robot-Assisted Arm Training Had Differential Effects on Upper Limb Function in Chronic Stroke Survivors; vol. 26; 362-363

Study details

Secondary publication of another included study- see primary study for details	Wu, Ching-yi; Yang, Chieh-ling; Chuang, Li-ling; Lin, Keh-chung; Chen, Hsieh-ching; Chen, Ming-de; Huang, Wan-chien; Effect of therapist-based versus robot-assisted bilateral arm training on motor control, functional performance, and quality of life after chronic stroke: a clinical trial; 2012; vol. 92; 1006-1016
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review. Wu, Ching-yi; Chuang, Li-ling; Chen, Ming-De; Chen, Yu-ting; Lin, Keh-chung; Abstract P289: Therapist-Based and Robot-Assisted Physical Training Have Differential Effects on Motor Control of Upper Limb and Quality of Life after Chronic Stroke; 2012

Wu, 2012

Bibliographic Reference	Wu, Ching-yi; Chuang, Li-ling; Chen, Ming-De; Chen, Yu-ting; Lin, Keh-chung; Abstract P289: Therapist-Based and Robot-Assisted Physical Training Have Differential Effects on Motor Control of Upper Limb and Quality of Life after Chronic Stroke; 2012

Study details

Secondary publication of another included study- see primary study for details	Wu, Ching-yi; Yang, Chieh-ling; Chuang, Li-ling; Lin, Keh-chung; Chen, Hsieh-ching; Chen, Ming-de; Huang, Wan-chien; Effect of therapist-based versus robot-assisted bilateral arm training on motor control, functional performance, and quality of life after chronic stroke: a clinical trial; 2012; vol. 92; 1006-1016
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review. Wu, Ching-yi; Chen, Ming-De; Chen, Yu-ting; Wu, Li-Ling; Lin, Keh-chung; Unilateral and Bilateral Robot-Assisted Arm Training Had Differential Effects on Upper Limb Function in Chronic Stroke Survivors; vol. 26; 362-363

Wu, 2012

Bibliographic Reference	Wu, Ching-yi; Yang, Chieh-ling; Chuang, Li-ling; Lin, Keh-chung; Chen, Hsieh-ching; Chen, Ming-de; Huang, Wan-chien; Effect of therapist-based versus robot-assisted bilateral arm training on motor control, functional performance, and quality of life after chronic stroke: a clinical trial; 2012; vol. 92; 1006-1016

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review. Wu, Ching-yi; Chuang, Li-ling; Chen, Ming-De; Chen, Yu-ting; Lin, Keh-chung; Abstract P289: Therapist-Based and Robot-Assisted Physical Training Have Differential Effects on Motor Control of Upper Limb and Quality of Life after Chronic Stroke; 2012 Wu, Ching-yi; Chen, Ming-De; Chen, Yu-ting; Wu, Li-Ling; Lin, Keh-chung; Unilateral and Bilateral Robot-Assisted Arm Training Had Differential Effects on Upper Limb Function in Chronic Stroke Survivors; vol. 26; 362-363
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months)
Subgroup 3: Region of upper limb trained	Mixed

Subgroup 4: Dose (hours per day)	≥1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Mixed Has three modes: a passive-passive mode, active-passive mode and active-active mode.

Study arms

Robot assisted arm training (N = 14)
Robot-assisted (Bi-Manu-Track) arm trainer (RAT Group). Each group received treatment for 90 to 105 minutes per session, 5 sessions on weekdays, for 4 weeks.

Conventional therapy (N = 28)
A combination of two arms. 1) therapist-mediated bilateral arm training group (n=14), 2) CT involved weight bearing, stretching, strengthening of the paretic arms, coordination, unilateral and bilateral fine-motor tasks, balance, and compensatory practice on functional tasks. Each group received treatment for 90 to 105 minutes per session, 5 sessions on weekdays, for 4 weeks.

