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| **Table 2 – studies characteristics** |
| **Author, year of publication** | **Design and Aim** | **Inclusion and exclusion cognitive criteria** | **Participants** | **Rehabilitation protocol**  | **Cognitive outcomes and follow-up (if cognitive outcome is present)** | **Cognitive results** |
| **Abdullah HA, 2011** | pilot RCTTo explore the efficacy of this new type of RT as compared to standard physiotherapy treatment in treating the post-stroke arm; to evaluate client satisfaction with the proposed robotic system; and to provide data for sample size calculations for a proposed larger multicenter RCT | IC: able to follow simple instructions.EC: N/A | EG (n=8)- Mean age: 75.7 ± 5.8- Gender: 5 M / 3 F - Type of stroke: N/A- Affected side: dominant/not dominant: N/A; 3 L / 5 R- Stroke onset (weeks): 4.3 ± 1.6CG (n=11) - Mean age: 70.4 ± 14.8- Gender: 3 M / 8 F- Type of stroke: N/A- Affected side dominant/not dominant: N/A; 6 L / 4 R / 1 bilateral- Stroke onset (weeks): 4.3 ± 4.7 | EG: RT with a novel robot, (not specified) until discharge. Each exercise was done 10 times for the total treatment time of the sessionCG: Supervised conventional therapy where assorted techniques for upper extremity retraining (task specific training, passive, active and resistive exercises). 45 min, 3 d/wk until discharge | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Ambrosini E, 2021** | single-blind RCTTo evaluate whether arm training assisted by a hybrid robotic system, combining personalized EMG-triggered FES with a light-weight, passive exoskeleton during task-oriented exercises with real objects, improves arm functions, strength, dexterity, ADL and quality of life compared with advanced conventional therapy of the same frequency and duration in a population of stroke survivors | IC: MMSE > 20EC: severe aphasia preventing communication, previous neurological disorder | EG (n=36)- Mean age: 60.9 ± 13.7 - Gender: 25 M / 11 F - Type of stroke: 27 I / 9 E- Affected side: dominant; not dominant N/A; 15 R /21 L- Stroke onset (days): 63.4 ± 58.8 CG (n=36) - Mean age: 67.8 ± 12.2 - Gender: 25 M /11 F- Type of stroke: 26 I / 10 E - Affected side: dominant/ not dominant: N/A; 13 R / 23 L - Stroke onset (days):62.1 ± 76.9  | EG: 30 min of training with RETRAINER system + 60 min of advance conventional therapy (ADT)\* CG: 90 min of ADT\* 27 sessions, 3 d/wk for 9 weeks, 90 min each\*ADT: upper-limb passive and/or active motion, arm cycle-ergometer without FES, FES of forearm muscles, virtual reality-augmented arm exercises. Repetitive task training and mirror therapy | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Ang KK, 2014** | RCTTo investigate the efficacy of an Electroencephalography (EEG)-based Motor Imagery (MI) Brain-Computer Interface (BCI) coupled with a Haptic Knob (HK) robot for arm rehabilitation in stroke patients. | IC: ability to understand simple instructionsEC: severe aphasia, inattention; hemi spatial neglect | EG – BCI-HK (n=6)- Mean age: 54.0 ± 8.9 - Gender: 4 M / 2 F - Type of stroke: 2 I / 4 H- Affected side: 2 dominant; 4 not dominant- Stroke onset (weeks): N/A\*EG-HK (n=8)- Mean age: 51.1 ± 6.3 - Gender: 6 M / 2 F - Type of stroke:4 I / 4 H- Affected side: 5 dominant; 3 not dominant- Stroke onset (weeks): N/A\*CG (n=7) - Mean age: 58.0 ± 19.3- Gender: 4 M / 3 F- Type of stroke:5 I / 2 H - Affected side: 4 dominant; 3 not dominant- Stroke onset (weeks): N/A\*\*IC: > 4 months post stroke,  | EG-BCI: EEG-based MI-BCI coupled with HK robot-assisted physical practice (PP) therapyEG-HK: HK robot-assisted PP therapy.CG: distal arm training of forearm pronation-supination movements incorporating wrist control and grasp-release of various objects.18 sessions, 3 d/wk for 6 weeks, 60 min each\* All groups underwent overall therapist-assisted arm mobilization (30 min) after each treatment | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Aprile I, 2020** | RCTTo evaluate, in subjects with subacute stroke, the efficacy of standardized UL robotic rehabilitation (using an organizational model in which 1 physical therapist supervises 3 subjects, each treated using a set of 4 robots and sensor-based devices), compared with UL conventional therapy | IC: cognitive and language abilities adequate to understand the experiments and the follow instructions EC: cognitive disorders  | EG (n=111)- Mean age: 69.5 ± 10.9 - Gender: 63 M / 48 F - Type of stroke: 81 I / 30 H- Affected side: dominant/not dominant: N/A; 63 L / 48 R- Stroke onset (days): \*Days from index stroke to enrollment: 15-30: 57; 31-90: 39; 91-180: 15CG (n=113) - Mean age: 68.5 ± 11.5 - Gender: 64 M / 49 F- Type of stroke: 84 I / 29 H - Affected side: dominant-not dominant: N/A; 55 L / 58 R- Stroke onset (days): \*Days from index stroke to enrollment: 15-30: 60; 31-90: 36; 91-180: 17 | EG: RT with Motore (Humanware, Italy); Amadeo (Tyromotion, Austria) + vibratory treatment (frequency of 60 Hz) before finger treatment; Pablo (Tyromotion, Austria); Diego (Tyromotion, Austria). During each session, one system was used for each subject. CG: conventional therapy (assive, active, and active-assisted exercises on the 3 UL joints, task-oriented exercises included reaching and grasping movements (eg, reaching and picking up a glass or other objects), activities of daily living).30 session, 5 d/wk, 45 min\*all subjects underwent conventional rehabilitation sessions (6 d/wk), 45 min, focused on lower limb, sitting and standing training, balance, and walking. Subjects underwent OT and speech therapy, if needed | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Brokaw EB, 2014** | RCTTo compare the effects of equal doses of robotic and conventional therapy in individuals with chronic stroke.  | IC: N/AEC: cognitive deficits that would limit their ability to complete the study protocol (MMSE < 24); hemispatial neglect (>3 errors on the Star Cancellation Test28), | EG (n=7)CG (n=5) \*Baseline characteristics were not classified in CG and EG- Mean age: 57 ± 11.7 - Gender: 9 M / 3 F - Type of stroke: N/A- Affected side: dominant/ not dominant: N/A; 7 L; 5 R- Stroke onset (years): 3.0 ± 1.9  | EG: Combination of ARMin III robot and the HandSOME device.CG: conventional therapy. Treatments focused on practice of specific tasks: reach and grasp of various objects, isolated hand movements and whole body activities.12 hours of robotic or conventional therapy and then crossed over to the other therapy type after a 1-month washout period.  | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Burgar CG, 2011** | RCTTo evaluate whether Mirror Image Movement Enabler (MIME) could facilitate similar or greater motor recovery as the same amount of early hands-on therapy (the primary aim of this study), we provided training in the acute inpatient rehabilitation setting. A secondary aim was to assess the dose-response effect of RA upper-limb therapy, which has not previously been reported. | IC: EC: MMSE < 22; neurological conditions that would have precluded exercise in short duration | EG-Robot-Lo (n=17)- Mean age: 58.6 ± 2.3 - Gender: N/A- Type of stroke: N/A- Affected side: N/A- Stroke onset (days): 16.6 ± 2.4 \*Side of stroke: 9 L / 10 REG-Robot-Hi (n=17)- Mean age: 58.6 ± 2.3 - Gender: N/A- Type of stroke: N/A- Affected side: N/A- Stroke onset (days): 16.6 ± 2.4 \*Side of stroke: 9 L / 8 RCG (n=18) - Mean age: 68.1 ± 3.3- Gender: N/A- Type of stroke: N/A- Affected side: N/A- Stroke onset (days):10.6 ± 1.2 \*Side of stroke: 5 L / 13 R | EG: RA groups performed the movements with continuous direct visualization of the limbs, using physical objects as targets to maintain a more functional (using physical instead of virtual targets) and goal-directed set of tasks. The MIME system was programmed to provide 4 modes of RA training. Forces applied to the subject’s forearm assisted or resisted elbow and shoulder movements in three-dimensional space.EG-Robot-Lo: 15 sessionsEG-Robot-Hi: 30 sessionsCG: PT aimed at improving the function of the paretic UL through a variety of therapeutic modalities. + exposure to MIME (5 min) with the robot positioning targets for static and dynamic tracking, reaching, and self range-of-motion tasks. The robot did not apply any forces to the CG subjects during these tasks.15 (EG-Robot-Lo and CG) or 30 (EG-Robo-Hi) sessions, 5 d/wk, 60 min each \* All group underwent at least 2 h of rehabilitation therapy 5 or more d/wk | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Calabrò RS, 2019** | RCTThe objective of this study was the evaluation of the clinical and neurophysiological effects of intensive robot-assisted hand therapy compared to intensive occupational therapy in the chronic recovery phase after stroke. | IC: MMSE > 24EC: N/A | EG (n=25)- Mean age: 65 ± 3 - Gender: 11 M / 14 F - Type of stroke: 25 I / 0 H- Affected side: N/A- Stroke onset (months): 10 ± 2 CG (n=25) - Mean age: 64 ± 3 - Gender: 24 M / 11 F- Type of stroke:25 I / 0 H - Affected side: N/A- Stroke onset (months): 10 ± 2  | EG: RT using AmadeoTM (Tyromotion GmbH; Graz, Austria)CG: intensive conventional PT of the affected hand.40 sessions, 5 d/wk, for 8 weeks, 45 min each+ both groups were subjected to conventional lower limb physiotherapy and bimanual activities. | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Carpinella I, 2020** | pilot RCTTo assess the effects of planar robotic rehabilitation versus arm-specific physiotherapy in persons post-stroke on motor strategies derived from instrumented kinematic analysis of upper limb and trunk during the execution of a non-trained task involving horizontal and vertical arm movements. The second aim was to compare the effects of the two rehabilitation approaches on arm function as measured by clinical scales. | IC: N/AEC: MMSE < 20; evidence of severe verbal comprehension deficit, apraxia and/or visuospatial neglect as assessed through neurological examination | EG (n=19)- Mean age: 67.0 (58.0–70.0)\* - Gender: 10 M / 9 F - Type of stroke: 13 I / 6 H- Affected side: dominant/not dominant: N/A; 10 L / 9 R- Stroke onset (weeks): N/A\*; 12 chronic; 7 sub-acuteCG (n=19) - Mean age: 59.0 (46.0–69.0)\* - Gender: 10 M / 9 F- Type of stroke: 12 I / 7 H - Affected side: dominant/not dominant: N/A; 12 L / 7 R- Stroke onset (weeks): N/A\*; 10 chronic; 9 sub-acute\*Age was represented as Median (1st-3rd quartile) IC: first ischemic or hemorrhagic stroke | EG: received a robot-based training using a planar robotic manipulandum (Braccio di Ferro, Celin s.r.l., Italy)CG: usual care arm-specific physiotherapy that consisted of passive and active mobilization of scapula, shoulder, elbow and wrist, followed by task-oriented exercises that incorporated single or multi-joint movements20 sessions, 5 d/wk for 4 weeks, 45 min each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Chinembiri B, 2021** | RCTTo compare the effects of the upper limb robotic training with matched Occupational therapy training on upper limb function and independence-related quality of life in post-stroke patients within the Brunnstrom arm motor recovery stages 1 to 4. | IC: N/AEC: N/A | EG (n=25)- Mean age: 57.72 ± 7.37 - Gender: N/A- Type of stroke: 12 I / 13 H- Affected side: dominant/ not dominant: N/A; 15 L / 10 R- Stroke onset (weeks): N/A\*CG (n=20) - Mean age: 57.25 ± 9.23 - Gender: N/A- Type of stroke: 11 I / 9 H- Affected side: dominant/ not dominant: N/A; 10 L / 10 R- Stroke onset (weeks): N/A\*\*IC: post-stroke duration (1–12 months) | EG: 20 min of RT using Fourier M2 (Fourier Intelligence, China) upper-limb based robot machine and 50 min of occupational therapyCG: OT training on upper limb function and independence related quality of life according to their Brunnstrom arm motor recovery stage30 training sessions each lasting 50 minutes (CG) and 70 minutes (EG) per day, 5 days a week (Monday to Friday) for a total of 6 weeks. | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Cho KH, 2019** | RCTTo assess whether robot-assisted reach training (RART) with an active assistant protocol can improve upper extremity function and kinematic performance in chronic stroke survivors. | IC: Korean MMSE ≥24 EC: N/A | EG (n=19)- Mean age: 59.94 ± 7.66 - Gender: 17 M / 2 F - Type of stroke: 14 I / 5 H- Affected side: dominant/not dominant: N/A; 10 L / 9 R- Stroke onset (weeks): N/A\*CG (n=19) - Mean age: 60.21 ± 8.38- Gender: 11 M / 8 F- Type of stroke: 12 I / 7 H - Affected side: dominant/not dominant: N/A; 11 L / 8 R- Stroke onset (weeks): N/A\*\*IC: at least 6 months prior to the time of recruitment | EG: RART with assist-as-needed CG: RART with guidance force18 sessions, 3 d/wk for 6 weeks, 40 min each. \*RART program was conducted with high inertia robotic system (WAM, Barrett Technology, Inc., Newton, Reaching movements toward targets in 3-dimensional space in 6 directions.  | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Cho KH, 2021** | RCTTo directly compare the effects of high inertia robot arm (whole arm manipulator, WAM) and low inertia robot arm (Proficio) on upper limb motor function in chronic stroke patients. | IC: Korean MMSE ≥24 EC: | EG (n=20)- Mean age: 63.55 ± 7.66 - Gender: 13 M / 7 F - Type of stroke: 7 I / 13 H- Affected side: dominant/ not dominant: N/A; 5 L / 15 R- Stroke onset (weeks): N/A\*CG (n=20) - Mean age: 60.25 ± 9.42 - Gender: 14 M / 6 F- Type of stroke:10 I / 10 H - Affected side: dominant/ not dominant: N/A; 11 L / 9 R- Stroke onset (weeks): N/A\*\*IC: at least 6 months after the onset of stroke | EG: robot-assisted arm training with high inertia robotic system (WAM, Barrett Technology, Inc., Newton, MA, USA)CG: robot-assisted arm training with low inertia robotic system (Proficio, Barrett Technology, Inc., Newton, MA, USA)12 sessions, 3 d/wk for 4 weeks, 40 min each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Conroy SS, 2011** | RCTTo determine the efficacy of 2 distinct 6-week robot-assisted reaching programs compared with an intensive conventional arm exercise program (ICAE) for chronic, stroke-related upper-extremity (UE) impairment. To examine whether the addition of robot-assisted training out of the horizontal plane leads to improved outcomes. | IC: N/AEC: N/A | EG-planar (n=20)- Mean age: 57 ± 12 - Gender: 11 M / 9 F - Type of stroke: 16 I / 4 H- Affected side: dominant/ not dominant: N/A- Stroke onset (years): 3 ± 2 EG-planar with vert (n=19)- Mean age: 60 ± 13 - Gender: 10 M / 9 F - Type of stroke: 16 I / 2 H- Affected side: dominant/ not dominant: N/A- Stroke onset (years): 5 ± 8 CG (n=19) - Mean age: 56 ± 6.3 - Gender: 10 M / 9 F- Type of stroke: 19 I / 0 H- Affected side: dominant/ not dominant: N/A- Stroke onset (years): 4 ± 6  | EG-planar: RT using InMotion 2.0 (Interactive Motion Technologies, Inc, Cambridge, Massachusetts)..EG-planar with vert: RT using a planar robot (InMotion,2.0) + vertical robot - InMotion Linear Robot (Interactive Motion Technologies, Inc, Cambridge, Massachusetts).CG: Intensive Conventional Arm Exercise. (Active repetitive arm motions using an arm ergometer, a timed target-specific skate-board activity reaching from a center point outward, and shoulder and elbow range of motion exercises).18 sessions, 3 d/wk for 6 week, 60 min each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Conroy SS, 2019** | RCTTo investigate the efficacy of robot-assisted therapy combined with therapist- assisted task training versus robot-assisted therapy alone on motor outcomes and use in participants with moderate to severe chronic stroke-related arm disability. | IC: N/A EC: inability to give informed consent | EG (n=22)- Mean age: 55.7 ± 10.2 - Gender: 14 M / 8 F - Type of stroke: 18 I / 4 H- Affected side: dominant/ not dominant: N/A -Stroke onset (months): 36.4 (median: 19.5; range 7-148) CG (n=23) - Mean age: 56.4 ± 12.7- Gender: 15 M / 8 F- Type of stroke: 19 I / 4 H- Affected side: dominant/ not dominant: N/A- Stroke onset (months): 39.3 (median: 35.3; range 7 – 163)  | All participants trained on 2 distinct robots in a set progression of 4-week training blocks. Weeks 1-4 focused on distal arm training using InMotion 3.0 (Bionik Labs, Watertown, USA); Weeks 5-8 focused on proximal arm training using InMotion2 (Bionik Labs, Watertown, USA) and Weeks 9-12 alternated distal and proximal robotic trainingEG: only RTCG: 45 minutes of RT followed by 15 minutes of therapist-assisted transition to task activities. These activities were progressive in nature utilizing everyday items for contextual multijoint tasks.36 sessions. 3 d/wk for 12 weeks, 60 min each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Daly JJ, 2005** | single-blind RCTTo test response of severely and moderately impaired chronic stroke survivors to daily motor learning treatment composed of task component and whole task practice in conjunction with shoulder/elbow robotics or wrist and finger functional neuromuscular stimulation (FNS). | IC: N/AEC: N/A | EG (n= 6)- Mean age: N/A (21-49 y: 3; 50-62y: 3) - Gender: 6M / 0 F - Type of stroke: 5 I / 1 H- Affected side: N/A- Stroke onset (years): Years poststroke: 1-3: 3; 4:3CG (n=6) - Mean age: N/A(21-49 y: 3; 50-62 y: 3)- Gender: 3 M / 3 F- Type of stroke: 6 I / 0 H - Affected side: N/A- Stroke onset (years): Years poststroke: 1-3: 4; 4:2 | EG: 90 min of RT with InMotion2 (Interactive Motion Technologies, Inc, Cambridge, Massachusetts) CG: 90 subjects used FNS for wrist and finger muscle activation 60 sessions, 5 d/wk for 12 weeks, 90 min each. \*all subject underwent 3.5 h of practice of functional task components and whole task practice without technology assistance | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Daly JJ, 2019** | RCTThe questions were the following: (1) Is there need for long-dose therapy or is there a mid-treatment plateau? (2) Are the observed gains from the prior-studied protocol retained after treatment? | IC: no other prior neurological condition; and ability to follow 2-step commands.EC: N/A | EG-prossimal (n=8)- Mean age: N/A; Age range (years): 21-49: 2; 50-62: 4; ≥ 63: 2)- Gender: 6 M / 2 F - Type of stroke:5 I / 3 H- Affected side N/A - Stroke onset (years): 0.5-3: 6 >4: 2 EG-distal (n=10)- Mean age: N/A. Age range (years): 21-49: 2; 50-62: 5; ≥63:2) - Gender: 7 M / 3 F - Type of stroke: 7 I / 3 H- Affected side: N/A - Stroke onset (years): 0.5-3: 10; >4: 0 EG-total (n=18) - Mean age: N/A. Age range (years): 21-49: 2; 50-62: 11; ≥63: 5) - Gender: 15 M /3 F- Type of stroke: 14 I / 4 H - Affected side: N/A- Stroke onset (years): 0.5-3: 18; >4: 0   | EG-prossimal: proximal-focused technology applications (FES and robotics for shoulder/elbow muscles/ movements (Vectra Pro (Chatanooga Group, Inc, Hixson, TN) and InMotion2 Shoulder-Elbow-Robot; InteractiveMotion Technologies, Inc, Cambridge, MA)) EG-distal: distal-focused technology (FES for wrist/hand muscles (EMS + 2 [Staodyn, Inc, Longmont, CO]) applications groupEG-total: equal proximal and distal technology applications. 60 sessions, 5 d/wk for 12 weeks, 90 min each\*all subject underwent 3.5 h of motor learning of coordinated movements, task component and full task practice | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Daunoravicene K, 2018** | RCTTo identify the effect of robot training on functional recovery of the arm | IC: MMSE > 21 EC: MMSE < 21 points, had aphasia  | EG (n = 17)- Mean age: 65.88 ± 4.87- Gender; 11 M / 6 F- Type of stroke: 13 I / 4 H- Affected side: 11 R / 6 L-Stroke onset (weeks): 8.64 ± 3.53CG (n = 17)- Mean age: 65.47 ± 4.05- Gender; 11 M / 6F- type of stroke: 15 I / 2 H- affected side: 13 R / 4 L- Stroke onset (weeks): 9.65 ± 6.18 | EG: Patients underwent RT with Armeo Spring (Hocoma AG, Volketswil, Switzerland). CG: Conventional functional rehabilitation (OT sessions, including exercising, physical activities, active table games etc.). 10 sessions, 5 d/wk for 2 weeks, 30 (EG) or 35-60 (CG) min each | COGNITIVE OUTCOME:- Addenbrooke’s Cognitive Examination-Revised (AEC-R)FOLLOW UP: Pre-treatment (pre) and after treatment (post)  | EG: AEC-R pre 73.88 ± 14.32; post 85.24 ± 10.15; pre-post 11.36 ± 4.17 CG: AEC-R: pre 74.47 ± 9.34 post 76.94 ± 8.19; pre-post 2.47 ± 1.15(p-value: pre 0.0446; post 0.008; pre-post <0.030)Robotic training influenced cognitive abilities much more than motor functions, which was reflected by the significant difference between the tested groups |
| **Dehem S, 2019** | single- blind RCTTo evaluate the effectiveness of upper-limb robotic assisted training (RAT) used as partial substitution to conventional therapy in the early phase of stroke rehabilitation, following the 3 ICF domains. | IC: MMSE ≥ 15EC: N/A | EG (n=23)- Mean age: 67.3 ± 11.1 - Gender: 11 M / 12 F - Type of stroke: 16 I / 7 H- Affected side: dominant/not dominant: N/A; 13 L / 10 R- Stroke onset (days): 28.1 ± 4.4 CG (n=22) - Mean age: 68.6 ± 19.1 - Gender:10 M / 12 F- Type of stroke:19 I / 3 H - Affected side: dominant/not dominant: N/A; 10 L / 12 R- Stroke onset (days): 27.5 ± 6.6  | EG: 45 min RT using end-effector REAplan robot (Axinesis, Wavre, Belgium) + PT and OT CG: Conventional therapy focused on motor rehabilitation, matched with their personal needs and the centre’s means144 (36 for RT) sessions, 5 (4 for RT) d/wk for 9 weeks, 45 min each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Doost M, 2021** | RCT To investigate whether training under the robotic active-assisted mode improves bimanual motor skill learning (biMSkL) more than training under the active mode in stroke patients | IC: N/A EC: N/A | EG (n=23) - Mean age: 63.9 ± 11 - Gender: 12/11 - Type of stroke: 20 I / 3 H - Affected side: 13 dominant; 10 not dominant - Stroke onset (weeks): N/A\*CG (n=26)\*- Mean age: 27.4 ± 3.2- Gender: N/A- Type of stroke: N/A- Affected side: N/A- Stroke onset (weeks): N/A\*IC: chronic stroke (> 6 months)CG: healthy subjects | EG: The subjects trained for two consecutive days with either the active-as-sisted or the active robotic modes to learn a complex bimanual motor skill using REAplan robotic device (AXINESIS, Wavre, Belgium). During each sessions, subject underwent 3 phases: series of TEST, training with either the active or active-assisted robotic modes and another series of TEST. TEST: four series of exercises. Each exercise (20 sec-onds) was repeated five times, separated by a 50-second pauseCG: same protocol2 sessions, 30 min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A  | COGNITIVE RESULTS: N/A |
