CANADIAN STROKE BEST PRACTICE RECOMMENDATIONS

Rehabilitation and Recovery following Stroke Evidence Tables

Management of the Arm and Hand Following Stroke

Teasell R, Salbach NM (Writing Group Chairs)
on Behalf of the Canadian Stroke Best Practice Recommendations
Rehabilitation and Recovery following Stroke Writing Group

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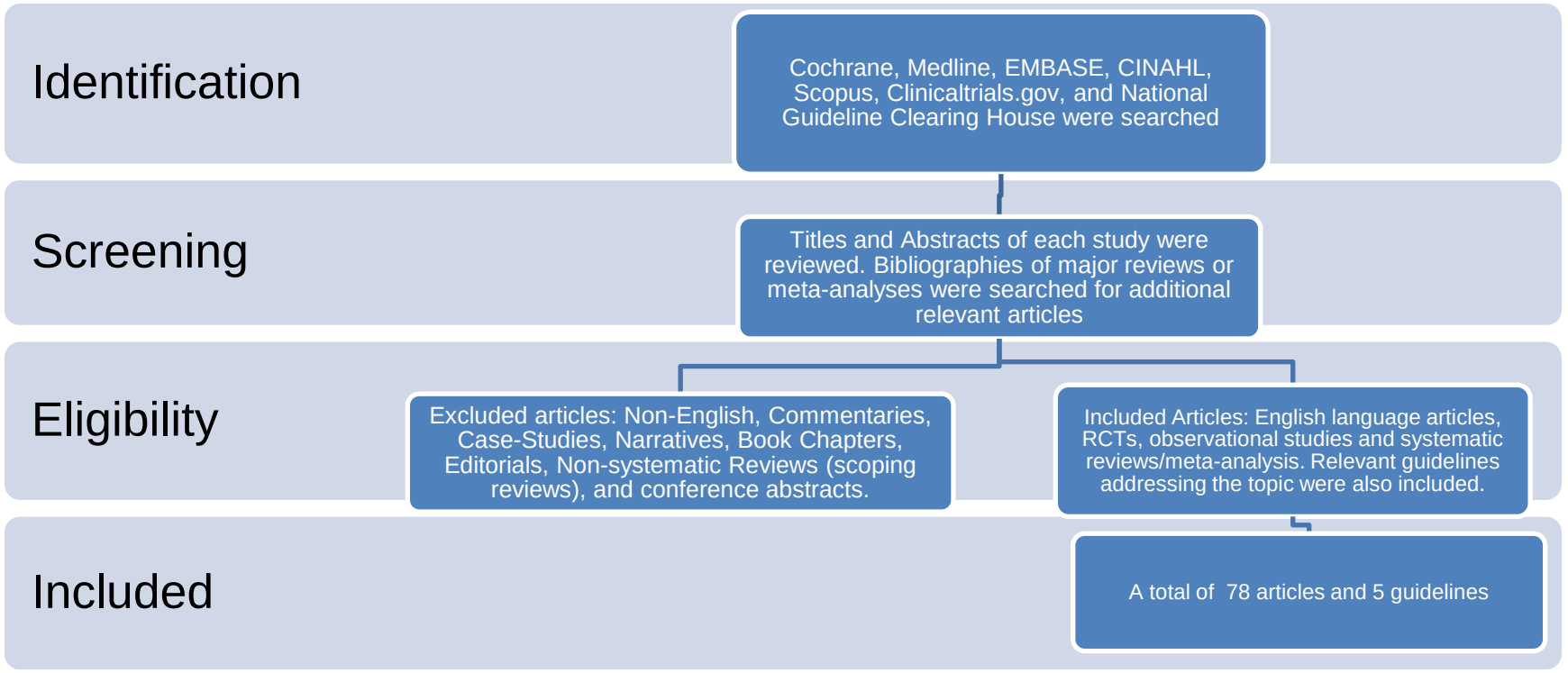
Search Strategy



Cochrane, clinicaltrials.gov, Medline, EMBASE, CINAHL, Scopus were searched using the keywords: Stroke AND (“upper extremity” OR “upper limb” OR “hand” OR “arm”) AND (rehabilitation OR therapy OR intervention). Titles and abstract of each article were reviewed for relevance. Bibliographies were reviewed to find additional relevant articles. Articles were excluded if they were: non-English, commentaries, case-studies, narrative, book chapters, editorials, non-systematic review, or conference abstracts. Additional searches for relevant best practice guidelines were completed and included in a separate section of the review. A total of 78 articles and 5 guidelines were included and were separated into separate categories designed to answer specific questions.

Published Guidelines

Guideline	Recommendations
Clinical Guidelines for Stroke Management 2017. Melbourne (Australia): National Stroke Foundation.	Strong Recommendation For stroke survivors with some active wrist and finger extension, intensive constraint-induced movement therapy (minimum 2 hours of active therapy per day for 2 weeks, plus restraint for at least 6 hours a day) should be provided to improve arm and hand use. Trunk restraint may also be incorporated into the active therapy sessions at any stage post-stroke. Weak Recommendation For stroke survivors with mild to severe arm weakness, mechanically assisted arm training (e.g. robotics) may be used to improve upper limb function. Strong Recommendation AGAINST Hand and wrist orthoses (splints) should not be used as part of routine practice as they have no effect on function, pain or range of movement. Weak Recommendation For stroke survivors with mild to moderate arm impairment, virtual reality and interactive games may be used to improve upper limb function. Virtual reality therapy should be provided for at least 15 hours total therapy time and is most effective when used in the first six months after stroke. Weak Recommendation For stroke survivors with mild to severe arm or hand weakness, electrical stimulation in conjunction with motor training may be used to improve upper limb function. Weak Recommendation For stroke survivors with mild to moderate weakness of their arm, mental practice in conjunction with active motor training may be used to improve arm function. Weak Recommendation For stroke survivors with mild to moderate weakness, complex regional pain syndrome and/or neglect, mirror therapy may be used as an adjunct to routine therapy to improve arm function after stroke. Weak Recommendation For stroke survivors with at least some voluntary movement of the arm and hand, repetitive task-specific training may be used to improve arm and hand function
Intercollegiate Stroke Working Party. National clinical guideline for stroke, 5th edition. London: Royal College of Physicians, 2016.	**4.2.1 Recommendations** A People with stroke with potential or actual arm movement should be given every opportunity to practice functional activities. Practice should be characterised by movements that are of high intensity, repetitive and are task-specific. These activities may be bilateral or unilateral depending on the task. B People with stroke who have 20 degrees of active wrist extension and 10 degrees of active finger extension in the affected hand should be considered for constraint-induced movement therapy.

Guideline	Recommendations
	C People with stroke who have been assessed as cognitively suitable to participate in mental practice of an activity should be trained and encouraged to use it to improve arm function, as an adjunct to conventional therapy. D People with reduced arm function after a stroke should only be offered robot-assisted movement therapy or neuromuscular electrical stimulation as an adjunct to conventional therapy in the context of a clinical trial. E People without movement in the affected arm after a stroke should be trained in how to care for their affected arm and monitored for any change.
Winstein CJ, Stein J, Arena R, Bates B, Cherney LR, Cramer SC, Deruyter F, Eng JJ, Fisher B, Harvey RL, Lang CE, MacKay-Lyons M, Ottenbacher KJ, Pugh S, Reeves MJ, Richards LG, Stiers W, Zorowitz RD; on behalf of the American Heart Association Stroke Council, Council on Cardiovascular and Stroke Nursing, Council on Clinical Cardiology, and Council on Quality of Care and Outcomes Research. **Guidelines for adult stroke rehabilitation and recovery: a guideline for healthcare professionals from the American Heart Association/American Stroke Association.** ***Stroke* 2016;47:e98–e169**	Functional tasks should be practiced; that is, task-specific training, in which the tasks are graded to challenge individual capabilities, practiced repeatedly, and progressed in difficulty on a frequent basis. Class I; LOE A All individuals with stroke should receive ADL training tailored to individual needs and eventual discharge setting. Class I; LOE A All individuals with stroke should receive IADL training tailored to individual needs and eventual discharge setting. Class I; LOE B CIMT or its modified version is reasonable to consider for eligible stroke survivors. Class IIa; LOE A Robotic therapy is reasonable to consider to deliver more intensive practice for individuals with moderate to severe upper limb paresis. Class IIa; LOE A NMES is reasonable to consider for individuals with minimal volitional movement within the first few months after stroke or for individuals with shoulder subluxation. Class IIa; LOE A Mental practice is reasonable to consider as an adjunct to upper extremity rehabilitation services. Class IIa; LOE A Strengthening exercises are reasonable to consider as an adjunct to functional task practice. Class IIa; LOE B Virtual reality is reasonable to consider as a method for delivering upper extremity movement practice. Class IIa; LOE B Somatosensory retraining to improve sensory discrimination may be considered for stroke survivors with somatosensory loss. Class IIb; LOE B Bilateral training paradigms may be useful for upper limb therapy. Class IIb; LOE A Acupuncture is not recommended for the improvement of ADLs and upper extremity activity. Class III; LOE A
Scottish Intercollegiate Guidelines Network (SIGN). **Management of patients with stroke: rehabilitation, prevention and management of complications, and discharge planning. A national clinical guideline.**	*4.3.1 Upper-Limb Function-Summary of Recommendations* **Consider** constraint induced movement therapy; mental practice; electromechanical/robotic devices **Not recommended** repetitive task training/splinting; increased intensity of rehabilitation **Insufficient evidence**