Outcomes

Study timepoints
- Baseline

- 4 week (End of intervention)

Continuous outcomes

Outcome	Robot assisted arm training, Baseline, N = 14	Robot assisted arm training, 4 week, N = 14	Conventional therapy, Baseline, N = 28	Conventional therapy, 4 week, N = 28
Arm function (Fugl Meyer Assessment) Reports subscales for proximal and distal. Total values used. Scale range: 0-66. Final values. Values for the therapist-based arm training and control treatment arms were combined. Mean (SD)	43.29 (10.09)	47.14 (10.97)	44.43 (11.08)	48.64 (11.4)
Stroke-specific Patient Reported Outcome Measures (Stroke Impact Scale) Total score used, subscales also reported. Scale range: 0-100. Final values. Values for the therapist-based arm training and control treatment arms were combined. Mean (SD)	68.62 (7.62)	73.97 (8.68)	64.75 (8.76)	66.18 (10.11)

Arm function (Fugl Meyer Assessment) - Polarity - Higher values are better
Stroke-specific Patient Reported Outcome Measures (Stroke Impact Scale) - Polarity - Higher values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(FuglMeyerAssessment)-MeanSD-Robot assisted arm training-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Stroke-specificPatientReportedOutcomeMeasures(StrokeImpactScale)-MeanSD-Robot assisted arm training-Conventional therapy-t4

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Low
Overall bias and Directness	Overall Directness	Directly applicable

Xu, 2020

Bibliographic Reference	Xu, Q.; Li, C.; Pan, Y.; Li, W.; Jia, T.; Li, Z.; Ma, D.; Pang, X.; Ji, L.; Impact of smart force feedback rehabilitation robot training on upper limb motor function in the subacute stage of stroke; Neurorehabilitation; 2020; vol. 47 (no. 2); 209-215

Study details

Secondary publication of another included	NR

study- see primary study for details	
Other publications associated with this study included in review	NR
Trial name / registration number	NR
Study type	Randomised controlled trial (RCT)
Study location	China
Study setting	Rehabilitation hospital
Study dates	NR
Sources of funding	The study was supported by the Beijing Muncipicipal Administration of hospitals youth programme (No. QML2019002).
Inclusion criteria	First onset of Cerebral infarction or cerebral haemorrhage; patients with the course of disease between 1 and 6 months; patients aged between 18 and 75 years; patients who can coordinate the rehabilitation treatment; patients who signed the informed consent form.
Exclusion criteria	Patients with recurrent stroke; patients with severe cardiac insufficiency or renal insufficiency; patients with aphasia; patients with cognitive impairment; patients with psychiatric symptoms; patients with pacemakers; patients carrying internal metal fixation at the electrical stimulation site; patients with severe spasticity caused by dystonia; patients with severe osteoarthritis or severe osteoporosis.
Recruitment / selection of participants	NR
Intervention(s)	The robot (model Fourier M2, Fourier Intelligence, Shanghai, China) was used to perform a variety of intensive functional training n the affected side of each patient through various real-life mechanical scene simulations and comprehensive training methods. the treatment was guided by a therapist. Each patient was required to use the affected sides upper limbs, shoulder joints, and elbow joints to move the handle to the targets on the affected side in accordance with the designated order for motion control training. Robot training was provided in addition 20 min/time, once/day and five days/week.

	Concomitant therapy - the patients in both groups received regular neurological medical and physical therapy with equal treatment volume. A 6 weeks rehabilitation programme was designed for all the patients.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Proximal limb
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised
Subgroup 8: Type of movement delivered by robotic device	Not stated/unclear
Population subgroups	NR
Comparator	Each patient underwent traditional occupational therapy targeting the scapula and joints of the uppers limbs of the affected side, such as therapist -assisted stretch, loosening, or patients-based designed activities, such as roller training, pushing level sanding board, looping, stick insertion, or item transferring. Control group was trained with traditional exercises, 40 min, once/day, and five days/week.