| **Edwards DJ, 2019** | Double-blind RCTTo determine whether tDCS, delivered prior to robotic training, could augment clinical improvement.  | IC: cognitive function sufficient to understand the experiments and follow instructions.EC: N/A | EG (n=41)- Mean age: 70.0 [64.0,77.0]\*- Gender: 25 M / 16 F - Type of stroke: 41 I / 0 H- Affected side: N/A- Stroke onset (days): 654.0 [365.0,1445.0]\* CG (n=41) - Mean age: 66.0 [61.0,73.0]\*- Gender: 25 M / 16 F - Type of stroke: 41 I / 0 H- Affected side: N/A- Stroke onset (days): 1201.0 [425.0,1693.0]\*\*Variables present median [IQR] | EG: RT using MIT Manus and MIT on alternate days + tDCS stimulation CG: RT using MIT Manus and MIT on alternate days + sham tDCS36 sessions, 3 d/wk for 9 week, 60 min each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Fazekas G, 2007** | Preliminary RCTTo investigate the clinical usefulness of the REHAROB therapeutic System, which provides passive robot-mediated physiotherapy for patients with spastic hemiparesis | IC and EC are not specified in the article | EG (n=15)- Mean age: 55.9 (range: 28-77)- Gender: 10 M / 5 F - Type of stroke: N/A- Affected side: dominant/not dominant: N/A; 6 L / 9 R- Stroke onset (months): 9.5 (range: 1.1-44)CG (n=15) - Mean age: 56.6 (range: 28:82)- Gender: M / F- Type of stroke: N/A - Affected side: dominant/not dominant: N/A; 7 L / 8 R- Stroke onset (months): 23.2 (range: 1.2-87)\*not all subjects included are stroke patients: 6 in EG and 2 in CG are “traumatic brain injury”  | EG: RT using REHAROB Therapeutic System (combination of Mirror Image Movement Enabler (MIME) and the Massachusetts Institute of Technology (MIT)-Manus robot) + Bobath therapy sessions (30 min)CG: Bobath therapy sessions20 sessions, on workdays, 30 min (CG) or 60 min (EG) each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Gandolfi M, 2019** | Single-blinded RCTTo evaluate the effects of Robot-assisted UL training on UL spasticity, function, muscle strength and the electromyographic UL muscles activity in chronic stroke patients treated with Botulinum toxin. | IC: MMSE ≥ 24EC: severe neuropsychologic impairment (global aphasia, severe attention deficit or neglect) | EG (n= 16)- Mean age: 59.31 ± 14.40 - Gender: 12 M / 4 F - Type of stroke: N/A- Affected side: dominant/not dominant: N/A; 6 L / 10 R- Stroke onset (years): 6.0 ± 3.1 CG (n=16) - Mean age: 59.13 ± 14.97- Gender: 10 M / 6 F- Type of stroke: N/A- Affected side: dominant/not dominant: N/A; 8 L / 8 R- Stroke onset (years): 5.1 ± 2.2 | EG: robot-assisted UL training Armotion (Reha Technology, Olten, Switzerland) and botulinum toxin (BoNT) treatment CG: conventional treatment combined with BoNT treatment.10 sessions, 2 d/wk for 5 weeks, 45 min each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Grigoras AV, 2021** | RCTTo test a Hybrid FES-Robot Assisted Hand Motor Training Program in Sub-Acute Stroke Survivors | IC: N/AEC: MMSE < 25; patients with other neurological disorders or cognitive deficit; | EG (n=13)- Mean age: 62.76 ± 9.23 - Gender: 5 M / 8 F - Type of stroke: 12 I / 1 H- Affected side: N/A- Stroke onset (months):3.69 ± 1.03CG (n=12) - Mean age: 64.75 ± 10.60 - Gender: 6 M / 6 F- Type of stroke: 11 I / 1 H - Affected side N/A- Stroke onset (months):3.76 ± 0.73 | EG: RT using a hybrid FES - mechatronic glove system for dexterity rehabilitation + standard conventional therapyCG: standard conventional therapy RT: 12 sessions, 6 d/wk for 2 weeks, 30 min eachStandard conventional therapy: 10 sessions, 5 d/wk, 30 min each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| Gueye T, 2021 | RCTTo evaluate the effectiveness of virtual reality therapy (VRT) Armeo Spring® upper limb exoskeleton (Armeo) in early post-stroke rehabilitation with a focus on the elderly. | IC: mild hemispatial neglect syndrome (HSNS) (according to Catherine Bergego Scale (CBS)EC: severe cognitive impairment or severe sensoric aphasia and the presence of any other neurological condition | EG (n = 25)- Mean age: 66.56 ± 12.26- Gender; 14 M / 11 F- Type of stroke: 20 I / 5 H- Affected side: 18 R / 7 L- Stroke onset (days): 14.88 ± 6.45CG (n = 25)- Mean age: 68.12 ± 11.97- Gender: 15 M / 10 F- Type of stroke: 24 I /1 H- Affected side: 14 R / 11 L - Stroke onset (days): 16.4 ± 7.25 | EG: Armeo Spring (Hocoma AG, Volketswil, Switzerland) performing with VRTCG: Armeo Spring (Hocoma AG, Volketswil, Switzerland) 12 sessions, 3 d/wk, 45 min each\*Both groups underwent 3 h of conventional therapy | COGNITIVE OUTCOME:- Montreal Cognitive Assessment (MoCA)FOLLOW UP: Pre-treatment (pre) and at the end of treatment (post)  | EG: MoCA pre 21.8 ± 4.88; post 25.6 ± 3.54; pre-post% 3.8 ± 17.43CG: MoCA pre 20.3 ± 6.14; post 22.9 ± 5.53; pre-post% 2.6 ± 12.8(pvalue 0.302)MoCA outcome did not show any difference between the IG and CG. |
| **Han Yoo D, 2013** | Pilot RCTTo investigate the effect of three-dimensional robot-assisted therapy on upper limb function of patients with stroke | IC: no visual neglect or impaired cognitive function (MMSE > 24 points)EC: N/A | EG (n=11)- Mean age: 50.9 ± 10.9- Gender: 7/4 - Type of stroke: 8 I / 3 H- Affected side: dominant/non dominant: N/A; 5 R/ 6 L- Stroke onset (months): 45.8±41.8 CG (n=11) - Mean age: 49.7±8.9- Gender: 6/5- Type of stroke: 7 I / 4 H- Affected side: 7R/4L- Stroke onset (months): 41.5 ± 33.1 | EG: three-dimensional ro-bot assisted therapy (30 min) and conventional rehabilitation therapy (60 min).CG: conventional rehabilitation therapy 18 sessions, 3 d/wk for 6 weeks, 60 (CG) or 90 (EG) min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Hesse S, 2005** | Single-blind RCTTo compare a computerized arm trainer (AT), allowing repetitive practice of passive and active bilateral forearm and wrist movement cycle, and electromyography-initiated electrical stimulation (ES) of the paretic wrist extensor in severely affected subacute stroke patients. | IC: able to understand the meaning of the studyEC: apraxia (ie, 1 fault in the tasks waving goodbye, saluting, and making a fist with the nonaffected hand after verbal instruction and demonstration, and using an eraser, comb, and screwdriver with the objects handed to the patient and verbally instructed); | EG (n=22)- Mean age: 65.4 ± 11.5 - Gender: 10 M / 12 F - Type of stroke: 20 I / 2 H- Affected side: dominant/not dominant: N/A; 14 L / 8 R- Stroke onset (weeks): 5.1 ± 1.3 CG (n=22) - Mean age: 64.0 ± 11.6 - Gender: 10 M / 12 F- Type of stroke: 20 I / 2 H - Affected side: dominant/not dominant: N/A; 11 L / 11 R- Stroke onset (weeks): 5.5 ± 1.4 | EG: 800 repetitions per session with the robot (Bi-Manu-Track) CG: 60 to 80 wrist extensions per session with ES30 sessions, workdays for 6 weeks, 20 min each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Hesse S, 2014** | Single-blind RCTTo evaluate the effectiveness and efficiency of robot-assisted arm group therapy (RAGT) versus individual arm therapy (IAT) to restore motor function in the moderately to severely affected patient after stroke | IC: Able to give informed consent (approved by the local ethical committee) in the studyEC: N/A  | EG (n=25)- Mean age: 71.4 ± 15.5 - Gender: 13 M / 12 F - Type of stroke: 22 I / 3 H- Affected side: dominant/not dominant: N/A; 14 L / 11 R- Stroke onset (weeks): 4.5 ± 1.7 CG (n=25) - Mean age: 69.7 ± 16.6 - Gender: 10 M / 25 F- Type of stroke: 19 I / 6 H- Affected side: dominant/not dominant: N/A; 13 L / 12 R- Stroke onset (weeks): 4.5 ± 1.4  | EG: 30 min of RAGT (Bi-Manu- Track, the electromechanical finger trainer Reha-Digit and two mechanical arm trainers, the Reha-Slide and Reha-Slide duo.) + IAT. 15 min each with two of the devices during one RAGT.CG: 2 sessions (30 min each) of IAT a day20 sessions, workdays for 4 weeks, 30 min each twice a day | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Horsley S, 2019** | Single-blind RCTIn adults undergoing rehabilitation after stroke, does 1 hour of daily practice of intensive, active, repetitive reaching prevent or reduce upper limb contracture, decrease pain, or improve upper limb function? If so, are these effects maintained two weeks after cessation of the intervention? | IC: N/AEC: had language, comprehension or cognitive problems that prevented informed consent | EG (n=25)- Mean age: 65.9 ± 12.7 - Gender: 16 M / 9 F - Type of stroke: 18 I / 7 H- Affected side: dominant/not dominant: N/A; 16 L / 9 R- Stroke onset (days): 28.3 ± 27.1CG (n=25) - Mean age: 68.5 ± 13.0 - Gender: 12 M / 13 F- Type of stroke: 23 I / 2 H - Affected side: dominant/not dominant: N/A; 15 L / 10 R - Stroke onset (days): 24.9 ± 14.1  | EG: RT using SMART Arm Device + conventional upper limb trainingCG: conventional upper limb training25 sessions, 5 d/wk for 5 weeks, 60 min each\*For the 2 weeks immediately after the 5-week intervention period, participants in both groups received only the usual upper limb therapy provided by occupational therapists and physiotherapists. | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Housman SJ, 2009** | single-blind RCTTo compare semiautonomous training with Therapy Wilmington Robotic Exoskeleton (T-WREX) and conventional semiautonomous exercises that used a tabletop for gravity support. | IC: N/AEC: severe cognitive dysfunction, aphasia, hemispatial neglect, or apraxia sufficient to limit comprehension or completion of experimental tasks | EG (n=14)- Mean age: 54.2 ± 11.9 - Gender: 11 M / 3 F- Type of stroke: 9 I (1 with hemorrhagic conversion) / 4 H + 1 unknown- Affected side: dominant/not dominant: N/A; 10 L / 4 R- Stroke onset (months): 84.5 ± 96.3 CG (n=25) - Mean age: 56.4 ± 12.8 - Gender: 7 M / 7 F - Type of stroke: 8 I / 5 H + 1 unknown- Affected side: dominant/not dominant: N/A; 10 L / 4 R - Stroke onset (months): 112.4 ± 128.5  | EG: RT using T-WREX (developed by the authors)CG: conventional exercises, which are the standard of care for therapy groups and home exercise programs using a tabletop 24 sessions, 3 d/wk for 8-9 weeks 60 min each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Hsieh YW, 2011** | Pilot RCTTo investigate the treatment effects of RT on different outcomes relative to conventional rehabilitation (CR) in patients with stroke, (b) test the dose– response relations by using 2 groups receiving higher intensity and lower intensity RT, and (c) examine the effects of RT training on 8-OHdG, a biomarker of oxidative stress.  | IC: MMSE ≥ 24EC: severe neuropsychologic impairments (eg, global aphasia and severe attention deficits) | EG high intensity (n=6)- Mean age: 56.04 ± 13.74 - Gender: 4 M / 2 F - Type of stroke: 5 I / 1 H- Affected side: N/A- Stroke onset (months): 21.33 ± 7.17 EG low intensity (n=6)- Mean age: 52.45 ± 1.98 - Gender: 4 M / 2 F - Type of stroke: 6 I / 0 H- Affected side: N/A- Stroke onset (months): 13.0 ± 7.04CG (n=6) - Mean age: 54.0 ± 8.05 - Gender: 5 M / 1 F- Type of stroke: 4 I / 2 H - Affected side: N/A- Stroke onset (months): 28.33 ± 19.9 | EG: Bi-Manu-Track (Reha-Stim Co, Berlin, Germany)\*The dose of the higher intensity RT was twice the number of repetitions in the lower intensity RT.CG: conventional OT techniques such as neurodevelopmental techniques with emphasis on functional tasks and muscle strengthening20 sessions, 5 d/wk for 4 weeks, 90-105 min/d each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Hsieh YW, 2016**  | Single-blind RCTTo investigate the effects of the sequential combination of RT and modified form of constraint- induced therapy (mCIT) (RT + mCIT), compared with RT alone, focusing on motor control strategies measured by kinematic analysis and on motor and ADL functions using clinical measures. We hypothesized that (1) RT + mCIT would lead to different benefits on the motor control strategies compared with and RT alone and that (2) RT + mCIT would contribute to better performances in ADL than RT alone. | IC: MMSE ≥ 22EC: N/A | EG (n=17)- Mean age: 55.1 ± 9.4 - Gender: 11 M / 6 F - Type of stroke: 8 I / 9 H- Affected side: N/A- Stroke onset (months): 20.2 ± 13.6 CG (n=17) - Mean age: 52.6 ± 13.6- Gender: 13 M / 4 F- Type of stroke: 13 I / 4 H - Affected side: N/A- Stroke onset (months): 24.8 ± 14.4 | EG: RT with Bi-Manu-Track (Reha-Stim Co, Berlin, Germany) + 2 weeks of mCIT CG: RT with Bi-Manu-Track (Reha-Stim Co, Berlin, Germany)20 sessions, 5 d/wk for 4 weeks, 90-105 min/d each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Hsu HY, 2019** | single-blind RCTTo compare a repetitive task training program delivered using robotics with a routine care repetitive task training program facilitated by therapists. | IC: MMSE > 24; Lowenstein occupational therapy cognitive assessment (LOTCA) item scores: visual perception ≥ 8, spatial perceptions ≥ 6, praxis ≥ 6 and visuomotor organisation ≥ 14EC: Wernicke’s aphasia or global aphasia leading to difficulty of following written or spo- ken multi-step instruction | EG (n=22)- Mean age: 53.1 ± 13.9 - Gender: 11 M / 11 F - Type of stroke: N/A\*- Affected side: 13 dominant; 9 not dominant- Stroke onset (weeks): N/A\*CG (n=21) - Mean age: 52.6 ± 12.5- Gender: 9 M / 12 F- Type of stroke: N/A\* - Affected side: 9 dominant; 12 not dominant- Stroke onset (weeks): N/A\*\*IC: Diagnosis of stroke with unilateral cerebral infarction or hemorrhage whose time post-stroke was more than six months  | EG: RT using Bi-Manu-Track (Reha-Stim Co, Berlin, Germany) CG: usual care: therapist-facilitated task-specific training for the affected limb12 sessions, 3 d/wk for 4 weeks, 50 min each\*All participants received a 10- minute per-protocol sensorimotor stimulation session prior to interventions as part of usual care | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Huang Y, 2020** | RCTTo compare the rehabilitation effects of the electromyography (EMG)-driven neuromuscular electrical stimulation (NMES) robotic hand and EMG-driven robotic hand for chronic stroke. | IC: MMSE > 21EC: N/A | EG (n=15)- Mean age: 57.33 ± 9.19- Gender: 12 M / 3 F - Type of stroke: 8 I / 7 H- Affected side: N/A - Stroke onset (years): 8.27 ± 4.32 CG (n=15) - Mean age: 60.07 ± 6.88- Gender: 12 M / 3 F- Type of stroke: 10 I / 5 H - Affected side: N/A - Stroke onset (years): 6.20 ± 3.41  | EG: training with EMG-driven NMES robotic hand. Assistance was only in hand-opening motions for the entire phase of finger extension, while no assistance from NMES was provided during finger flexion to avoid the possible increase of finger spasticity after stimulation. CG: EMG-driven robotic hand.20 sessions, 3-5 d/wk for 7 weeks, 30 min each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Hung CS, 2019** | Single-blind RCTTo examine the treatment effects between unilateral hybrid therapy (UHT; unilateral robot-assisted therapy [RT] + modified constraint-induced movement therapy) and bilateral hybrid therapy (BHT; bilateral RT + bilateral arm training) compared with RT. | IC: MMSE ≥ 22; no other neurologic problemsEC: N/A | EG-UHT (n=9)- Mean age: 49.95 ± 10.59 - Gender: 6 M / 3 F - Type of stroke: 3 I / 6 H- Affected side: dominant/not dominant: N/A; 5 L/ 4 R- Stroke onset (months): 24.78 ± 27.59EG-BHT (n=11)- Mean age: 62.63 ± 8.51 - Gender: 7 M / 3 F - Type of stroke: 8 I / 2 H- Affected side: dominant/not dominant: N/A; 4 L/ 6 R- Stroke onset (months): 36.70 ± 26.80CG (n=10) - Mean age: 51.73 ± 8.46- Gender: 9 M / 2 F- Type of stroke: 3 I / 8 H- Affected side: dominant/not dominant: N/A; 7 L/ 4 R- Stroke onset (months): 23.45 ± 15.84  | EG-UHT: unilateral RT using Bi-Manu-Track (Re-ha-Stim Co, Berlin, Ger-many) and mCITEG-BHT: bilateral RT using Bi-Manu-TrackTM (Reha-Stim Co, Berlin, Germany)CG: RT using Bi-Manu-Track (Re-ha-Stim Co, Berlin, Ger-many) in both the unilateral and bilateral modes. + 10 min of home program teaching in each session. 18 sessions, 3 d/wk for 6 weeks, 90 min each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Hung CS, Hsieh YW, 2019** | RCTTo investigate the effects on motor and daily function of robot-assisted therapies in people with chronic stroke using the Bi-Manu-Track (BMT) and InMotion 3.0 (IMT) compared with control treatment (CT). | IC: MMSE ≥ 24; no other neurologic problemsEC: comorbidity with other severe neurological or neuropsychological impairment (e.g., epilepsy, global aphasia, severe attention deficits), | EG-BMT (n=10)- Mean age: 57.5 (54.15–62.16)\*- Gender: 6 M / 4 F - Type of stroke: 7 I / 3 H- Affected side: N/A- Stroke onset (months): 26.00 (15.75–34.50)\*EG-IMT (n=10)- Mean age: 52.04 (48.59–58.23)\* - Gender: 8 M / 2 F - Type of stroke: 7 I / 3 HAffected side: N/A - Stroke onset (months): 20.50 (10.25–42.25)\*CG (n=10) - Mean age: 55.54 (49.41–61.56)\*- Gender: 6 M / 4 F- Type of stroke: 6 I / 4 H -Affected side: N/A - Stroke onset (months): 25.00 (15.00–32.50)\*\*(Quartile 1–Quartile 3) | EG-BMT: RT with bilateral symmetrical practice of forearm pronation–supination and wrist flexion–extension using BMT\*.EG-IMT: RT using IMT with two types of forearm pronation– supination and wrist circumduction\*. \*EG groups underwent 20 min of functional-based activitiesCG: individualized occupational therapy according to patient’s needs and level of impairment20 sessions, 5 d/wk for 4 weeks, 90 min each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A. | COGNITIVE RESULTS: N/A |
| **Hung CS, Lin KC, 2019** | RCTTo investigate the effects of unilateral hybrid therapy (UHT) and bilateral hybrid therapy (BHT) compared with robot-assisted therapy (RT) alone in patients with chronic stroke. | IC: MMSE ≥ 24; no other neurological conditionEC: N/A | EG-UHT (n=14)- Mean age: 53.17 ± 12.28 - Gender: 9 M / 5 F - Type of stroke: 7 I / 7 H- Affected side: N/A- Stroke onset (months): 37.86 ± 34.77EG-BHT (n=15)- Mean age: 58.45 ± 13.11 - Gender: 10 M / 5 F - Type of stroke: 6 I / 9 H- Affected side: N/A- Stroke onset (months): 29.33 ± 28.44CG (n=15) - Mean age: 52.68 ± 8.75- Gender: 11 M / 4 F- Type of stroke: 11 I / 4 H - Affected side: N/A- Stroke onset (months): 32.53 ± 24.25 | EG-UHT: unilateral RT using Bi-Manu-Track (Reha-Stim Co, Berlin, Germany) + unilateral arm trainingEG-BHT: bilateral RT using Bi-Manu-Track (Reha-Stim Co, Berlin, Germany) + bilateral arm training CG: 80 min to 90 min of RT using Bi-Manu-Track (Re-ha-Stim Co, Berlin, Germany). Participants practiced both the unilateral and bilateral modes18 sessions, 3 d/wk for 6 weeks, 90 min each\*all participants received 10 minutes of home-program teaching in each intervention session | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Hwang Ch, 2012** | Prospective RCTTo evaluate individual finger synchronized robot-assisted hand rehabilitation in stroke patients. | IC: N/AEC: apraxia (≤2 on the Alexander Scale), impaired consciousness (≥1 for the NIH Stroke Scale question Ia–c), aphasia (≥2 for the NIH Stroke Scale question IX) | EG (n=9)- Mean age: 50.2 ± 3.7 - Gender:5 M / 4 F - Type of stroke: N/A- Affected side: N/ACG (n=6) - Mean age: 51.3 ± 3.0 - Gender: 4 M / 2 F- Type of stroke: N/A- Affected side: N/A- Stroke onset (months): 5.3 ± 5.9 | EG: RT using Amadeo, (Tyromotion, Austria)CG: 10 sessions of passive range of motion training + 10 sessions of RT20 sessions, 5 d/wk for 4 weeks, 45 min each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Iwamoto Y, 2019** | RCTTo determine whether upper limb rehabilitation using single joint Hybrid Assistive Limb (HAL-SJ) affects ADL function and the use of a hemiparetic arm in ADLs of acute stroke patients. | IC: N/AEC: were not able to follow instructions | EG(n = 6)- Mean age: 62.33 ± 10.23 - Gender; 5 M / 1 F- type of stroke: 3 I / 3 H- affected side: dominant/not dominant: N/A; 2 L / 4 R - Stroke onset: N/A\*CG (n = 6)- Mean age: 59.67 ± 24.56- Gender; 3 M / 3 F- Type of stroke: 4 I / 2 H- Affected side: dominant/not dominant: N/A; 3 L / 3 R- Stroke onset: N/A\*\*IC: within 2 weeks after stroke onset. | EG: A-B-A-B designCG: B-A-B-A designA: 5 days of combination therapy (robotic rehabilitation using HAL-SJ and occupational therapy).B: days of occupational therapy.20 sessions, 5 d/wk 40 min each | COGNITVE OUTCOME:-FIM of the cognitive items (FIM-cognitive subscore) FOLLOW UP: on days 14, 19, 24, 29, and 34 after stroke onset | EG: FIM-cognitive subscore score changes between 14 and 34 0.7 ± 53.28CG: FIM-cognitive subscore score changes between 14 and 34 1 ± 2.3P value: 0.923No significative variation was found out between the groups |
| **Jiang S, 2021** | pilot RCTTo examine the effects of short-term upper limb RT on the rehabilitation of sub-acute stroke patients. | IC:MMSE ≥ 18EC: impaired cognition | EG (n= 23)- Mean age: 62.43 ± 11.293 - Gender: 9 M / 14 F - Type of stroke: 16 I / 7 E- Affected side: dominant/not dominant: N/A; 11 L / 12 R - Stroke onset (days): 20.09 ± 5.526 CG (n=22) - Mean age: 66 ± 11.506- Gender: 15 M / 7 F- Type of stroke: 18 I / 4 E - Affected side: dominant/not dominant: N/A; 10 L / 12 R- Stroke onset (days): 19.41 ± 7.042 | EG: RT using Armeo Spring arm robot (Hocoma AG, Volketswil, Switzerland) + conventional rehabilitation therapy twice a dayCG: twice a day conventional rehabilitation therapy 10 sessions, 5 d/wk for 2 weeks, 60 (CG) or 120 (EG) each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Kahn LE, 2006** | RCTTo investigate the effects of robotically administered active-assistive exercise and compare those with free reaching voluntary exercise in improving arm movement ability after chronic stroke. | IC: N/AEC: difficulty understanding the experimental tasks, hemispatial neglect | EG (n=10)- Mean age: 75.8 ± 45.5 - Gender: 4 M / 6 F - Type of stroke: N/A- Affected side: N/A - Stroke onset (months): 75.8 ± 45.5 CG (n=22) - Mean age: 55.9 ± 12.3 - Gender: 7 M / 2 F- Type of stroke: N/A - Affected side: N/A - Stroke onset (months): 103.1 ± 48.2 | EG: active-assistive reaching exercise with a simple robotic device (the Assisted Rehabilitation and Measurement Guide, ARM Guide)CG: task-matched amount of unassisted reaching 24 sessions, 3 d/wk for 8 weeks, 45 min each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Kim MS, 2019** | Prospective single-blinded RCT To investigate the therapeutic effects of a newly developed shoulder robot on poststroke hemiplegic shoulder pain. | IC: N/AEC: Korean MMSE < 15 | EG (n=18)- Mean age: 65.9 ± 9.4- Gender: 11 M / 7 F - Type of stroke: 11 I / 7 H- Affected side: dominant/not dominant; 12 L / 6 R- Stroke onset (weeks): N/A\*CG (n=18) - Mean age: 