Guideline	Recommendations
Edinburgh (Scotland): SIGN; 2010 Jun. p.19	Electrostimulation; routine EMG biofeedback; virtual reality; bilateral training; approach to therapy
Management of Stroke Rehabilitation Working Group. **VA/DoD clinical practice guideline for the management of stroke rehabilitation.** **Washington (DC): Veterans Health Administration, Department of Defense; 2010. p. 96**	*13.6 Recommendations* 1. Recommend that UE functional recovery should consist of the practice of functional tasks, emphasizing progressive difficulty and repetition. 2. Recommend that treatment should be tailored to the individual patients considering the intervention that are most appropriate, engaging the patient, and are accessible and available. 3. Recommend Constraint-Induced Movement Therapy (CIMT) for individuals with at least 10 degrees of extension in two fingers, the thumb and the wrist. **A** 4. Recommend robot-assisted movement therapy as an adjunct to conventional therapy in patients with deficits in arm function to improve motor skill at the joints trained. **B** 5. Recommend bilateral practice to improve UE function. **B** 6. Recommend treatment with FES for patients who have impaired upper extremity muscle contraction, specifically with patients with elbow/wrist motor impairment. **B** 7. Recommend FES for patients who have shoulder subluxation. **B** 8. Consider FES and mental practice combined with repetitive and intense motor practice of functional tasks. **B** 9. Consider strengthening exercises in addition to functional task practice. **C** 10. Consider virtual reality as practice context. **C** 11. Insufficient evidence to recommend Mirror therapy. **I** 12. Do NOT use repetitive practice of movements in rehabilitation of upper extremity.

Evidence Tables

Repetitive Task Training

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Systematic Reviews					
French et al. 2016 **UK** **Cochrane Review**	Low-quality evidence on GRADE.	6 RCTs specific to upper limb, 3 trials of both upper and lower limb, and 2 trials of whole therapy approaches (from a total of 33 trials). Subjects were in the acute phase in 10 trials, the subacute phase in 14 trials, and the chronic phase in 9 trials.	Comparison of repetitive task training protocols to various control conditions (attention control or usual care). Dosage ranged from <10hr to >40hr, with most trials providing 10-21hr. Duration ranged from 2wk to 20wk, with most trials providing 2-4wk.	**Primary outcomes:** Action Research Arm Test, Frenchay Arm Test, Motor Assessment Scale, Wolf Motor Function Test, Southern Motor Group Assessment, Box & Block Test, 9/10-Hole Peg Test, Functional Test of the Hemiparetic Upper Extremity, Stroke Impact Scale Outcomes were assessed before and after treatment.	Arm function: SMD=0.25, 95% CI 0.01 to 0.49; 11 studies, 749 subjects Hand function: SMD=0.25, 95% CI 0.00 to 0.51; 8 trials, 619 subjects Upper limb, ≤6mo follow-up: SMD=0.92, 95% CI 0.58 to 1.26; 3 trials, 153 subjects Adverse events: Insufficient evidence.
Langhorne et al. 2009 **UK** **Systematic review & meta-analysis**	N/A	8 RCTs specific to upper limb were identified in a Cochrane review (French et al. 2007) from a total of 14 studies. Subjects in 6 studies were recruited within the first week up to 50 days post stroke; the remainder were recruited in the chronic phase of stroke.	Comparison of task-specific training protocols (with or without routine rehabilitation) to control conditions (other therapy approaches or a lower-limb therapy program). Dosage ranged from a total of 20hr to 63hr. ranged from 2wk to 11wk.	**Primary outcomes:** Motor Assessment Scale, Jebsen Taylor Hand Function Test, Upper Extremity Function Test, Action Research Arm Test, Southern Motor Group Assessment, 10-Hole Peg Test, Rivermead Motor Assessment, Wolf Motor Function Test Outcomes were assessed before and after treatment. In 5 studies, there were follow- up periods of 4, 6, and 9 months and 4	Arm function: SMD=0.19, 95% CI -0.01 to 0.38, p>0.05 (414 subjects) Hand function: SMD= 0.05, 95% CI (-0.18 to 0.29, p>0.05 (281 subjects) Adverse events: No reporting (Authors recommended that task-specific training should be used improve ADLs)

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
				years.	
Clinical Trials					
Turton et al. 2017 **UK** **RCT**	CA: ☑ Blinding: Patient ☒ Assessor ☑ ITT ☒	47 subjects in the subacute phase of stroke (treatment=112d; control=135d) with upper limb deficit.	Subjects were randomized to receive conventional rehabilitation alone or with reach-to-grasp training (RTG). RTG consisted of 14 1hr-sessions over 6wk, with 1hr/d of self-practice.	**Primary outcomes:** Action Research Arm Test (ARAT), Wolf Motor Function Test (WMFT), Motor Activity Log (MAL) Outcomes were assessed at baseline, 7wk, 12wk, and 24wk.	ARAT scores improved over time in the RTG group but not in the control group. WMFT and MAL scores improved over time in both groups. No within- or between-group statistical analyses were reported.
Hubbard et al. 2015 **Australia** **RCT**	CA: ☑ Blinding: Patient ☒ Assessor ☑ ITT ☒	23 subjects in the acute phase of stroke (<1wk) with Motor Assessment Scale – Upper Limb scores ≤16.	Subjects were randomized to receive conventional rehabilitation alone or with intensive training. Rehabilitation consisted of 6 (mean) therapy visits. Intensive training consisted of repetitive, task-specific exercises 2hr/d, 5d/wk for 3wk.	**Primary outcomes:** Motor Assessment Scale – Upper Limb (MAS-UL), 1mo, and 6mo.	At 1mo, both groups showed significant improvement on the MAS-UL, which was maintained up to 3mo. There was no significant difference between groups at any time point.
Shimodozono et al. 2013 **Japan** **RCT**	CA: ☑ Blinding: Assessor ☑ Patient ☑ ITT: ☑	49 subjects in the subacute phase of stroke (experimental=6.4±2.1wk; control=7.4±3.0wk) with Brunnstrom Proximal Upper-Limb stage ≥III.	Subjects were randomized to receive repetitive facilitative exercise (RFE) or conventional rehabilitation. Both groups received 40min sessions 5x/wk for 4wk of their allocated treatment. Both groups performed 30min/d of dexterity-related training immediately after each session. Both groups participated in a standard inpatient rehabilitation program. RFE involved 100 standardized movements of ≥5 joints of affected upper limb.	**Primary Outcomes:** Action Research Arm Test (ARAT), Fugl-Meyer Assessment (FMA) Outcomes were assessed at baseline, 2wk, and 4wk.	After 4 weeks of treatment, there were significantly greater improvements in ARAT (p=0.009) and FMA (p=0.019) scores for the RFE group compared to the control group.
Han et al. 2013	CA: ☑	32 subjects in the subacute phase of stroke (A=41±19d;	Subjects were randomized into one of three groups.	**Primary Outcomes:** Fugl-Meyer Assessment	After 2wk, there were no significant between-group differences in FMA and

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
China **RCT**	Blinding: Assessor ☑ Patient ☒ ITT: ☒	B=43±38d; C=38±21d) with impaired upper limb function due to ataxia, weakness, sensory loss, and/or visuospatial impairment.	All groups received arm training (5x/wk for 6 wks) including: correct positioning and caring of the arm; passive, assisted, and active movements; strength training; and functional activities. Groups received varying daily intensities of training: 1) Group A, 1hr/d; 2) Group B, 2hr/d; or 3) Group C, 3hr/d.	(FMA), Action Research Arm Test (ARAT) Outcomes were assessed at baseline, 2wk, 4wk, and 6wk.	ARAT scores (p>0.05). After 4wk, the improvements in FMA scores were significantly greater in group C than in groups A and B (p<0.05). There were no significant differences in FMA scores between groups A and B (p>0.05). ARAT score improvement was significantly greater in group C than in group A (p<0.05). There were no significant differences in ARAT scores between groups A and B or groups B and C (p>0.05) After six weeks, FMA and ARAT scores increased significantly in all groups (p<0.05 for all). FMA and ARAT scores improved more significantly in groups C and B than in group A (p<0.05). There were no significant differences in FMA and ARAT scores between groups B and C (p<0.05).