Number of participants	55
Duration of follow-up	6 weeks post treatment
Indirectness	NR
Additional comments	NR

Study arms

Rehabilitation robot training (N = 22)

Conventional therapy (N = 23)

Characteristics

Arm-level characteristics

Characteristic	Rehabilitation robot training (N = 22)	Conventional therapy (N = 23)
% Female Nominal	25	30
Mean age (SD) Mean (SD)	62.2 (10.1)	60.7 (10.6)
Ethnicity	NR	NR

Characteristic	Rehabilitation robot training (N = 22)	Conventional therapy (N = 23)
Nominal		
Comorbidities Nominal	NR	NR
Severity Nominal	NR	NR
Time after stroke (days) Mean (SD)	51 (19.1)	47.2 (24)

Outcomes

Study timepoints

- Baseline
- 6 week

Continuous outcomes

Outcome	Rehabilitation robot training, Baseline, N = 22	Rehabilitation robot training, 6 week, N = 20	Conventional therapy, Baseline, N = 23	Conventional therapy, 6 week, N = 20
Activties of daily living (Modified Barthel index) 0-100, final value Mean (SD)	47.8 (17)	54.8 (20.2)	47.3 (15)	53.3 (16.2)

Outcome	Rehabilitation robot training, Baseline, N = 22	Rehabilitation robot training, 6 week, N = 20	Conventional therapy, Baseline, N = 23	Conventional therapy, 6 week, N = 20
Arm function (FMA total) 0-100, final value Mean (SD)	25.1 (8.6)	31.8 (10)	30.4 (8.8)	35.4 (9.1)

Activties of daily living (Modified Barthel index) - Polarity - Higher values are better
Arm function (FMA total) - Polarity - Higher values are better

Dichotomous outcomes

Outcome	Rehabilitation robot training, Baseline, N = 22	Rehabilitation robot training, 6 week, N = 22	Conventional therapy, Baseline, N = 23	Conventional therapy, 6 week, N = 23
Withdrawal for any reason intervention reasons = 1 change of disease condition, 1 discharged halfway. control reasons = 2 changes to disease conditions and 1 discharged halfway No of events	n = 0 ; % = 0	n = 2 ; % = 9	n = 0 ; % = 0	n = 3 ; % = 13

Withdrawal for any reason - Polarity - Lower values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Activtiesofdailyliving(ModifiedBarthelindex)-MeanSD-rehabilitation robot training-conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(Due to bias arising from the randomisation process)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armfunction(FMAtotal)-MeanSD-Rehabilitation robot training-Conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(Due to bias arising from the randomisation process)*
Overall bias and Directness	Overall Directness	Directly applicable

Dichotomousoutcomes-Withdrawalforanyreason-NoOfEvents-Rehabilitation robot training-Conventional therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	Some concerns *(Due to bias arising from the randomisation process)*
Overall bias and Directness	Overall Directness	Directly applicable

Yoo, 2013

Bibliographic Reference	Yoo, Doo Han; Cha, Yong Jun; kyoung Kim, Su; Lee, Jae Shin; Effect of three-dimensional robot-assisted therapy on upper limb function of patients with stroke; Journal of Physical Therapy Science; 2013; vol. 25 (no. 4); 407-409

Study details

Secondary publication of another included study- see primary study for details	No additional information.
Other publications associated with this study included in review	This study was included in the Cochrane review that this review was based on: 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 of Systematic Reviews 2018, Issue 9. Art. No.: CD006876. DOI: 10.1002/14651858.CD006876.pub5. For further information about the data extraction please see the Cochrane review.
Study type	Randomised controlled trial (RCT)
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Chronic (>6 months) Mean 41.5-45.8 months
Subgroup 3: Region of upper limb trained	Not stated/unclear
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	<5 days per week
Subgroup 6: Dose (duration)	≥6 weeks
Subgroup 7: Level of supervision	Supervised

Subgroup 8: Type of movement delivered by robotic device	Mixed Device can deliver passive or active assisted movement

Study arms

Robot assisted arm training (N = 11)
3-dimensional robot-assisted therapy (RAT) and conventional rehabilitation therapy (CT) for a total of 90 minutes (RAT: 30 minutes, CT: 60 minutes) a day with 10 minutes rest halfway through the session, received training 3 days a week for 6 weeks