64.7 ± 8.3- Gender: 11 M / 7 F- Type of stroke: 12 I / 6 H - Affected side: dominant/not dominant; 14 L / 4 R- Stroke onset (weeks): N/A\*\*IC: subacute stroke | EG: RT + conventional therapyCG: Conventional physical therapy directed at both improving upper extremity mechanics and reducing neurologic injuryCT: twice a dayRT: 20 sessions, 5 d/wk for 4 weeks, 30 min each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Klamroth-Marganska V, 2014** | Prospective RCTTo address whether robotic training of an affected arm with ARMin after stroke reduces motor impairment with respect to arm and hand function more effectively than does conventional therapy. To investigate whether RT with ARMin had long-term effects on impairment, activity, and participation (ie, social functioning),1 and which subpopulations benefit most from the intervention. | IC: Ability to communicate effectively with the examiner such that the validity of the patient’s data could not be compromised; No serious cognitive defects or aphasia preventing effective use of ARMinEC: N/A | EG (n=38)- Mean age: 55 ± 13- Gender: 21 M / 14 F - Type of stroke: N/A- Affected side: 19 dominant; 19 not dominant- Stroke onset months): patients with time since stroke ≥ 27 months: 21 (mean: 80 ± 42); patients with time since stroke < 27 months: 17 (mean: 18 ± 6)CG (n=35) - Mean age: 58 ± 14 - Gender: 25 M / 10 F- Type of stroke: N/A - Affected side: 15 dominant; 20 not dominant- Stroke onset (months): patients with time since stroke ≥ 27 months: 15 (mean: 76 ± 48); patients with time since stroke < 27 months: 20 (mean: 13 ± 6) | EG: RT with ARMin CG: conventional therapy24 sessons, 3 d/wk for 8 weeks, 45 min each | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Kutner NG, 2010** | RCTTo explore change in patient-reported, health- related quality of life associated with robotic-assisted therapy combined with reduced therapist-supervised training.  | IC: MMSE > 24EC: N/A | EG (n=7)- Mean age: 51.0 ± 11.3 - Gender: 5 M / 2 F - Type of stroke: 5 I / 2 H- Affected side: N/A- Stroke onset (days):184.1 ± 126.5 CG (n=22) - Mean age: 61.9 ± 13.4 - Gender: 5 M / 5 F- Type of stroke: 7 I / 3 H- Affected side: N/A - Stroke onset (days): 269.6 ± 111.1  | EG: 30 h of RT using Hand Mentor robotic system + 30 h of repetitive task practice (RTP)CG: RTP60 h over 3 weeks | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Lee HC, 2021** | pilot RCTTo investigate the effects of robot-assisted therapy (RT) with a Gloreha device on sensorimotor and hand function and ability to perform activiy daily linving (ADL) among patients with stroke | IC: Could understand instructionEC: N/A | EG (n=14)- Mean age: 59.56 ± 8.29 - Gender: 9 M / 5 F - Type of stroke: 5 I / 9 H- Affected side: dominant/ not dominant: N/A; 9 L; 5 R- Stroke onset (days): 882.0 ± 957.67 CG (n=10) - Mean age: 53.50 ± 12.33- Gender: 7 M / 3 F- Type of stroke: 4 I / 6 H - Affected side: dominant/ not dominant: N/A; 8 L; 2 R - Stroke onset (days): 883.30 ± 1020.49 | EG: RT with Gloreha Sinfonia (Brescia, Italy).CG: conventional OT, included task-oriented bilateral hand, grasp-and-release and pinch activities\*Both groups underwent 20-min warm-up program (to inhibit spasticity)12 sessions, 2 d/wk for 6 weeks, 60 min each. | COGNITIVE OUTCOMS: N/AFOLLOW-UP: N/A | COGNITIVE RESULTS: N/A |
| **Lee KW, 2016** | RCTTo determine the efficacy of a stretching and strengthening exercise program using an upper extremity robot, as compared with a conventional occupational therapy program for upper extremity spasticity in stroke patients. | IC: N/AEC: non-compliance due to cognitive impairment | EG (n= 22)- Mean age: 50.27 ± 11.11 - Gender: 15 M / 7 F - Type of stroke: 13 I / 9 H- Affected side: dominant/not dominant: N/A; 11 L / 11 R- Stroke onset (days):40.91 ± 22.83 CG (n=22) - Mean age: 52.32 ± 8.66- Gender: 14 M / 8 F- Type of stroke: 12 I / 10 H - Affected side: dominant/not dominant: N/A; 9 L / 13 R- Stroke onset (days):41.86 ± 20.28  | EG: RT using an upper-extremity robot (Neuro-X; Apsun Inc., Seoul, Korea) and CT was administered by occupational therapistsCG: CT alone, twice a day20 sessions, 5 d/wk for 2 weeks, 30 minutes each twice a day  | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Lee KW, 2017** | RCTTo determine the effects of combining robot-assisted game training with conventional upper extremity rehabilitation training (RCT) on motor and daily functions in comparison with conventional upper extremity rehabilitation training (OCT) in stroke patients. | IC: K-MMSE ≥ 10EC: N/A | EG (n=25)- Mean age: 55.76 ± 13.60 - Gender: 14 M / 11 F - Type of stroke: 17 I / 8 H- Affected side: dominant/not dominant: N/A; 13 L / 12 R- Stroke onset (days): 15.40 ± 8.05 CG (n= 25) - Mean age: 57.88 ± 11.12 - Gender: 12 M /13 F- Type of stroke:15 I / 10 H - Affected side: dominant/not dominant: N/A; 14 L / 11 R- Stroke onset (days): 14.40 ± 6.95 | EG: RT using an upper-extremity robot (Neuro-X; Apsun Inc., Seoul, Korea) and CT was administered by occupational therapistsCG: CT alone, twice a day20 sessions, 5 d/wk for 2 weeks, 30 minutes each twice a day  | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Lee MJ, 2018** | Single-blind RCTTo investigate the effects of robot-assisted therapy on upper-extremity function and the ability to perform activities of daily living (ADL) in patients with stroke-induced hemiplegia. | IC: K-MMSE ≥ 21EC: patients with cognitive deficits | EG (n=15)- Mean age: 52.07 ± 14.07 - Gender: 8 M / 7 F - Type of stroke: 5 I / 10 H- Affected side: dominant/not dominant: N/A; 6 L / 7 R- Stroke onset (months): 7-12: 4; 13-24: 6; CG (n= 15) - Mean age: 50.27 ± 11,17- Gender: 11 M / 4 F- Type of stroke: 8 I / 7 H - Affected side: dominant/not dominant: N/A- Stroke onset (months): 7-12: 3; 13-24: 7; 25 and above: 5  | EG: Robot-assisted therapy for the experimental group using REJOYCE robot + OTCG: OT40 sessions, 5 d/wk for 8 weeks, 60 min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Lee SH, 2020** | Single-Blind RCTTo directly compare end -effector (EE) and exoskeleton (Exo) robots in a selected population of chronic stroke patients with moderate-to-severe upper limb impairment. | IC: ability to follow simple instructions.EC: N/A | EG-EE (n=19)- Mean age: 54.00 ± 10.01 - Gender: 11 M / 8 F - Type of stroke: 10 I / 9 H- Affected side: dominant/not dominant: N/A; 10 L / 9 R- Stroke onset (months): 6.42 ± 5.06 CG-Exo (n=19) - Mean age: 49.47 ± 10.88 - Gender: 15 M / 4 F- Type of stroke: 5 I / 14 H - Affected side: dominant/not dominant: N/A; 8 L / 11 R- Stroke onset (months):8.26 ± 7.57 | EG-EE: RT using InMotion2 (Interactive Motion Technologies, Watertown, MA, USA)CG-Exo: RT using Armeo Power (Hocoma, Volketswil, Switzerland)20 sessions, 5 d/wk for 4 weeks, 30 min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Liao WW, 2012** | RCTTo compare the outcome of robot-assisted therapy with dose-matched active control therapy by using accelerometers to study functional recovery in chronic stroke patients | IC: MMSE ≥ 22EC: unable to follow treatment instructions. | EG (n=10)- Mean age: 55.51 ± 11.17- Gender: 6 M / 4 F - Type of stroke: N/A- Affected side: dominant/not dominant: N/A; 4 L / 6 R- Stroke onset (months): 23.90 ± 13.39 CG (n=10) - Mean age: 54.56 ± 8.20 - Gender: 7 M / 3 F- Type of stroke: N/A - Affected side: dominant/not dominant: N/A; 3 L / 7 R- Stroke onset (weeks): 22.20 ± 17.47 | EG: Robot-assisted therapy using Bi-Manu-TrackCG: active control therapy20 sessions, 5 d/wk for 4 weeks, 90-105 min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Lo AC, 2010** | RCTTo determine whether a rehabilitation protocol using the MIT–Manus robotic system, as compared with a program based on conventional rehabilitative techniques or usual care, could improve functioning and quality of life of stroke survivors with long-term upper-limb deficits.  | IC: N/AEC: N/A | EG (n= 49)- Mean age: 66 ± 11 - Gender: 47 M / 2 F - Type of stroke: 42 I / 7 H- Affected side: N/A- Stroke onset (years): 3.6 ± 4.0 CG (n=50) - Mean age: 64 ± 11- Gender: 48 M / 2 F- Type of stroke: 44 I / 6 H - Affected side: N/A- Stroke onset (years): 4.8 ± 4.0  | EG: RT using the MIT–Manus robotic system (Interactive Motion Technologies)CG: intensive comparison therapy36 sessions, 3 d/wk for 12 weeks, 60 min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Lum PS, 2002** | RCTTo compare the effects of robot-assisted movement training with conventional techniques for the rehabilitation of upper-limb motor function after stroke | IC: N/AEC: unable to cooperate with the study tasks | EG (n=13)- Mean age: 63.2±3.6- Gender: 12M / 1F - Type of stroke: N/A- Affected side: N/A- Stroke onset (months): 30.2± 6.2 CG (n=14) - Mean age: 65.9±2.4 - Gender: 8M / 6F- Type of stroke: N/A- Affected side: N/A- Stroke onset (months): 28.8± 6.3 | EG: Robot-assisted movement using mirror image movement enabler (MIME)CG: Conventional treatment that targeted proximal upper-limb function that was based on neurodevelopmental therapy24 sessions, 3 d/wk for 8 weeks, 50 min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Lum PS, 2006** | Follow-up study of RCTThese results are discussed in light of the need for further device development and continued clinical trials. | IC: N/AEC: Cognitive impairments with a score < 21 on the Folstein Mini-Mental State Examination | EG-RC (n=10)- Mean age: 62.3 ± 2.8- Gender: 9 M / 1 F - Type of stroke: N/A\* - Affected side: N/A- Stroke onset (weeks): 13.0 ± 2.1 EG2 Robot-Unilateral (RU) (n=9)- Mean age: 69.8 ± 4.0 - Gender: 5M / 4F - Type of stroke: N/A\* - Affected side: N/A- Stroke onset (weeks): 10.0 ± 1.9 EG 3 Robot-Bilateral (RB) (n=5)- Mean age: 72.2 ± 11.7- Gender: 2M / 3F - Type of stroke: N/A\* - Affected side: N/A- Stroke onset (weeks): 6.2 ± 1.0CG (n=6) - Mean age: 59.9 ± 5.5 - Gender: 4M / 2F- Type of stroke: N/A\* - Affected side: N/A - Stroke onset (weeks): 10.6 ± 2.7\*IC: chronic stroke | EG1 (RC)\*: spent approximately half the treatment time in the unilateral mode and the other half in the bilateral modeEG2 (RU)\*: performed exercises that progressed from the easiest exercise modes (passive) to the most challenging (active-constrained). No bilateral exercise was performed.EG3 (RB)\*: the same as RU, but only in bilateral mode.CG: 50 min of conventional treatment of equivalent intensity and duration targeting proximal upper-limb function based on Neuro Developmental Therapy\*All the robot-groups performed 50 min of robotic assisted movement, following a core set of 12 targeted reaching movements15 sessions, 3 d/wk for 4 weeks, 60 min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Masiero S, 2007** | Single-blind RCTTo investigate whether early therapy with a novel robotic device can reduce motor impairment and enhance functional recovery of post-stroke patients with hemiparetic and hemiplegic upper limb. | IC: N/AEC: severe neuropsychological impairment (global aphasia, severe attention deficit or neglect) | EG (n=57)- Mean age: 63.4±11.8- Gender: 9 M / 6 F - Type of stroke: 17 I / 0 E- Affected side: 11R/4L- Stroke onset (weeks): N/A\*CG (n=15) - Mean age: 68.8±10.5 - Gender: 10 M / 5 F- Type of stroke: 15 I / 0 E - Affected side: 10R/5L- Stroke onset (weeks): N/A\*\*IC: consecutively admitted to the Stroke Unit of Padova Hospital after first, single, unilateral, ischemic stroke | EG: standard rehabilitative treatment (based on the Bobath concept) and OT + early sensorimotor robotic training by Neuro-Rehabilitation-roBot (NeReBot – invention University of Padua) CG: standard rehabilitative treatment + similar initial exposure to the robot (30min/wk twice) except that the exercises were performed with the unimpaired upper limb.25 sessions, 2 sessions a day, 4 h a wk for 5 weeks | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Masiero S, 2014** | RCTTo assess the effects of NeReBot on arm function and ADLs, when NeReBot training is used in substitution of conventional rehabilitation therapy | IC: MMSE >18EC: severe neuropsychological impairment (global aphasia, severe attention deficit, or severe spatial inattention) | EG (n=14)- Mean age: 65.60±9.2 - Gender: 10 M / 4 F - Type of stroke: 12 I / 2 H- Affected side: N/A- Stroke onset (days): 8.342±3.2 CG (n=16) - Mean age: 66.83±7.9 - Gender: 10 M / 6 F- Type of stroke: 14 I / 2 H - Affected side: N/A- Stroke onset (weeks): 10.23±2.4  | EG: conventional therapy (for 65% of exercise time) and substitutive robotic treatment (for 35% of exercise time) by Neuro-Rehabilitation-roBot (NeReBot – invention University of Padua) training for 40 minutes a day (divided into two 20-minute sessions)CG: only conventional treatment (for 100% of exercise time)Total daily rehabilitation treatment time of 120 minutes, 25 sessions, for 5 days a week, for 5 weeks | COGNITIVE OUTCOME: N/AFOLLOW UP: | COGNITIVE RESULTS: N/A |