GRASP (Graded Repetitive Arm Supplementary Program)

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Harris et al. 2009 **Canada** **RCT**	CA: ☑ Blinding: Assessor ☑ Patient ☒ ITT: ☑	103 subjects in the acute phase of stroke (21±7d) with a Fugl-Meyer Upper Limb Motor Impairment Scale score between 10 and 57.	Subjects were randomized to receive graded repetitive arm supplementary program (GRASP) or an educational protocol (control) for 4wk. GRASP was a self-administered program designed to improve ADL skills through exercises for strengthening, range of motion, and gross/fine motor skills.	**Primary Outcomes:** Chedoke Arm & Hand Activity Inventory-9 (CAHAI) **Secondary Outcomes:** Action Research Arm Test (ARAT), Motor Activity Log (MAL), 12-Item Short Form Survey (SF-12), Grip strength, Pain, Fatigue. Outcomes were assessed at baseline, 4wk, and 3mo follow-up.	At 4wk, both groups showed improvement in CAHAI scores, but the GRASP group had significantly greater improvement (+14.1 vs. +7.9, p<0.001). This improvement was maintained at 3mo, with significantly greater scores in the GRASP group (50.4 vs. 45.4, p=0.037). At 4wk, the GRASP group had significantly higher ARAT (+11.7 vs. +7.0, p=0.025) and MAL (AOU: +1.3 vs. +0.9, p=0.023; QOU: +1.2 vs. +0.9, p=0.007) scores and grip strength (+4.1 vs +2.0, p=0.027) than the control group. Completion rate was 58%.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
					Adverse event of pain occurred in 15%.

Constraint-Induced Movement Therapy (CIMT)

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Stock et al. 2017 **Norway** **RCT**	CA: ☒ Blinding: Patient ☒ Assessor ☑ ITT ☒	47 subjects in the acute phase of stroke (early=17±7d, late=18±7d) with a modified Rankin Scale score ≤2.	Subjects were randomized to receive CIMT early (<28d) or late (6mo). Both groups received standard care when the other group received CIMT. CIMT consisted of motor skills training 3hr/d and restriction for 90% waking hours, both 5d/wk for 2wk.	**Primary Outcome:** Wolf Motor Function Test (WMFT) Fugl-Meyer Assessment (FMA), 9-Hole Peg Test (9HPT), Modified Rankin Scale (mRS) baseline, 2wk, 6mo, 6mo+2wk, and 1yr.	WMFT, 9HPT, mRS: The early group had significantly greater improvement than the late group at 2wk ($p<0.05$). However, there were no significant differences between groups at 6mo, 6mo+2wk, or 1yr. FMA: There was no significant difference between groups at any time point.
Liu et al. 2017 **China** **Systematic review and meta-analysis**	PEDro scores ranged from 5 to 8, with a median score of 6.5.	16 RCTs involving 738 subjects in the acute (<1mo) and subacute (1-3mo) phases of stroke with upper limb impairment.	Comparison of CIMT to conventional therapy, without any additional therapies. Intensity ranged from 30min/d, 3d/wk to 6hr/d, 5d/wk, with most trials providing 2-3hr/d, 5d/wk. Duration ranged from 2wk to 10wk, with most trials providing 2wk.	Action Research Arm Test (ARAT), Wolf Motor Function Test (WMFT), Motor Activity Log (MAL), Fugl-Meyer Assessment (FMA), Modified Barthel Index (mBI) Outcomes were assessed before and after treatment, with 1-3mo follow-up in 6 trials and 3-6mo follow-up in 3 trials.	ARAT: WMD=8.35, 95%CI 1.98-14.71; Z=41.9, p=0.001; 5 trials, I^2=94% WMFT: WMD=5.998, 95%CI -1.862-13.858; Z=1.50, p=0.135; 2 trials, I^2=18% MAL, quality: WMD=0.812, 95%CI 0.331-1.293, Z=3.31, p=0.001; 4 trials, I^2=57% MAL, amount: WMD=1.014, 95%CI -0.114-2.142; Z=1.76, p=0.078; 4 trials, I^2=92% FMA: WMD=10.822, 95%CI 7.419-14.226; Z=6.23, p<0.001; 13 trials, I^2=85% mBI: SMD=10.706, 95%CI 4.417-16.966; Z=3.34, p=0.001; 6 trials, I^2=91% In subgroup analysis, low-intensity CIMT was found to have a greater effect than high-intensity CIMT on ARAT, FMA, and MAL.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
					Results of sensitivity analyses and publication bias assessment were not significant (p>0.05).
Kwakkel et al. 2016 **Netherlands** **RCT** **EXPLICIT**	CA: ☒ Blinding: Assessor ☑ Patient ☒ ITT: ☑	58 subjects in the acute phase of stroke (mean=9±4d) with hemiparesis but favourable prognosis (>10° finger extension).	Subjects were randomized to receive usual care alone (control) or with modified CIMT (mCIMT). CIMT involved restraint for 3hr/d, 5d/wk for 3wk.	**Primary Outcomes:** Action Research Arm Test (ARAT), Wolf Motor Function Test (WMFT), Modified Erasmus Nottingham Sensory Assessment (mENSA), Frenchay Arm Test (FAT), Motricity Index (MI), Motor Activity Log (MAL), 9-Hole Peg Test (9HPT), Outcomes were assessed weekly for 5wk, and then at 8wk, 12wk, and 26wk.	mCIMT had significantly greater improvement than usual care on ARAT at 5wk (β=1.757, p=0.011), 8wk (β=1.312, p=0.002), and 12wk (β=0.615, p=0.023), but not at 26wk (β=0.095, p=0.389). mCIMT had significantly greater improvement than usual care on SIS at 8wk (β=1.389, p=0.038). There were no significant differences between groups on WMFT, mENSA, FAT, MI, MAL, or 9HPT at 5wk, 8wk, 12wk, or 26wk.
Etoom et al. 2016 **Italy** **Systematic review and meta-analysis**	PEDro scores ranged from 4 to 8.	38 RCTs involving 1561 subjects with upper limb impairment. Subjects were in the acute/subacute phase in 16 trials, the chronic phase in 13 trials, and mixed in 9 trials.	Comparison of CIMT to various control conditions (other rehabilitative techniques, conventional therapy, no treatment) for upper limb. Dosage and duration: ≥10hr/d over 10-14d in 11 trials, 4-6hr/d over 10-14d in 8 trials, 4-6hr/d over 15-28d in 8 trials, and 2-5hr/d over 50-60d in 5 trials.	Action Research Arm Test, Wolf Motor Function Test, Motor Assessment Scale, Motor Activity Log, Fugl-Meyer Assessment, Functional Impact Measure, Stroke Impact Scale, 9/16-Hole Peg Test, Grooved Peg Test, Grip strength Outcomes were assessed before and after treatment, with 1-3mo follow-up in 10 trials and 4-6mo follow-up in 6 trials.	CIMT had a significant, moderate effect on arm function after treatment (SMD=0.557, 95%CI 0.301-0.813, p<0.05; 36 trials with 1473 subjects) Effect of CIMT was not significant at 1-3mo (SMD=-0.049, 95%CI -0.155-0.231, p>0.05) or 4-6mo (SMD=0.086, 95%CI -0.234-0.407, p>0.05). In subgroup analyses, the effect was not significant for trials with: - acute/subacute stroke subjects only (SMD=0.584, 95%CI -0.033-1.202, p>0.05) - CIMT delivered 4-6hr/d over 10-14 (SMD=0.439, 95%CI -0.20-0.898, p>0.05) - allocation concealment (SMD=0.394, 95%CI -0.013-0.802, p>0.05; 11 trials) - intention-to-treat analysis (SMD=0.134, 95%CI -0.374-0.615, p>0.05; 11 trials) - power calculations (SMD=0.407, 95%CI -1.05-0.919, p>0.05; 8 trials)
Corbetta et al. 2015 **Italy**	Majority of studies had unclear risk of bias.	42 RCTs involving 1453 participants with residual motor power in paretic arm, potential for recovery, and limited	Comparison of CIMT, mCIMT, or CIMT with adjunct to various control conditions (bilateral arm training, conventional	Arm function: Action Research Arm Test, Wolf Motor Function Test, Emory Motor Function Test, Manual Function Test, Rivermead	Arm function: SMD=0.34, 95%CI 0.12-0.55, p<0.05; 34 trials with 858 subjects, I^2=47% Arm impairment: SMD=0.82, 95%CI 0.31-1.34, p<0.05; 18 trials with 372 subjects, I^2=77%