Conventional rehabilitation therapy (N = 11)
The control group received only CT for 60 minutes a day on the same days as the first group

Outcomes

Study timepoints
- Baseline
- 6 week (End of intervention)

Continuous outcomes

Outcome	Robot assisted arm training, Baseline, N = 11	Robot assisted arm training, 6 week, N = 11	Conventional rehabilitation therapy, Baseline, N = 11	Conventional rehabilitation therapy, 6 week, N = 11
Activities of daily living (Modified Barthel Index) Scale range: 0-100. Final values. Mean (SD)	77.5 (9.6)	77.9 (9.7)	75.3 (5)	75.4 (5.1)
Arm function (Wolf Motor Function Test) Scale range: 0-85 (assumed by number of items in the scale). Final values. Mean (SD)	41.7 (15.5)	43.4 (15.9)	33 (6.1)	33.3 (6.3)
Arm muscle strength (grip power) (kg) Final values. Mean (SD)	7.5 (5.6)	8.5 (5.8)	5 (2.4)	5.1 (2.3)

Activities of daily living (Modified Barthel Index) - Polarity - Higher values are better
Arm function (Wolf Motor Function Test) - Polarity - Higher values are better
Arm muscle strength (grip power) - Polarity - Higher values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Activitiesofdailyliving(ModifiedBarthelIndex)-MeanSD-Robot assisted arm training-Conventional rehabilitation therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Physicalfunction-upperlimb(WolfMotorFunctionTest)-MeanSD-Robot assisted arm training-Conventional rehabilitation therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armmusclestrength(grippower)-MeanSD-Robot assisted arm training-Conventional rehabilitation therapy-t6

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High
Overall bias and Directness	Overall Directness	Directly applicable

Zengin-Metli, 2018

Bibliographic Reference	Zengin-Metli, D.; Ozbudak-Demir, S.; Eraktas, I.; Binay-Safer, V.; Ekiz, T.; Effects of robot assistive upper extremity rehabilitation on motor and cognitive recovery, the quality of life, and activities of daily living in stroke patients; Journal of Back & Musculoskeletal Rehabilitation; 2018; vol. 31 (no. 6); 1059-1064

Study details

Secondary publication of another included study- see primary study for details	NR
Other publications associated with this study included in review	NR
Trial name / registration number	NR
Study location	Turkey
Study setting	Stroke rehabilitation centre
Study dates	NR
Sources of funding	NR
Inclusion criteria	Stroke patients according to the WHO, age between 45-75 years, time after stroke was 6-24 weeks, upper extremity Brunnstrom stage 3-6, cooperative
Exclusion criteria	unstable patients with systematic problems such as heart or lung disease, limited range of motion of the upper limb, ataxia. dystonia and dyskinesia, visual and or haring impairment, aphasia, severe spasticity (Ashworth 3-4), received Botulinum toxin A injection in the last 6 months, shoulder subluxation or severe pain in the upper limbs.

Recruitment / selection of participants	NR
Intervention(s)	Armeo Spring HocomAG Inc. was used for robotic rehabilitation. Assistive component of the robot was set as tailor as to the subjects clinical status. the programme was individualised according to the patients ability and motor stage and level of difficulty was progressed or regressed during the rehabilitation process through the therapists control. The computer game encouraged shoulder adduction-abduction and flexion and extension along with wrist and hand movements by the joystick gripping. concomitant therapy - Conventional program consisted of neurophysiological exercises with Brunnstron approach, range of motion exercises and postural education.
Subgroup 1: Severity	Not stated/unclear
Subgroup 2: Time after stroke at the start of the trial	Subacute (7 days - 6 months)
Subgroup 3: Region of upper limb trained	Mixed
Subgroup 4: Dose (hours per day)	<1 hour
Subgroup 5: Dose (days per week)	≥5 days per week
Subgroup 6: Dose (duration)	<6 weeks
Subgroup 7: Level of supervision	Supervised

Subgroup 8: Type of movement delivered by robotic device	Active assisted movement
Population subgroups	NR
Comparator	Conventional program consisted of neurophysiological exercises with Brunnstron approach, range of motion exercises and postural education.
Duration of follow-up	post treatment (3 weeks intervention)
Indirectness	NR