| **Mazzoleni S, 2019** | RCTTo investigate the effectiveness of combining tDCS and wrist robot-assisted rehabilitation in subacute stroke patients in comparison with the wrist robotic training only | IC: cognitive and speech abilities sufficient to understand instructions and to provide informed consentEC: N/A | EG (n=20)- Mean age: 67.50±16.30 - Gender: 8M / 12F - Type of stroke: 13I / 7H- Affected side: 20R/0L - Stroke onset (weeks): N/A\*CG (n=19) - Mean age: 68.74±15.83 - Gender: 7M / 12F- Type of stroke: 16I / 3H- Affected side: 11R/8L- Stroke onset (weeks): N/A\*\*IC: stroke onset time should be of 25±7 days | EG: robot-assisted wrist rehabilitation in combination with real tDCS. CG: robot-assisted rehabilitation with sham tDCS.Wrist training was based on goal-directed reaching tasks by using the InMotion WRIST robot (Bionik Laboratories Corp., Watertown, MA, USA)30 sessions, 5 d/wk for 6 weeks, 30 min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **McCabe J, 2015** | Randomized Controlled TrialTo compare response to upper-limb treatment using robotics plus motor learning (ML) versus functional electrical stimulation (FES) plus ML versus ML alone, according to a measure of complex functional everyday tasks for chronic, severely impaired stroke survivors. | IC: N/AEC: N/A | EG1 (R+ML) (n=12)- Mean age: N/A (21-49 y: 2; 50-81 y: 10) - Gender: 10M / 2F - Type of stroke: N/A- Affected side: N/A- Stroke onset (years): N/A (1-3: 9; ≥4: 3) EG2 (FES+ML) (n= 12)- Mean age: N/A (21-49: 3; 50-81: 9) - Gender: 7M / 5F - Type of stroke: N/A- Affected side: N/A- Stroke onset (years): N/A (1-3: 10; ≥4: 2)CG (ML) (n= 11) - Mean age: N/A (21-49: 2; 50-81: 9) - Gender: 6M / 5F- Type of stroke: N/A - Affected side: N/A- Stroke onset (weeks): N/A (1-3: 8; ≥4:3) | EG1 (robotics+ML): used the robot (InMotion2 Shoulder- Elbow Robot) for 1.5h/d + ML without technologies (3.5h).EG2 (FES+ML): used FES for 1.5h/d + ML without technologies (3.5h).CG (ML): ML intervention.60 sessions, 5 d/wk for 12 weeks, 5 h each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Orihuela-Espina F, 2016** | Pre-post parallel-group RCTTo establish whether robot active assisted therapies provides any additional motor recovery for the hand when administered during the subacute stage (<4 months from event) in a Mexican adult population diagnosed with stroke. | IC: N/AEC: severe cognitive impairment, aphasia, hemispatial neglect assessed with the Mini Mental State method | EG (n=9)- Mean age: 56.22±13.72- Gender: 5 M / 4 F - Type of stroke: 9 I / 0 H- Affected side: 6 R / 3 L- Stroke onset: N/A\*CG (n=8) - Mean age: 55.00±25.78- Gender: 6 M / 2 F- Type of stroke: 8 I / 0 H - Affected side: 5 R / 3 L- Stroke onset: N/A\*\*IC: subacute stroke patients, more than 1 week and less than 4 months since the stroke | EG: robotic assisted therapy (robot Amadeus Tyromotion, Austria). The robot based treatment involved two stages; first passive activities (300 repetitions), followed with partial assistance or resistance (300 repetitions)CG: classical occupational therapy40 sessions, 5 d/wk for 8 sessions, 60 min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Park JH, 2020** | Single‑blinded pilot RCTTo evaluate the differences in the clinical and kinematic outcomes between active-assistive and passive robotic rehabilitation among stroke survivors. | IC: cognitive function of the level that facilitates the understanding and obeying of instructions of this studyEC: N/A | EG (ACT): (n=10)- Mean age: 54.9 ± 10.7 - Gender: 8 M / 2 F - Type of stroke: 5 I / 5 H- Affected side: 6 R / 4 L- Stroke onset (months): 11.8 ± 11.0CG (PSV): (n=9) - Mean age: 53.9 ± 16.7- Gender: 8M / 1F- Type of stroke: 4I / 5H - Affected side: 5R/4L- Stroke onset (months): 9.6 ± 4.5  | EG (Active‑assistive robotic intervention group): intervention using an Armeo ® Power (Hocoma Inc, Zurich, Switzerland). Participants were trained with virtual reality (VR) environment.CG (Passive robotic intervention group): used an Armeo ® Spring robot (Hocoma Inc, Zurich, Switzerland). Participants were trained under the VR enviroment20 sessions, 5 d/wk for 4 weeks, 30 min each  | COGNITIVE OUTCOME: N/AFOLLOW UP: | COGNITIVE RESULTS: N/A |
| **Park JH, 2021** | RCTTo identify the effects of robot-assisted hand training on hemispatial neglect in stroke patients with chronic stroke after 20 sessions’ intervention compared to a CG  | IC: Korean version of MMSE ≥ 24, 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).EC: N/A | EG(n=12)- Mean age: 69.08 ±  4.71- Gender: 7M / 5F- Type of stroke: 6 I / 6 H- Affected side: 12 L- Stroke onset (month): 9.50 ± 2.6CG (n=12) - Mean age: 71.58 ± 3.17- Gender: 6 M / 6 F- Type of stroke: 7 I / 5 H- Affected side: 12 L- Stroke onset (month): 9.08 ± 2.10 | EG: RT using the Amadeo Robotic device (Trymotion GmbH, Graz, Austria). CG: conventional treatments for hemispatial neglect symptoms. (Using a prism and vibration stimulation + compensatory approach) 20 sessions, 30 min, 5/wk for 4 weeks | COGNITIVE OUTCOME:- Line bisection test (LBT) - Albert's Test (AT) - Catherine Bergego Scale (CBS).FOLLOW UP: Pre-treatment (pre) and at the end of treatment (post) | EG: - LBT pre 9.38 ± 0.37; post 6.27 ± 0.36 (P < .001) - AT: pre 7.67 ± 0.64; post 5.00 ± 0.38(P < .01)- CBS pre 20.75 ± 0.79; post 15.83 ± 1.07 (P < .001)CG:- LBT: pre 8.66 ± 0.32; post 7.89 ± 0.34(P < .01) - AT: pre 6.75 ± 0.46; post 5.92 ± 0.45(P > .05)- CBS pre 19.75 ± 0.53; post 18.50 ± 0.37 (P < .05)Results description:The significant differences in changes in the LBT and the AT suggesting that robot-assisted hand training showed a greater improvement in ameliorating hemispatial neglect symptoms compared to the conventional treatment. After intervention, both groups showed a significant improvement in the CBS but there was a statistically significant difference in changes in the EG group (P < .001; η2 = 0.569). This finding indicated that robot-assisted hand training was more clinically beneficial in reducing hemispatial neglect symptoms in the participants’ activities of daily living. |
| **Perini G, 2020** | Randomized controlled pilot studyTo evaluate the efficacy of MeCFES followed by robotic therapy compared to standard care arm rehabilitation for post-stroke patients. | IC: MMSE > 24EC: N/A | EG (n=9)- Mean age: 58.7±20.6 - Gender: 5M / 4F - Type of stroke: N/A- Affected side: 3R/6L- Stroke onset (months): 35.3±44.5 CG (n=9) - Mean age: 61.4±9 - Gender: 4M / 5F- Type of stroke: N/A- Affected side: 3R/6L- Stroke onset (weeks): 42±44.7  | EG: 45 minute Task Oriented (TO) activity session with MeCFES and immediately after a 45-minute session with the planar robot (2 x 45 minutes, 3 sessions per week, x 10).CG: TO activities as part of a standard care protocol (45 minutes, 5 sessions per week x 20) | COGNITIVE OUTCOME: N/AFOLLOW UP: | COGNITIVE RESULTS: N/A |
| **Qian Q, 2017** | Pilot RCTTo investigate the training effects of the device-assisted approach on subacute stroke patients and to compare the effects with those achieved by the traditional physical treatments | IC: MMSE > 21EC: severe aphasia | EG (n=14)- Mean age: N/A- Gender: 5 M / 9 F - Type of stroke: 5 I / 9 H- Affected side: N/A- Stroke onset (days): min/max days after stroke: 25/148CG (n=10) - Mean age: N/A- Gender: 6 M / 4 F- Type of stroke: 4 I / 6 H - Affected side: N/A- Stroke onset (days): min/max days after stroke: 14/142 | EG: upper limb training with the electromyography (EMG)-driven neuromuscular electrical stimulation (NMES)-robotic arm (their invention)CG: traditional therapy20 sessions, 5 d/wk for 4 weeks, 60 min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Qian Q, 2019** | RCTTo investigate the training effectiveness of two different joint-supporting strategies by the driven neuromuscular electrical stimulation (NMES)-robots, i.e. direct support to distal fingers and relatively more proximal support to the wrist-elbow segments, with the same electromyography (EMG)-driven control in UE physical training on chronic stroke patients  | IC: MMSE> 21EC: Severe dysphasia | EG-HAND (n=15)- Mean age: 57.3 ± 8.87 - Gender: 12M / 3F - Type of stroke: 7 I / 8 H- Affected side: N/A - Stroke onset (years): 8.26 ± 4.17 EG-SLEEVE (n=15) - Mean age: 57.7 ± 5.93- Gender: 10M / 5F- Type of stroke: 9I / 6E - Affected side: N/A- Stroke onset (years): 7.87 ± 3.07  | EG-HAND: motor trainings with NMES-robotic (their invention) support to the finger jointsEG-SLEEVE: motor trainings with NMES-robotic (their invention) support to the wrist-elbow joints20 sessions, 3–5 d/wk for 7 consecutive weeks, 60 min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Rabadi M, 2008** | Prospective, randomized controlled studyTo determine the efficacy of activity-based therapies using arm ergometer or robotic or group occupational therapy for motor recovery of the paretic arm in patients with an acute stroke (4 weeks) admitted to an inpatient rehabilitation facility, and to obtain information to plan a large randomized controlled trial. | IC: N/AEC: N/A | EG1 (MITManus) (n=10)- Mean age: 79.5±6.17 - Gender: 5M / 5F - Type of stroke: 10I / 0H- Affected side: N/A- Stroke onset (days): 19.00±4.71EG2 (Ergonometer) (n=10)- Mean age: 69.20±10.22 - Gender: 9M / 1F - Type of stroke: 7I / 3H- Affected side: N/A- Stroke onset (days): 22.20± 15.11 CG (OT) (n=10) - Mean age: 67.80±12.66 - Gender: 5M / 5F- Type of stroke: 10I/ 0H - Affected side: N/A - Stroke onset (days): 22.5±18.22  | EG (MITManus): robot-aided therapy using MITManus robot (designed by the Massachusetts Institute of Technology for clinical neurological applications, built by Interactive Motion Technologies)EG2 (Ergonometer):training with the Monark arm ergometer (Monark-Crescent AB of Sweden)CG: occupational therapy alone based on randomization. 