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Cochrane Review	Publication bias and small study effects were potential issues.	pain/spasticity. Subjects were in the acute phase of stroke in 13 trials, the subacute phase in 6 trials, and the chronic phase in 5 trials. The remaining trials had a wide range or were unclear in terms of onset.	therapy, no treatment) for upper limb. Restraint ranged from 2-6hr/d, with most trials providing 6hr/d. Practice ranged from 5-45hr/wk, with most trials providing 10-25hr/wk. Duration ranged from 2-10wk, with most trials providing 2wk.	Motor Assessment, Motor Assessment Scale Arm impairment: Fugl Meyer Assessment, Chedoke McMaster Impairment Inventory, Birgitta Lind Marks Assessment, Jamar hand dynamometer, Force transducer grip strength, Isometric force Perceived function: Motor Activity Log Dexterity: Grooved Pegboard Test, 9/16-Hole Peg Test, Box & Block Test, Perdue Pegboard Test Disability: Functional Independence Measure, Barthel Index. Quality of life: Stroke Impact Scale, with some trials providing follow-up between 1mo and 3yr.	Perceived function, quality: MD=0.68, 95%CI 0.47-0.88, p<0.05; 29 studies with 891 subjects, I^2=74% Perceived function, amount: MD=0.79, 95%CI 0.50-1.08, p<0.05; 28 studies with 851 subjects, I^2=87% Dexterity: SMD=0.42, 95%CI 0.04-0.79, p<0.05; 7 trials with 113 subjects, I^2=0% Disability: SMD=0.24, 95%CI -0.05-0.52, p>0.05; 11 trials with 344 subjects Disability, 3/6mo follow-up: SMD=-0.21, 95%CI -0.57-0.16, p>0.05; 3 trials with 125 subjects Quality of life: MD=6.54, 95%CI -1.2-14.28, p>0.05; 8 trials with 96 subjects, I^2=0% There were no significant effects of stroke onset, amount of practice, or region of restraint.
Wolf et al. 2006 **USA** **RCT** **EXCITE Trial**	CA: ☒ Blinding: Assessor ☑ Patient ☒ ITT: ☑ (primary outcome only)	222 subjects with first-ever ischemic or hemorrhagic stroke onset 3 to 9 months prior. Patients were recruited who met criteria for either higher or lower motor function, High: at least 20º of wrist extension and at least 10º of active extension of each metacarpophalangeal and intraphalangeal joint of all digits. Low: 10º of active wrist extension, at	Comparison of CIMT vs. usual care. CIMT: 6 hours of shaping (task practice) each weekday + constraint worn for a goal of 90% of waking hours (7 days/week), for 2 weeks Control group: usual care, which could range from no therapy to a formal structured therapy program.	**Primary Outcomes:** WMFT, MAL **Secondary Outcomes:** FIM, SIS Assessments were conducted at baseline, posttreatment and follow-up at 3, 8 and 12 months	203 subjects completed the treatment; data from 169 subjects were included in 12 month assessment. From baseline to 12 months, the CIMT group showed greater improvements than the control group in both the WMFT Performance Time (19.3 to 9.3 seconds vs. 24.0 to 17.7 seconds, p<0.001) and in the MAL Amount of Use (1.21 to 2.13 vs. 1.15 to 1.65, p<.001) and MAL Quality of Movement (1.26 to 2.23 vs. 1.18 to 1.66, p<.001). In subgroup analyses, there were no differences in any of the outcomes based on baseline hand function (hi vs. low) at 12 months.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
		least 10º of thumb abduction/extension and at least 10º of extension in at least 2 additional digits			35 serious adverse events were reported, none of which appeared to be related directly to the intervention.

Mental Practice

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Guerra et al. 2017 **Brazil** **Systematic review & meta-analysis**	NA	20 RCTs involving 606 subjects with upper limb impairment. Stroke onset was <1mo in 3 trials, <3mo in 5 trials, >3mo in 2 trials, <6mo in 2 trials, >6mo in 1 trial, <12mo in 1 trial, and >12mo in 6 trials.	Comparison of MP + other treatment (physiotherapy, occupational therapy, physical practice) vs other treatment. Duration of sessions ranged from 10min to 60min, with most trials delivering 30min. Number of sessions ranged from 10 to 30, with most trials delivering 12 sessions.	Action Research Arm Test, Arm Functional Test, Canadian Occupational Performance Measure, Colour Trails Test, Grip Strength, Fugl-Meyer Assessment, Jebsen Taylor Test, Line Bisection Test, Motor Activity Log, Motricity Index, Movement Task, Nine-Hole Peg Test, Performance Task, Recognition Task, Star Cancellation Test, Wolf Motor Function Test, Outcomes were assessed before and after treatment	All trials: SMD=0.36, 95%CI 0.16-0.55; Z=3.57, p=0.0004; I^2=30% Higher quality trials (score >6): SMD=0.17, 95%CI -0.07–0.40; Z=1.39, p=0.16; I^2=27% There was no reporting on adverse events.
Machado et al. 2015 **Brazil** **Systematic review & meta-analysis**	NA	7 RCTs involving 162 subjects with upper limb impairment. Stroke onset was subacute in 1 trial, chronic in 5 trials, and not stated in 1 trial.	Comparison of MP + other treatment vs. other treatment. Duration of treatment ranged from 3wk to 12wk.	Action Research Arm Test, Fugl-Meyer Assessment, Motricity Index Outcomes were assessed before and after treatment, with 2-10wk follow-up in some trials	SMD= -1.77, 95%CI -4.89-1.35, I^2=89% There was no reporting on adverse events.
Barclay-Goddard et al. 2011 **Canada**	NA	6 RCTs involving 119 subjects with upper limb impairment.	Comparison of MP + other treatment vs. other treatment.	Action Research Arm Test, Wolf Motor Function Test, Frenchay Arm Test, Modified Ashworth Scale,	SMD=1.37, 95%CI 0.60-2.15, p<0.0001; 5 trials, 102 subjects, I^2=56% Subgroup analysis based on stroke chronicity and

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Cochrane Review		Mean stroke onset was 3wk (1 trial), 7wk (1 trial) and >6mo (4 trials).	Duration of treatment ranged from 3wk to 10wk.	Box & Block Test, TEMPA Outcomes were assessed before and after treatment.	dosage was not possible due to small numbers. There was no evidence of adverse events.

Bilateral Arm Training

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Hsieh et al. 2017 **Taiwan** **RCT**	CA:☑ Blinding: Assessor ☑ Patient ☒ ITT: ☒	31 subjects in the subacute phase of stroke (treatment=2.6±1.7mo, control=2.2±1.1mo).	Subjects were randomized to receive task-oriented training alone (control) or with bilateral arm training (BAT) for 1.5hr/d, 5d/wk over 4wk.	Arm function: Fugl-Meyer Assessment (FMA), Stroke Impact Scale (SIS), Box & Block Test (BBT), Grip strength, Actigraphy ADL: Functional Independence Measure (FIM), Modified Rankin Scale (mRS), Stroke Impact Scale (SIS) Outcomes were assessed at baseline, 4wk, and 3mo.	There were no significant between-group differences over time for FMA, SIS, FIM, mRS, BBT, Grip strength, or Actigraphy. There was a significantly greater improvement with BAT than control for SIS-Strength (F=7.20, p=0.012), but not SIS-Hand Function (F=0.397, p=0.534).
Stinear et al. 2014 **New Zealand** **RCT**	CA:☑ Blinding: Patient ☒ Assessor ☑ ITT ☑	57 subjects in the acute phase of stroke (<26d).	Subjects were randomized to receive bilateral arm training (BAT) or sham electrical stimulation (control) for 15min/d. Both groups received rehabilitation 45min/d, 5d/wk for 4wk.	**Primary Outcome:** Action Research Arm Test (ARAT) **Secondary Outcomes:** Modified Rankin Scale (mRS), Stroke Impact Scale (SIS) Outcomes were assessed at baseline, 6wk, 12wk, and 26wk.	At 12wk, a significantly greater proportion of the BAT group achieved ≥75% maximum recovery on ARAT than the control group (ITT: χ^2=4.25, p=0.039; PP: χ^2=3.99, p=0.046). At 12wk, subjects in the BAT group were significantly more likely to achieve their ARAT plateau than control subjects (ITT: OR=3.32; PP: OR=3.54). At 26wk, there were no significant between-group differences on mRS (p>0.40) or SIS (p>0.20).
Van Delden et al. 2012 **Netherlands**	PEDro scores ranged from 5 to 8.	9 RCTs with 452 subjects. Stroke onset was chronic in 8 trials and acute in 1	Comparison of unilateral arm training to bilateral arm training (motor task performed simultaneously with both	Function: Action Research Arm Test, Wolf Motor Function Test Impairment: Fugl Meyer	Function: SMD=0.20, 95%CI 0.0–0.4; Z=1.95, p=0.05; I^2=0% Impairment: SMD=0.06, 95%CI -0.20–0.33; Z=0.45 p=0.65; I^2=0%