Study arms

Robotic rehabilitation (Armeo Spring) (N = 20)

conventional rehabilitation (N = 15)

Characteristics

Study-level characteristics

Characteristic	**Study (N = 35)**
Ethnicity Nominal	NR

Characteristic	Study (N = 35)
Comorbidities Nominal	NR
Severity Nominal	NR

Arm-level characteristics

Characteristic	Robotic rehabilitation (Armeo Spring) (N = 20)	conventional rehabilitation (N = 15)
% Female Nominal	25	60
Mean age (SD) Nominal	NR	NR
Mean age (SD) Mean (SD)	59.25 (8.1)	63.27 (3.88)
Time after stroke weeks Mean (SD)	10.7 (4.9)	11.33 (5.26)

Outcomes

Study timepoints

- Baseline
- 3 week (post intervention)

Continuous outcomes

Outcome	Robotic rehabilitation (Armeo Spring), Baseline, N = 20	Robotic rehabilitation (Armeo Spring), 3 week, N = 20	conventional rehabilitation, Baseline, N = 15	conventional rehabilitation, 3 week, N = 15
Arm function (FMA shoulder/elbow/forearm) change score Mean (SD)	20.3 (18)	4.35 (3.2)	24.07 (4.73)	1.4 (1.88)
Person/participant generic health related quality of life (SF-36 PCS) 0-100 Mean (SD)	30.21 (7.38)	4.36 (6.29)	33.19 (8.52)	1.37 (5.22)
Person/participant generic health related quality of life (SF-36 MCS) 0-100, change score Mean (SD)	50 (10.73)	2.5 (7.86)	38.9 (15.22)	3.21 (5.37)
Activties of daily living (FIM) 0-126 Mean (SD)	92.6 (18.42)	14.7 (8.47)	91.47 (16.95)	13.67 (11.52)

Outcome	Robotic rehabilitation (Armeo Spring), Baseline, N = 20	Robotic rehabilitation (Armeo Spring), 3 week, N = 20	conventional rehabilitation, Baseline, N = 15	conventional rehabilitation, 3 week, N = 15
Arm strength (MI) change score Mean (SD)	NR (NR)	21.5 (3.87)	NR (NR)	22.87 (5)

Arm function (FMA shoulder/elbow/forearm) - Polarity - Higher values are better
Person/participant generic health related quality of life (SF-36 PCS) - Polarity - Higher values are better
Person/participant generic health related quality of life (SF-36 MCS) - Polarity - Higher values are better
Activties of daily living (FIM) - Polarity - Higher values are better
Arm strength (MI) - Polarity - Higher values are better

Critical appraisal - Cochrane Risk of Bias tool (RoB 2.0) Normal RCT

Continuousoutcomes-Armfunction(Functionalindependencemeasure-motor)-MeanSD-Robotic rehabilitation (Armeo Spring)-conventional rehabilitation-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(no details on randomisation or missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Person/participantgenerichealthrelatedqualityoflife(SF-36PCS)-MeanSD-Robotic rehabilitation (Armeo Spring)-conventional rehabilitation-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(no details on randomisation or missing data and bias in measurement of the outcome)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Person/participantgenerichealthrelatedqualityoflife(SF-36MCS)-MeanSD-Robotic rehabilitation (Armeo Spring)-conventional rehabilitation-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(no details on randomisation or missing data and bias in measurement of the outcome)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Activtiesofdailyliving(FIM)-MeanSD-Robotic rehabilitation (Armeo Spring)-conventional rehabilitation-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(no details on randomisation or missing data)*
Overall bias and Directness	Overall Directness	Directly applicable

Continuousoutcomes-Armstrength(MI)-MeanSD-Robotic rehabilitation (Armeo Spring)-conventional rehabilitation-t3

Section	Question	Answer
Overall bias and Directness	Risk of bias judgement	High *(no details on randomisation or missing data)*
Overall bias and Directness	Overall Directness	Directly applicable