12 sessions, 5 d/wk for 3 weeks, 40 min eachAll patients underwent standard OT e PT for 3 hours per day | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Ranzani R, 2020** | RCTTo evaluate whether robot-assisted therapy of hand function following a neurocognitive approach (i.e., combining motor training with somatosensory and cognitive tasks) produces an equivalent decrease in upper limb motor impairment compared to dose-matched conventional neurocognitive therapy, when embedded in therehabilitation program of inpatients in the subacute stage after stroke | IC: N/AEC: severe aphasia (Goodglass and Kaplan test < 1), severe cognitive deficits (Levels of Cognitive Functioning-Revised, LCF-R < 6) | EG (n=14)- Mean age: 70.00  ±  12.79- Gender: 10 M / 4 F- Type of stroke: 13 I / 1 H - Affected side: 8 L / 6 R- Stroke onset (weeks): 3.14  ±  1.51 CG (n=13) - Mean age: 67.46 ±  11.39- Gender: 8 M / 5 F- Type of stroke: 5 I / 7 H / 1 both- Affected side: 7 L / 6 R- Stroke onset (weeks): 3.08 ± 1.32 | EG: neurocognitive RT using ReHapticKnob haptic deviceCG: dose-matched conventional neurocognitive therapy (Perfetti) focused on hand function Both groups underwent neurocognitive sessions15 sessions, 4 d/wk for 4 weeks, 45 min each | COGNITIVE OUTCOME:- Mini Mental StateExamination (MMSE)- Albert Test (AT)- Frontal AssessmentBattery (FAB) FOLLOW UP: Pre-Treatment(T0), End of treatment (T1), 8 weeks FOLLOW UP(T2) and 6 months FOLLOW UP (T3)  | EG: - MMSE T0: 25.89 ± 3.60.Change from baseline, Mean (SD):T1: + 0.57 (1.91); T2: + 0.93 (1.64); T3: + 1.71 (3.07)- FAB T0 14.60 (2.38)Change from baseline, Mean (SD): T1: + 0.43 (1.74); T2: + 1.14 (1.70); T3: + 1.61 (1.67)- AT: T0 31.86 (0.36)Change from baseline, Mean (SD): T1: + 0.07 (0.27); T2: + 0.07 (0.48); T3: + 0.14 (0.36)CG: - MMSE T0 23.62 (5.47)Change from baseline, Mean (SD): T1: + 1.05 (1.87); T2: + 0.59 (2.41); T3: + 0.93 (3.33)- FAB: T0 11.98 (5.29); Change from baseline, Mean (SD): T1: + 1.26 (1.71); T2: + 1.49 (1.76); T3: + 1.05 (1.60)- AT: T0 31.77 (0.83)Change from baseline, Mean (SD): T1: + 0.15 (0.90); T2: + 0.15 (0.56); T3: + 0.08 (0.28)Only minor improvements were observed in both groups over time in cognitive functions. These changes were small mostly due to the saturation of these scales in a mildly/moderately impaired population, and did not show significant changes between the groups and over time following T1. |
| **Rodgers H, 2019** | Randomized controlled trial (RCT)To establish whether robot-assisted training improved upper limb function after a stroke compared with an enhanced upper limb therapy (EULT) program of the same frequency and duration and usual care alone. | IC: N/AEC: N/A | EG-RAT: (n=257)- Mean age: 59.9±13.5 - Gender: 156M / 101F - Type of stroke: 197 I / 60 E- Affected side: 112 R/ 145L- Stroke onset (days): 233; (102–549) EG-EULT: (n=259)- Mean age: 59.4±14.3 - Gender: 159M/100F - Type of stroke: 202 I / 57 E- Affected side: 116R /143L- Stroke onset (days): 258; (115–546)CG: (n=254) - Mean age: 62.5±12.5 - Gender: 153M / 101F- Type of stroke: 214 I / 40 E - Affected side: 113R / 141L- Stroke onset (days): 242; (107–549) | EG-RAT: robot-assisted training programme integrated with all three modules of the MIT-Manus robotic gym (shoulder–elbow module, wrist module, hand module integrated on to the shoulder–elbow module).EG-EULT: repetitive functional task practice to work towards participant-centred goalsCG: usual National Health Service care, which was provided by their local clinical service12 sessions, 3 d/wk for 4 weeks, 45 min each | COGNITIVE OUTCOME: N/AFOLLOW UP: | COGNITIVE RESULTS: N/A |
| **Rosenthal O, 2019** | Pilot RCTHypothesis: rehabilitation can be optimized by selecting the movements to be practiced based on the trainee’s performance profile. | IC: preserved basic cognitive function including under- standing instruction as assessed by MMSEEC: N/A | EG (n=7)- Mean age: 61.43 ± 8.81 - Gender: 5 M / 2 F - Type of stroke: N/A- Affected side: 5 dominant; 2 not dominant- Stroke onset (years): 3.71 ± 2.55 CG (n=9) - Mean age: 55.67 ± 16.61 - Gender: 5 M / 4 F- Type of stroke: N/A - Affected side: 6 dominant; 3 not dominant- Stroke onset (years): 4.11 ± 2.93  | EG: RT steepest gradients-based training, iteratively selected according to the steepest gradients principle with weekly remapping.CG: RT with standard “centre-out” reaching training\*RT using vBOT – robotic manipulandum20 sessions, 4 d/wk for 5 weeks. Session duration was not specified | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Sale P, 2014** | RCT To evaluate if intensive robot-assisted hand therapy compared with intensive occupational therapy in the early recovery phases after stroke with a 3-month follow-up. | IC: MMSE > 20; ability to understand and follow simple instructionsEC: cognitive impairment that would influence the ability to comprehend or perform the experiment | EG (n=11)- Mean age: 67.0 ± 12.4 - Gender: 8 M / 3 F - Type of stroke: 8 I / 3 H- Affected side: N/A- Stroke onset (weeks): N/A\*CG (n=9) - Mean age: 72.56 ± 8.98 - Gender: 6 M / 3 F- Type of stroke: 7 I / 2 H - Affected side: N/A- Stroke onset (weeks): N/A\*\*IC: The study included only patients enrolled 30±7 days after the event onset | EG: RT using Amadeo Robotic System (Tyromotion, Austria)CG: OT executed by a trained physiotherapist.Both groups underwent 3h/day of physiotherapy according to individually tailored exercise scheduling20 sessions, 5 d/wk for 4 weeks, 40 min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Serrezuela RR, 2020** | Pilot RCTTo determine if robotic therapy of Hemiplegic Shoulder Pain (HSP) could lead to functional improvement in terms of diminishing of pain, spasticity, subluxation, the increasing of tone and muscle strength, and the satisfaction degree. | IC: N/AEC: cognitive deficits that made it difficult to understand and follow instructions | EG (n=8)- Mean age: 65.38 ± 6.25 - Gender: 5 M / 3 F - Type of stroke: 8 I / 0 H- Affected side: N/A- Stroke onset (months): 6.25 ± 5.09 CG (n=8) - Mean age: 64.35 ± 12.61- Gender: 4 M / 4 F- Type of stroke: 8 I / 0 H - Affected side: N/A- Stroke onset (months): 4.25 ± 1.16 | EG: antigravitational movements using a grounded robotic platform of 4 freedom degrees developed by Mechanical and Industrial Engin- eering DepartmentCG: lymphatic massage and kinesitherapy that included the same movements practiced by robotic therapy group + 15 min of thermotherapy60 sessions, 5 d/wk for 3 months, 60 min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Straudi S, 2019** | Single-blinded RCTTo compare the effects of unilateral, proximal arm robot-assisted therapy combined with hand functional electrical stimulation to intensive conventional therapy for restoring arm function in subacute stroke survivors. | IC: N/AEC: MMSE < 21; presented with neurological conditions in addition to stroke that may affect motor function, | EG (n= 19)- Mean age\*: 68 (56-71)- Gender: 12 M / 7 F - Type of stroke: I / h N/A; Subcortical: 9 / Cortical 6 / Brainstem: 4.- Affected side: dominant; not dominant- Stroke onset (days)\*: 39 (21-62)CG (n= 20) - Mean age\*: 68 (58.5-73)- Gender: 12 M / 8 F- Type of stroke: I / H N/A; Subcortical: 10 / Cortical 9 / Brainstem: 1.- Affected side: dominant; not dominant- Stroke onset (days)\*: 32.5 (20-51) \*Median (interquartile range) | EG: robot-assisted arm therapy using Reo Therapy System (Motorika Medical Ltd, Israel) and hand functional electrical stimulation (RAT + FES).CG: intensive conventional therapy (ICT)30 sessions, 5 d/wk for 6 weeks, 100 min each  | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Susanto EA, 2015** | Pilot RCTTo evaluate the potential efficacy of intention-driven robot-assisted fingers training in chronic stroke patients | IC: MMSE > 21EC: other neurological diseases | EG (n=9)- Mean age: 50.7 ± 9.0 - Gender: 7 M / 2 F - Type of stroke: 6 I / 3 H- Affected side: dominant;/not dominant; 6 L / 3 R- Stroke onset (months): 16.4 ± 5.8 CG (n=10) - Mean age: 55.1 ± 10.6- Gender: 7 M / 3 F- Type of stroke: 5 I / 5 H- Affected side: dominant/not dominant: N/A; 6 L / 4 R- Stroke onset (months): 16.1 ± 5.1 | EG: robot-assisted fingers training group design by the research groupCG: non-assisted fingers training group+ 10 min of stretching before sessions20 sessions, 3 or 5 d/wk within 5 consecutive weeks. 60 min each  | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Takahashi K, 2016** | Prospective, open, blinded end point, randomized, multicenter exploratory clinical trialTo study the efficacy of robotic therapy as an adjuvant to standard therapy during post-stroke rehabilitation | IC: N/AEC: Severe aphasia | EG (n=30)- Mean age: 65.2±10.9 - Gender: 21 M / 9 F - Type of stroke: 30 I / 0 H- Affected side: N/A- Stroke onset (days): 47.8±7.0 CG (n=26) - Mean age: 64.6±11.5 - Gender: 18 M / 8 F- Type of stroke: 26 I / 0 H - Affected side: N/A- Stroke onset (days): 46.9±8.1  | EG: RT using ReoGo (Motorika Medical, Caesaria, Israel)CG: 40 min of self-guided therapyBoth groups underwent 40 min of standard therapy 42 sessions, daily for 6 weeks, 40 min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Taveggia G, 2016** | Randomized controlled studyTo evaluate the effectiveness of robotic-assisted motion and activity in addition to PRM for the rehabilitation of the upper limb in post-stroke inpatients | IC: N/AEC: aphasia or cognitive problems (MMSE≤21) | EG (n=27)- Mean age: 73 ± 10 - Gender: 9 M / 18 F - Type of stroke: N/A - Affected side: N/A - Stroke onset (months)\*: N/ACG (n=27) - Mean age: 68 ± 13 - Gender: 14 F/ 13 M- Type of stroke: N/A - Affected side: N/A - Stroke onset (months)\*: N/A\*Stroke time was not specified: CI: between 0.5 and 12 months post-onset | EG: RT using for Armeo Spring exoskeleton device (Hocoma Inc., Zurich, Switzerland) + 30 minutes per session with conventional treatment CG: conventional treatment, such as passive and active assisted mobilization of the upper limbs traditional training based on the Bobath concept30 sessions, 5 d/wk for 6 weeks, 30 (CG) or 60 (EG) min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Timmermans AA, 2014** | Randomized controlled trialTo investigate the effectiveness and added value of the Haptic Master robot combined with task-oriented arm hand training in chronic stroke patients. | IC: fair to good cognitive level (Mini Mental State Examination (MMSE) score ≥ 26), able to read and understand the Dutch languageEC: severe neglect, severe additional neurological impairment, Broca aphasia, Wernicke aphasia, global aphasia | EG (n=11)- Mean age: 61.8 ± 6.8 - Gender: 8 M / 3 F- Type of stroke: N/A- Affected side: dominant/non dominant: N/A; 4 R / 7 L- Stroke onset (years): 2.8±2.9 CG (n=11) - Mean age: 56.8 ± 6.4 - Gender: 8 F / 3 M - Type of stroke: N/A- Affected side: dominant/non dominant: N/A; 3 R / 8 L- Stroke onset (years): 3.7±3.0  | EG: The experimental group, by