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Systematic review and meta-analysis		trial. Hemiparesis was mild in 4 trials, moderate in 2 trials, and mild to severe in 3 trials.	limbs). Studies using robot assistance, electrical stimulation, mirror therapy, or virtual reality were excluded. Interventions were provided 20min/d-6hr/d, 3-6d/wk for 1-8wk.	Assessment, Motor Status Scale Performance: Motor Assessment Scale Perception: Motor Activity Log	Performance: SMD= -0.72, -1.72–0.28; Z=1.41, p=0.16; I^2=NA Perception: Amount, SMD=0.42, 95%CI 0.09-0.76; Z=2.50, p=0.01; I^2=0%; Quality, SMD=0.45, 95%CI 0.12-0.78; Z=2.70, p=0.007; I^2=32% Adverse events: No reporting
Coupar et al. 2010 **UK** **Cochrane Review**	Majority of studies were of poor or uncertain quality.	18 RCTs with 549 subjects. (14 RCTS with 421 subjects were included in pooled analysis). Stroke onset was acute/subacute in 4 trials, chronic in 12 trials, mixed in 1 trial, and not reported in 1 trial.	Comparison of bilateral training to usual care of other intervention. 7 trials used adjunctive treatments (electrical stimulation, robotic devices, auditory cueing). Intervention period ranged from 1 to 30 sessions over 6wk.	**Primary Outcomes** *Arm function:* Action Research Arm Test, Motor Assessment Scale, Frenchay Arm Test, Wolf Motor Function Test, Upper-Extremity Function Test, Box & Block Test, Chedoke Arm & Hand Activity Inventory, TEMPA *ADL:* Barthel Index, Rankin Scale, Katz Index, Functional Independence Measure, Rehabilitation Action Profile, Rivermead ADL **Secondary Outcomes** *Motor impairment:* Fugl Meyer Assessment, Rivermead Motor Assessment, Motor Club Assessment *Extended ADL:* Nottingham EADL, Rivermead EADL, Frenchay Activity Index	<u>Bilateral training vs usual care:</u> *Arm function:* SMD= -0.07, 95%CI -0.42–0.28, p=0.68, 4 trials *Motor impairment:* SMD=0.43, 95%CI 0.06–0.81, p=0.023, 4 trials *ADL:* SMD=0.25, 95%CI -0.14–0.63, p=0.21, 3 trials *Extended ADL:* SMD=0.1; 95%CI -0.47–0.77, p=0.63. 1 trial <u>Bilateral training vs other intervention:</u> *Arm function:* SMD= -0.20, 95%CI 0.49–0.09, p=0.18, 6 trials *Motor impairment:* SMD= -0.25, 95%CI -0.55–0.0, p=0.099, 4 trials *ADL:* SMD= -0.25, 95%CI -0.57–0.08, p=0.14, 3 trials *Extended ADL:* SMD= -0.65, 95%CI -1.29 – -0.01, p=0.04, 1 trial
Cauraugh et al. 2010 **USA**	Medium quality.	25 studies (trials and non-trials) with 366 subjects. Stroke onset was acute	Comparison of bilateral arm training vs various controls (unilateral, dose-matched exercise, usual care, no treatment).	Action Research Arm Test, Fugl-Meyer Assessment, Motor Assessment Scale, Box & Block Test, Movement Time, Functional	SMD=0.734, 95%CI 0.489-0.979, p<0.001, I^2=63%

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Systematic review and meta-analysis		in 2 studies, subacute in 4 studies, and chronic in 19 studies.	Studies adjunctive treatments (electrical stimulation, robotic devices).	Independence Measure, Modified Ashworth Scale	

Mirror Therapy

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Zeng et al. 2017 **China** **Systematic review and meta-analysis**	Selection bias: low Performance bias: high Detection bias: low Attrition bias: low Reporting bias: low Publication bias: none detected	11 RCTs with 347 subjects. Stroke onset was acute/subacute in 4 studies and chronic in 7 studies.	Comparison of mirror therapy (MT) and conventional therapy (CT) vs. CT alone (control was 5d/wk in all studies. Intensity ranged from 20min/d to 90min/d, with most studies providing 30min. Duration ranged from 3wk to 8wk, with most studies providing 4wk.	Motor function: Fugl-Meyer Assessment, Action Research Arm Test, Wolf Motor Function Test, Brunnstrom Recovery Stages, Box & Block Test, ABILHAND **Secondary Outcomes:** ADL: Functional Independence Measure, Modified Barthel Index,	Motor function: SMD=0.51, 95%CI 0.29-0.73; Z=4.56, p<0.00001; I^2=61% Heterogeneity was not correlated with sample size, stroke onset, or treatment duration.
Perez-Cruzado et al. 2017 **Spain** **Systematic review**	PEDro scores ranged from 6 to 9, with a mean score of 7.	15 RCTs with 509 subjects. Stroke onset was acute in 9 studies and chronic in 6 studies.	Comparison of mirror therapy (MT) and conventional therapy (CT) vs. CT alone (control). Frequency was 5d/wk in all studies. Intensity ranged from 20min/d to 90min/d, with more studies providing	**Primary Outcomes:** Motor recovery, Motor function, Dexterity Outcomes were assessed before and after treatment	Motor recovery: 8 studies found that MT was better than control, with statistical significance and large effect size. Motor function: 4 studies found that MAT was better than control, with statistical significance and moderate-to-large effect size. Dexterity: 4 studies found that MT was better than control, with statistical significance and large effect size.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
			30min. Duration ranged from 3wk to 8wk, with most studies providing 4wk.		
Timmermans et al. 2013 **Netherlands** **RCT**	CA: ☒ Blinding: Patient ☒ Assessor ☑ ITT: ☑	42 subjects at subacute stroke onset (treatment=36±27d, control=32±18d) with hemiparesis.	Subjects were randomized to receive mirror therapy (MT) or usual care (control). Both groups received training 3x/d for 6wk.	**Primary Outcomes:** Fugl-Meyer Assessment (FMA), Wolf Motor Function Test (WMFT), Frenchay Arm Test (FAT) Outcomes were assessed before and after treatment, and at 12mo follow-up.	Both groups showed significant improvements on FMA and WMFT after treatment ($p<0.05$), but there were no significant differences between groups ($p>0.05$). Only MT group showed significant improvement on FAT after treatment, and at 12mo follow-up ($p<0.05$), but there was no significant difference with control ($p>0.05$).
Radajewska et al. 2013 **Poland** **RCT**	CA: ☒ Blinding: Assessor ☒ Patient ☒ ITT: ☒	60 subjects at a mean of 9.25wk stroke onset with hemiparesis.	Subjects were randomized to mirror therapy (MT) or control. Both groups received therapy for a maximum of 30min/d in 20 sessions over 5wk. Treatment group received 15min sessions of MT 2x/day, 5d/wk for 3 wk. Within each group, patients were divided into left- versus right-arm paresis subgroups.	**Primary Outcomes:** Frenchay Arm Test (FAT), Motor Status Scale (MSS), Functional Index 'Repty' (FIR), Outcomes were assessed before and after treatment, and at 3wk follow-up.	In the left-hand subgroups, those in the MT group showed a significantly greater improvement on the FAT than controls ($p=0.035$), but there were no significant between-group differences on MSS or FIR ($p>0.05$ for all). In the right-hand subgroups, there were no significant between-group differences over time for any outcome ($p>0.05$).
Thieme et al. 2013 **Germany** **RCT**	CA:☑ Blinding: Assessor ☑ Patient ☒ ITT:☑	60 subjects within 3mo of stroke onset with severe hemiparesis.	Subjects were randomized to receive individual mirror therapy (iMT), group MT (gMT), or sham MT (control). All groups received standard therapy. MTs were delivered 20x for 30min/x over 5wk.	**Primary Outcomes:** Fugl Meyer Assessment (FMA), Action Research Arm Test (ARAT) **Secondary Outcomes:** Barthel Index (BI), Stroke Impact Scale (SIS), Modified Ashworth Scale (MAS), Star Cancellation Test (SCT)	Subjects in all groups significantly improved over the treatment period. There were no significant differences between groups on any of the outcomes, except on MAS and SCT, both favouring greater improvement in the iMT group ($p<0.05$).

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
				Outcomes were assessed before and after treatment.	
Thieme et al. 2012 **Germany** **Cochrane Review**	PEDro scores ranged from 3 to 8, with a median score of 7.	14 RCTs with 567 subjects. Stroke onset was acute/subacute in 6 trials and chronic in 8 trials.	Comparison of mirror therapy vs. various controls (no treatment, usual care, or another treatment). Treatments were delivered 30-45min/d, 3-5d/wk for 3-6wk.	**Primary Outcomes:** Motor function: Fugl Meyer Assessment, Action Research Arm Test, Wolf Motor Function Test, Motor Assessment Scale, Brunnstrom Recovery Stages **Secondary Outcomes:** ADL: Functional Independence Measure, Barthel Index	Motor function, post treatment: SMD=0.61, 95%CI 0.22-1.0, p= 0.002, I^2=75% (11 studies) Motor function, 6mo follow-up: SMD=1.09, 95%CI 1.09-1.87, p= 0.0068 (4 studies) ADL, post treatment: SMD=0.33, 95%CI 0.05-0.60, p= 0.020 (4 studies) Adverse events: Only one study reported.

Strength Training

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Harris & Eng 2010 **Canada** **Systematic review and meta-analysis**	N/A	13 RCTs with 517 subjects. Stroke onset was acute/subacute in 9 trials and chronic in 4 trials.	Comparison of programs that included strength or resistance training (excluding robotic devices, electrical stimulation, CIMT) vs. various control conditions (active program, usual care, or no therapy). Treatment was on average 1hr/d, 2-3d/week for 4wk.	Motor function: Action Research Arm Test, Wolf Motor Function Test, Rivermead Motor Assessment, Motor Assessment Scale, Function Test, Purdue Peg Board, Box & Block Test, TEMPA ADL: Functional Independence Measure, Barthel Index, 36-Item Short-Form Health Survey Grip strength Outcomes were assessed before and after treatment.	Motor function: SMD=0.21, 95%CI 0.03–0.39, p=0.03 (11 trials) Grip strength: SMD=0.95, 95%CI 0.05–1.85, p=0.04 (5 trials) ADL: SMD=0.26, 95%CI -0.10–0.63, p=0.16 (5 trials) Subgroup analyses: Subacute (8 trials): SMD=0.27, 95%CI 0.06-0.48, p=0.01 Chronic (4 trials): SMD=0.32, 95%CI 0.02-0.63, p=0.04 Adverse events: 6 trials found none; 7 trials did not report.

Interventions for Sensory Impairment

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Cai et al. 2017 **Australia** **Systematic review and meta-analysis**	N/A	22 RCTs (1425 subjects). Only 7 studies evaluated upper extremity outcomes. Of these, 4 RCTs evaluated spasticity, and 4 RCTs evaluated motor function (1 RCT evaluated both). Of these, 3 did not report on the time post stroke, 1 evaluated participants in the acute phase of stroke recovery, and 3 corresponded to the sub-acute phase of stroke.	Interventions for the 7 RCTs evaluating upper limb recovery include: electroacupuncture combined with rehabilitation versus rehabilitation only (n=6), and electroacupuncture combined with rehabilitation and baclofen versus rehabilitation with baclofen (n=1).	**Primary Outcomes:** Modified Ashworth Scale (MAS). **Secondary Outcomes:** Fugl Meyer Assessment (FMA), adverse events.	MAS (n=4) SMD=-0.57, 95% CI -0.84 to -0.29, I^2=0%, p<0.0001. FMA (n=4) SMD=13.32, 95% CI -6.53 to 33.17, I^2=100%, p=0.19. The review reported high heterogeneity in treatment protocols among the studies evaluating upper extremity motor function. Adverse events: No reporting.
Doyle et al. 2010 **USA** **Cochrane Review**	N/A	13 RCTs (467 subjects) with disturbance in sensory function following stroke. Subjects in 3 studies were recruited and average of within 1 month of stroke; subjects in 5 studies were recruited within 6 months of stroke and subjects in 2 studies were recruited in the chronic phase of stroke. Stroke chronicity of subjects was not stated in 3 trials.	Types of interventions evaluated included: sensory retraining programs (n=5), electrical stimulation (n=2), inflatable splints (n=2), thermal stimulation (n=1), rTMS (n=1), intermittent pneumatic compression (n=1), tensive mobilizations (n=1)	36 measures of sensory impairment. 13 measures of UE function.	All 26 pooled analyses included the results of a single trial. Fugl Meyer upper limb (n=18) MD=-6.0, 95% CI -16.6 to 4.6. Fugl Meyer wrist/hand (n=18) MD=-0.12, 95% CI -9.06, 8.82. ARAT (n=100) MD=12.9, 95% CI 5.7 to 20.2. % of subjects achieving a >10% improvement in Brunnstrom Fugl Meyer at 12 months (n=100) OR=6.05, 95% CI 2.0 to 18.3. Adverse events: No reporting.
Laufer & Elboim-Gabyzon 2011 **Israel** **Systematic review**	N/A	15 RCTs or quasi RCTs. Treatment was applied to the UE in 7 studies. Subjects in 5 of the studies included subjects in the chronic phase of stroke; in 2 studies subjects were recruited <	Examination of the effectiveness of TENS on motor recovery Surface electrodes were placed over the median nerve at the wrist in all studies of UE. The ulnar, and radial nerves were	Pinch strength, Jensen-Taylor Hand Function Test (JTHF), FIM, ARAT, tapping frequency Outcomes were assessed before and after treatment only in 4 studies with follow-up at 24 hours (n=1), 30	No inferential statistics reported. The pinch strength of subjects in the TENS group was significantly greater than those in the control condition in 2/3 studies. JTHF test scores were higher in TENS group compared with control condition in 4/4 studies.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
		60 days post stroke.	also stimulated in 2 studies. Pulse duration ranged from 0.125 to 1 ms. Intensity of stimulation: just below sensory threshold, mild to strong paresthesias Treatment durations were a single 2-hour session (n=5), 2x 2hour sessions (n=1) and 2 hours, 3x/week for 1 month (n=1) Subjects in the control group received sham stimulation, minimal perception, subsensory, or subparathesia levels of TENS	days (n=1), 2 & 3 months (n=1)	In the single study that assessed ARAT, there was no difference in scores between the study groups. Adverse events: No reporting.
Calabro et al. 2017 **Italy** **RCT**	CA: ☒ Blinding: Assessor ☑ Patient ☑ ITT: ☒	20 patients with first ever left hemisphere stroke experienced more than 3 months before enrollment (experimental group=5±2mo; control group=6±2mo).	Participants in the experimental group received Armeo-Power robotic training coupled with focal muscle vibration therapy, while the control group received Armeo-Power training only. The therapy was provided for 1hr/session, 5 sessions/wk, for 8wk. A total of 40 sessions were conducted.	**Primary Outcomes:** Modified Ashworth Scale (MAS). **Secondary Outcomes:** Fugl Meyer Assessment (FMA), Functional Independence Measure (FIM), Hamilton Rating for Anxiety (HRS-A) and Depression (HRS-D). Outcomes were assessed at baseline before the intervention, after the intervention, and at one month follow-up.	There was a significant decrease in the MAS scores for the experimental group after the intervention ($p<0.001$), and at follow-up ($p=0.007$). There was no significant change in MAS scores at post intervention and at follow-up for the control group ($p=0.3$; $p=0.4$). A time x group interaction for the MAS showed a significant difference between the groups, and at post intervention and follow-up ($p<0.001$). The experimental group demonstrated a significant decrease in the FIM score, FMA, HRS-A and HRS-D at post intervention ($p<0.001$; $p=0.001$; $p=0.001$; $p=0.001$) and at follow-up, respectively ($p=0.01$; $p=0.007$; $p=0.001$; $p=0.001$). The control group demonstrated a significant decrease in the FMA scores at post intervention ($p=0.04$); no other outcomes were found to be significant.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Yao et al. 2014 **China** **RCT**	CA: ☒ Blinding: Assessor ☒ Patient ☒ ITT: ☒	68 participants with post-stroke upper limb dysfunction, within 6mo post stroke (experimental group: 5.2mo; control group: 5.1mo).	All patients received conventional rehabilitation for 40min/d, 6d/wk for 2mo in addition to electroacupuncture therapy for 3d/wk for 2mo. Experimental group received relaxed needling acupuncture to 3-5 major and 3-5 adjunct points, needles were retained for 30min while electroacupuncture was applied to the upper extremity and head. Control group received ordinary needling.	**Primary Outcomes:** Fugl Meyer Assessment (FMA), Neurological Function Deficit Scale (NFDS). Assessments were conducted at baseline and at post-intervention.	Significantly greater improvements were found in the experimental group compared to the control group regarding the NFDS ($p<0.05$) and FMA ($p<0.05$).
Wen et al. 2014 **China** **RCT**	CA: ☑ Blinding: Assessor ☑ Patient ☒ ITT: ☒	300 participants within the acute stage of stroke recovery (experimental group: 5.93d; control group: 6.04d).	Control group received basic therapy for acute stroke for 4wks. Experimental group received basic therapy in addition to electroacupuncture therapy and moxibustion therapy (300g of wormwood leaves ground up and placed in a heated bag, bag and applied to shoulder of affected side for 5-8min then used to iron the inside of affected arm and palm for 5-10min). Electroacupuncture and moxibustion therapy was administered for 5-7d/wk for 4wks.	**Primary Outcomes:** Fugl Meyer Assessment (FMA), Modified Rankin Scale (MRS). The FMA was assessed before and after the intervention. The MRS was evaluated at 6mo follow-up.	Significant within-group improvements on FMA scores from baseline to post intervention were found in both groups ($p<0.05$); however, no significant differences between the two groups were found. At 6mo, there was a significant difference in the number of independent patients assessed by the MRS favoring the experimental group over the control group ($p<0.05$).
Au-Yeung et al. 2014 **China**	CA: ☑ Blinding: Assessor ☑	73 subjects ≤ 46 hr post-stroke, demonstrating moderate to severe arm weakness, contralateral	Subjects were randomized into one of three groups: 1) Group 1-TENS, 2) Group 2-sham	**Primary Outcomes:** Hand grip, pinch strength, Action Research Arm Test (ARAT)	The TENS group improved significantly more than the control group in hand grip ($p=0.015$) and pinch strength ($p=0.007$) compared to controls beginning at week 4; improvements were maintained at follow