combining the T-TOAT (Technology-supported Task-Oriented Arm Training) method with the use of a Haptic Master robot (MOOG, Nieuw-Vennep, NL), received trajectory guidance through haptic feedbackCG: upper extremity movements without support64 sessions, , 4 d/wk twice a day for 8 weeks, 30 each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Tomić TJ, 2017** | Single-blind randomized Clinical TrialTo determine preliminary efficacy of the AA robotic device in comparison to the matched conventional arm training in subacute stroke patients undergoing rehabilitation | IC: N/AEC: N/A | EG (n=13)- Mean age: 56.5 ± 7.4 - Gender: 12 M / 1 F - Type of stroke: 12 I / 1 H- Affected side: dominant/non dominant: N/A; 5L / 8R- Stroke onset (weeks): 35.3 ± 9.7CG (n=13) - Mean age: 58.3 ± 5.2- Gender: 9 M / 4 F- Type of stroke: 11 I / 2 H - Affected side: dominant/non dominant: N/A; 6 L / 7 R- Stroke onset (weeks): 37.3 ± 7.7 | EG: RT using ArmAssist robotic system (TECNALIA R&I, Spain) training.CG: conventional rehabilitation and an additional Both groups underwent 30 minutes of OT15 sessions, 5 d/wk for 3 weeks, 30 min each. | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Tramontano M, 2020** | Two-arm single-blind randomized controlled trialTo evaluate the effects of a sensor-based technology on the upper limbs motor recovery in patients with stroke during post-acute neurorehabilitation. | IC: Mini-Mental State Examination (MMSE) ≥ 24EC: cognitive deficits affecting the ability to understand task instructions (MMSE <24) | EG (n=19)- Mean age: 56.8 ± 9.2- Gender: 15 M / 4 F - Type of stroke: 10 I / 9 H- Affected side: N/A- Stroke onset (months): 4.79 ± 0.79CG (n=18) - Mean age: 60.2 ± 14.9 - Gender: 12 M / 6 F- Type of stroke: 9 I / 9 H- Affected side: N/A- Stroke onset (months): 4.89 ± 0.66 | EG: RT upper limb training with PABLO®-Tyromotion. The training consisted in interactive-games based on virtual reality which allowed a task-oriented approach and a neurocognitive feedbackCG: Upper limb sensory-motor training12 sessions, 3 d/wk for 4 weeks, 40 min eachBoth groups underwent conventional neurorehabilitation. | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Vanoglio F, 2017** | Pilot RCTTo evaluate the feasibility and efficacy of robot-assisted hand rehabilitation in improving arm function abilities in sub-acute hemiplegic patients | IC: N/AEC: severe cognitive and behavioral disorders | EG (n=15)- Mean age: 72 ± 11 - Gender: 7/8 - Type of stroke: 10/5- Affected side: 4 dominant; 11 not dominant; 4 R / 11 L- Stroke onset (days): 15.2 ± 6.8 CG (n=15) - Mean age: 73 ± 14 - Gender: 7 M / 8 F- Type of stroke: 9 I / 6 H - Affected side: 5 dominant; 10 not dominant; 5 R / 10 L- Stroke onset (days): 17.8 ± 7.9 | EG: the affected hand was passively moved by the glove Gloreha Professional (Idrogenet, Lumezzane, Italy)CG: the physiotherapist passively moved the affected hand. 30 sessions, 5 d/wk for 6 weeks, 40 min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Villafañe JH, 2018** | Double blind randomized clinical trialTo determine the efficacy of robot assisted motion in addition to traditional physiotherapy (PT) and occupational therapy (OT) compared with additional time spent in PT and OT on stroke patients with hand paralysis on function, motor strength, spasticity, and pain | IC: N/AEC: severe spatial neglect, aphasia, or cognitive problems. | EG (n=16)- Mean age: 67±11 - Gender: 11/5 - Type of stroke: 12/4- Affected side: dominant/non dominant: N/A; 7R/9L- Stroke onset (weeks): N/A\* CG (n=16) - Mean age: 70 ± 12 - Gender: 10 M / 6 F- Type of stroke: 12 I / 4 H- Affected side: dominant/non dominant: N/A; 8 R / 8 L- Stroke onset (weeks): N/A\* \*Stroke onset was not specified: CI: between 0.5 and 12 months post onset | EG: RT using Gloreha (Brescia, Italy)CG: Additional PT and OTBoth groups performed a 1 hour sessions 5 days per week of both PT and OT.15 sessions, 3 d/wk for 5 weeks, 30 min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Volpe BT, 2000** | RCTTo test whether additional sensorimotor exercise delivered by a robotic device improved the motor outcome as measured by decreased impairment specific to the exercised limb, and whether it had an impact on disability | IC: to be able to follow simple instructions.EC: N/A | EG (n=30); - Mean age: 62 ± 2- Gender: 16 M / 14 F - Type of stroke 26 I / 4 H - Affected side: 17 L / 13 R\_ Stroke onset (days): 14.0 ± 0.9 CG (n=26) - Mean age: 67 ± 2 - Gender: 14 M / 12 F- Type of stroke: 23 I / 3 H- Affected side: 14 L / 12 R- Stroke onset (days): 15.8 ± 1.3 | EG: Robotic therapy with Mit-Manus (Interactive Motion Technologies, Cambridge, MA).CG: Pt and OT therapy + exposure to the robot (half the trials were performed with the unimpaired upper limb) performed 1 h/wk 25 sessions, 5 d/wk for 5 weeks, 60 min each. All patients experienced similar standard physical and occupational poststroke therapy. | COGNIYIVE OUTCOME:- Functional Independence Measure (FIM) Cognition score FOLLOW UP: Pre-treatment (pre), and after treatment (post) | EG: FIM Cognition score pre: 26.0 ± 4.0; post: 31.5 ± 3.5 (change to baseline p<0.001)CG: FIM Cognition score pre: 17.0 ± 5.5; post: 23.5 ± 5.5 (change to baseline p<0.001)The robot-trained group was better on the FIM cognition scores but both groups improved comparably from pre- to post-treatment. A definitive conclusion about the link among decreased upper limb motor impairment, increased motor function, and decreased disability is not possible because the scores were not assessed with the restriction of using only the affected or the unaffected upper limb |
| **Wolf SL, 2015** | Prospective, multi-site, single-blind RCTTo determine the efficacy of a home-based telemonitored robotic-assisted therapy as part of a home exercise program (HEP) compared with a dose-matched HEP-only intervention among individuals less than 6 months post-stroke and characterized as underserved. | IC: preserved cognitive function (a score of ≤3 on the Short Portable Mental Status Questionnaire)EC: hemispatial neglect (asymmetry > 3 errors on the Star Cancellation Test) | EG (n=51)- Mean age: 59.1±14.1 - Gender: 25 M / 26 F - Type of stroke: N/A- Affected side: 20R/31L- Stroke onset (days): 115.5±53.1CG (n=48) - Mean age: 54.7±12.2 - Gender: 31 M / 17 F- Type of stroke: N/A- Affected side: 23 R / 25 L- Stroke onset (days): 127.1±46.2 | EG: 2 hours of Hand Mentor Pro (HMP) robotic training modules and 1 hour of HEP CG: 2 hours of UE exercises of self-range of motion; weight-bearing activities; active assisted exercises with cane; shoulder exercises; elbow/forearm exercises; wrist/hand exercises and task-based activities; 1 hour of functional activities40 sessions, 5 d/wk for 8 weeks, 180 min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Wu CY, 2012** | Clinical Trial (randomized, pretest-posttest, control group)To compare the efficacy of therapist-based bilateral arm training (TBAT), robot-assisted bilateral arm training (RBAT), and a control treatment (CT) on motor control, functional performance, and quality of life after chronic stroke. | IC: no serious cognitive deficits (Mini-Mental State Examination score ≥ 22)EC: N/A | EG-RBAT (n=14)- Mean age: 55.13±12.72 - Gender: 10 M / 4 F - Type of stroke: N/A- Affected side: N/A- Stroke onset (months): 18±8.65 EG-TBAT (n=14)- Mean age: 57.04±8.78 - Gender: 12 M / 2 F - Type of stroke: N/A- Affected side: N/A- Stroke onset (months): 17.29±13.29 CG (n=14) - Mean age: 51.30±6.23 - Gender: 10 M / 4 F- Type of stroke: N/A- Affected side: N/A- Stroke onset (months): 17.57±9.8  | EG-RBAT: RBAT using Bi-Manu-Track (Reha-Stim Co, Berlin, Germany). + 15 to 20 minutes of unilateral and bilateral functional training and 5 minutes of tone normalizationEG-TBAT: bilateral functional tasks under one-on-one supervision of the therapists + 15 to 20 minutes of functional training and 5 minutes of tone normalizationCG (CT): weight bearing, stretching, strengthening of the paretic arms, coordination, unilateral and bilateral fine motor tasks, balance, and compensatory practice on functional tasks20 sessions, 90- to 105- minute therapy session, 5 times per week, for 4 week | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Xu Q, 2020** | RCTTo explore the impact of rehabilitation robot training (RRT) on upper limb motor function and daily activity ability in patients with stroke. | IC: N/AEC: patients with aphasia; patients with cognitive impairment | EG (n=20)- Mean age: 62.2±10.1 - Gender: 15 M / 5 F - Type of stroke: 16 I / 4 H- Affected side: N/A- Stroke onset (days): 51.0±19.1 CG (n=20) - Mean age: 60.7 ± 10.6- Gender: 14 M / 6 F- Type of stroke: 17 I / 3 H- Affected side: N/A- Stroke onset (days): 47.2 ± 24.0  | EG: upper limb robot assistance + traditional therapy CG: traditional therapy30 sessions, 5 d/wk for 6 weeks, 40 min each | COGNITIVE OUTCOME: N/AFOLLOW UP: N/A | COGNITIVE RESULTS: N/A |
| **Zengin-Metli D, 2018** | Prospective RCTTo evaluate the effects of robotic rehabilitation on upper extremity functions, cognitive development, and activities of daily living in patients with subacute stroke | IC:EC: | EG(n=20)- Mean age: 59.25 ± 8.10 - Gender: 15 M / 5 F - Type of stroke: N/A - Affected side: 4 dominant; 16 not dominant- Stroke onset (weeks): 11.33 ± 5.26 CG (n=15) - Mean age: 63,27 ± 3,88- Gender: 6M / 9F- Type of stroke: N/A- Affected side: 7 dominant; 8 not dominant- Stroke onset (weeks): 10.7 ± 4.9 | EG: RT using Armeo Spring HocomAG Inc. (Volketswill, Switzerland) for 15 sessions, 5/week for 3 weeks (30 min x session) + coventional rehabilitation program (15 sessions 5 d/w for 3 weeks).CG): conventional program consisted in a dose matched neurophysiological exercise program with Brunnstrom approach (range of motion exercises, and postural education) | COGNITIVE OUTCOME:- Functinal Indipendence Measure (FIM) Cognition score- Mini Mental State Examination (MMSE)FOLLOW UP: Pre-treatment (pre); post-treatment after 3 weeks (post) | EG: - FIM Cognition score pre: 31.85 ± 3.66; post: 34.25 ± 1.77 (change to baseline p<0.002)- MMT score pre: Moderate 2 (66.67%), Mild 1 (14.3%) and Normal 17 (68%); post: Moderate 2 (66.67%), Mild 0 (0%), Normal 18 (60%)p= 0.317CG: - FIM Cognition score pre: 27.6 ± 7.55; post: 32.07 ± 6.26 (change to baseline p<0.002)- MMT score pre: Moderate 1 (33.3%), Mild 6 (85,7%), Normal 8 (32%); post: Moderate 1 (33.3%); Mild 2 (100%); Normal 12 (40%)p= 0.046MMT increased only in the CG maybe because a significant difference was observed between the robot and the CG in terms of pre-treatment MMT levels: 17 of 20 patients in EG were in the normal cognitive level, while 8 in the CG were normal and 6 were mild cognitive impairment in the CG. Probably on the basis of this difference a significant increase in the CG was obtained only in terms of MMT levels |
|  CG: Control Group; d/wk: day per week; EC: Exclusion Cognitive Criteria; EG: Experimental Group; IC: Inclusion Cognitive Criteria; F: Female; H: Hemorrhagic; I: Ischemic; K-MMSE: Korean version of Mini Mental State Examination; L: Left; M: Male; MMSE: Mini Mental State Examination; OT: occupational therapy; PT: physical therapy R: Right; RT: Robot Therapy |