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
RCT	Patient ☑ ITT: ☑	to the lesion.	stimulation, or 3) Group 3-standard rehabilitation. Groups 1 and 2 also received standard rehabilitation therapy. Electrical Stimulation Treatment was received fir 60 min/day, 5 days/wk, for 4 wk.	Outcomes were assessed at pre-, 4, 12, and 24 wk post-treatment.	up (p≤ 0.006). No significant differences were found between the sham stimulation group and the control group for hand grip or pinch strength. There were no significant differences in ARAT scores between groups (p>0.05 for all).

Functional Electrical Stimulation

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Eraifej et al. 2017 **UK** **Systematic review & meta-analysis**	9 trials considered low risk of bias, one, high risk and in the remaining trails the risk of bias was unclear	20 RCTs including participants > 18 years with haemorrhagic or ischaemic stroke. Mean age was 60 years. Mean chronicity of stroke was <2 months (n=5), 1-3 years (n=5), >3 years (n=6).	Trials compared upper limb transcutaneous FES applied to the peripheral nervous system, defined as (a) applied to the skin externally and (b) during voluntary movement in addition to standard post-stroke rehabilitative therapy vs. a control group received standard care. FES ranged 20–50 Hz, peak current ≤ 70 mA and duration of stimulation from 3 to 10 s. Muscles stimulated included deltoid, triceps and the wrist and finger extensors/flexors. Treatment duration ranged from 2 weeks to 3 months	**Primary outcome:** Activities of daily living **Secondary outcomes:** Performance on non-ADL tasks	Pooling data from 8 trials, there was no significant difference between groups in ADL performance (SMD=0.64, 95% CI -0.02-1.30, p=0.06). In sub group analysis including 5 trials, persons who received FES during the acute phase of stroke (within 2 months) did benefit in ADL performance with FES (SMD=1.24, 95% CI 0.46, 2.03, p=0.002). FES was associated with significant improvement in Fugl-Meyer Assessment scores (MD=6.72, 95% CI 1.76, 11.68, p=0.008), but not Box & Block test (MD=5.37, 95% CI -0.06, 10.75).
Jeon et al. 2017	CA: ☑	20 participants in the	Participants were	**Primary Outcomes:**	The total FMA score was not significantly different

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Korea **RCT**	Blinding: Assessor ☑ Patient ☒ ITT: ☒	subacute stage of stroke recovery (experimental group: 3.9mo; control group: 4.6mo).	randomly allocated either to the experimental group or to the control group. For the experimental group, EMG-triggered FES was conducted with task-oriented training for 30min/d 5x/wk, while only cyclic FES was conducted for 30min/d, 5x/wk for the control group. The intervention lasted 4wk. Conventional therapy was provided for 30min/d, 5x/wk for both groups.	Fugl Meyer Assessment (FMA). Outcome was assessed before and after intervention.	between the groups, but the subscales for the shoulder (shoulder flexion, retraction, abduction, external rotation) showed significantly greater improvement in the experimental group compared to the control group ($p<0.05$).
Kwakkel et al. 2016 **Netherland** **RCT** **EXPLICIT trial**	CA: ☒ Blinding: Assessor ☑ Patient ☒ ITT: ☑	159 ischemic stroke patients were provided an intervention within 14d post stroke.	The electromyographic neuromuscular stimulation (EMG-NMES) group received the stimulation on finger extensors for 2 sessions of 30min/d, 5d/wk for 3wk. The modified constraint induced movement therapy (mCIMT) group received the intervention for 3hr/d, 5d/wk for 3wk. One of the control groups had unfavourable prognosis whereas a second control group had a favourable prognosis based on voluntary finger extension; both received usual care for 3wk and were compared to the experimental groups respectively.	**Primary Outcomes:** Action Research Arm Test (ARAT). **Secondary Outcomes:** Fugl Meyer Assessment (FMA-UE), Wolf Motor Function Test (WMFT), Motricity Index for the Upper Extremity (MI-UE), Erasmus modification of the Nottingham Sensory Assessment of the Upper Extremity (EmNSA-UE), Nine Hole Peg Test (NHPT), Frenchay Arm Test (FAT), Motor Activity Log-Quality of movement (MAL-QOL), Motor Activity Log-Amount of Use (MAL-AOU), Hand Domain of the Stroke Impact Scale (SIS-Hand). Outcomes were assessed at baseline and at 5, 8, 12,	There were no significant differences between the EMG-NMES and the control group (i.e. unfavorable prognosis) on the ARAT, FMA-UE, MI-UE, EmNSA-UE, WMFT, NHPT, MAL-AOU, MAL-QOM, FAT, and the SIS-Hand at any time point.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
				and 26wk post-treatment.	
Wilson et al. 2016 **USA** **RCT**	CA: ☒ Blinding: Assessor ☑ Patient ☒ ITT: ☑	122 patients within 6 months of stroke onset.	Participants received either cyclic neuromuscular electrical stimulation (cyclic NMES), or electromyographically (EMG)-triggered NMES, or sensory stimulation which involved surface electrodes set above sensory threshold but below motor threshold. Each intervention was provided for 40min/session, 2sessions/day, 5day/wk for 8 weeks.	**Primary Outcomes:** Fugl Meyer Assessment (FMA-UE). **Secondary Outcomes:** Arm Motor Ability Test (AMAT). Outcomes were assessed at baseline, mid-treatment, end of treatment, 1mo, 3mo, and 6mo after the completion of treatment.	No statistically significant differences between the groups was found on any outcome across time.
Cui et al. 2015 **China** **RCT**	CA: ☒ Blinding: Assessor ☑ Patient ☒ ITT: ☑	45 patients with subacute stroke (12hr-NMES group: 12.6wk; 30min-NMES group: 12.8wk; control group: 14.4wk).	Participants were randomized to one of three groups: (1) 12hr-NMES group which received 12 hours of NMES and conventional rehabilitation, (2) 30min-NMES group which received 30min of NMES and conventional rehabilitation, or (3) control group which received conventional rehabilitation. Electrical stimulation treatment was provided for 12hr or 30min session/d respectively, 6d/wk for 4wk.	**Primary Outcomes:** Fugl Meyer Assessment-proximal (shoulder/elbow) (FMA-p), Fugl Meyer Assessment-distal (wrist/hand) (FMA-d), Action Research Arm Test (ARAT), Modified Ashworth Scale (MAS). Outcomes were assessed at pre-, post-intervention and at 8wk follow-up.	There were no significant within-group and between-group differences regarding the MAS scores at 4 or 8wk. All groups demonstrated within-group improvements at 4 and 8wk on the FMA-p, FMA-d and the ARAT (all $p<0.05$). Significant improvements in the FMA-d were found in the 12h-NMES group compared with the NMES group at 4 and 8wk ($p=0.007$; $p=0.003$). Significant improvements in the FMA-p were obtained in the 12h-NMES group compared with the control group at 4 and 8wk ($p=0.01$; $p=0.000$).
Vafadar et al. 2015 **Canada** **Systematic review**	N/A	10 trials (9 RCTs and 1 quasi-RCT) evaluated the evidence for the effect of FES on shoulder subluxation,	Comparison of conventional therapy or conventional PT with OT versus electrical stimulation.	**Primary Outcomes:** Motor Assessment Scale, EMG measurements of supraspinatus and deltoid, Fugl Meyer Assessment,	Motor function: SMD=0.36, 95% CI -0.27 to 0.99, I^2=80%, p=0.26. Adverse events: No reporting.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
& meta-analysis		pain and UE motor function when added to conventional therapy. 9 studies evaluated UE motor function, of which only 6 applied FES during the early stages of stroke recovery (<6mo). Data from 5 trials was used to generate a meta-analysis (295 subjects).	Frequency of the intervention ranged from 1x/d to 5x/d and lasted from 4 to 6wk. Data on stimulation parameters was not provided.	Action Research Arm Test, Frenchay Arm Test, Motricity Index, Brunnstrom stages, Ashworth Scale. Assessment time point of outcomes was not indicated.	
Meilink et al. 2008 **Netherlands** **Systematic review and meta-analysis**	N/A	8 RCTs (157 subjects) Subjects in 6 of the studies were recruited in the chronic phase.	Examination of the effectiveness of surface EMG-NMES on motor recovery. Treatment: 35-100 Hz, 5-60 mA, average treatment parameter-1 sec ramp up, 5 sec stimulation, 1 sec ramp down, 25 sec rest. Duration 2-3 x/day for 30 min, 3-4 days/week for 2-8 weeks. Control condition was either no treatment or conventional therapy Treatment contrasts also included EMG-NMES vs. cyclical NMES	**Primary Outcomes:** ARAT, Fugl Meyer Assessment (UE), Block & Box test, reaction time. No indication of timing of outcome assessment.	FMA (UE): SMD=0.10, 95% CI -0.43 to 0.64, p=0.35. Results from 3 studies included. Box & Block test: SMD=0.37, 95% CI -0.27 to 1.01, p=0.13. Results from 3 studies included. ARAT; SMD=0.0, 95% CI -0.56 to 0.57, p=0.5. Results from 2 studies included. Reaction time: SMD=0.41, 95% CI -0.20 to 1.03, p=ns. Results from 2 studies included. Adverse events: No reporting.
Langhorne et al. 2009 **UK** **Systematic review and meta-analysis**	N/A	10 trials (126 subjects) specific to UE identified from a Cochrane review (Pomeroy et al. 2009) from 24 studies that examined electrostimulation for	Comparison of single channel, multi-channel, patterned multichannel stimulators, EMG-triggered FES, TENS +/- conventional therapy vs. control condition (no	**Primary Outcomes:** Box & Block test, Fugl Meyer Assessment (UE), MAL, Jebsen-Taylor Hand Function test, MAS, Upper Extremity Function test, ARAT, 9-Hole Peg Test.	Arm Function: SMD=0.47, 95% CI -0.03 to 0.97, p=ns. (227 subjects). Hand function: SMD=0.12, 95% CI -0.34 to 0.59, p=ns (71 subjects). Adverse events: No reporting.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
		promoting recovery of movement or functional ability after stroke + an additional 5 RCTs were identified Subjects in 8 studies were recruited during the chronic phase of stroke, subjects in 7 studies were recruited during the acute or subacute phase.	stimulation, sham stimulation). Frequency of intervention ranged from one to 5x/week for a duration of up to 5 months. Details of the specific magnitudes of the stimulation and treatment protocols are difficult to summarize.	Outcomes were assessed before and after treatment. In a single trial, additional assessments were conducted at 4, 8 and 12 weeks post intervention.	(authors recommend that FES of the arm or leg should not be used on a routine basis)

Non-Invasive Brain Stimulation

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
tDCS					
Chhatbar et al. 2016 **USA** **Systematic review and meta-analysis**	N/A	8 RCTs (213 subjects) investigating the role of tDCS (≥5 sessions) in post stroke recovery of upper limb.	Comparisons were conducted between active and sham tDCS stimulation groups.	**Primary Outcomes:** Fugl Meyer Assessment (FMA-UE). Hodge's g effect sizes were calculated, and evaluated based on the criteria: <0.2 = mild ~0.5 = moderate >0.8 = strong	**Hodge's g effect sizes:** tDCS (n=8): SMD=0.61, 95% CI 0.08 to 1.13, I^2=71%, p=0.02. [moderate effect size] Anodal tDCS (n=3): SMD=0.21, 95% CI -0.72 to 1.14, I^2=71%, p=0.65. Cathodal tDCS (n=4): SMD=0.43, 95% CI -0.23 to 1.08, I^2=45%, p=0.2. Bihemispheric tDCS (n=3): SMD=1.30, 95% CI -0.14 to 2.75, I^2=81%, p=0.08. Acute stroke (n=6): SMD=0.18, 95% CI -0.30 to 0.66, I^2=51%, p=0.47. Chronic stroke (n=4): SMD=1.23, 95% CI 0.20 to 2.25, I^2=71%, p=0.02. [strong effect size] **Meta-analysis:**

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
					tDCS (n=7): SMD=-0.06, 95% CI -0.31 to 0.20, I^2=0%, p=0.65. Anodal tDCS (n=2): SMD=-0.18, 95% CI -0.63 to 0.27, I^2=0%, p=0.43. Cathodal tDCS (n=4): SMD=0.03, 95% CI -0.37 to 0.42, I^2=0%, p=0.9. Bihemispheric tDCS (n=3): SMD=-0.05, 95% CI-0.59 to 0.49, I^2=0%, p=0.85. Acute stroke (n=5): SMD=-0.08, 95% CI -0.38 to 0.23, I^2=0%, p=0.62. Chronic stroke (n=4): SMD=-0.02, 95% CI -0.49 to 0.46, I^2=0%, p=0.65.
Straudi et al. 2016 **Italy** **RCT**	CA: ☒ Blinding: Assessor ☑ Patient ☑ ITT: ☒	23 stroke patients stratified by time post stroke onset (subacute: <6mo, chronic: >6mo)	Participants were allocated to one of two groups: robot-assisted therapy with real tDCS (RAT-tDCS), or to the control group which received RAT with sham tDCS. Each patient underwent 10 sessions (5 sessions/wk) for 2wk.	**Primary Outcomes:** Fugl Meyer Assessment (FMA-UE), Box and Block Test (BBT), Motor Activity Log-Amount of Use and Quality of Movement (MAL-QOM, MAL-AOU). Outcomes were assessed before and after the intervention.	No significant differences were found between the groups regarding any of the outcome measures. However, when the analysis was adjusted for stroke type and duration, a significant interaction effect ($p < 0.05$) was detected, showing that stroke duration (subacute vs. chronic) and type (cortical versus subcortical) modify the effect of tDCS and robotics on motor function. Patients with chronic and subcortical stroke benefited more from the treatments than patients with acute and cortical stroke, who presented very small changes. Adverse events were reported: mild side effects, skin redness under the site of stimulation, headache, sleepiness, and neck pain.
Triccas et al. 2016 **UK** **Systematic review and meta-analysis**	N/A	9 RCTs (371 subjects) were evaluated to determine the effect of multiple sessions of tDCS on upper limb motor function.	Different treatment parameters were evaluated: anodal, cathodal, bihemipsheric. Comparisons include tDCS with rehabilitation vs. sham tDCS with rehabilitation.	**Primary Outcomes:** Fugl Meyer Assessment (FMA-UE). Assessments were conducted at post intervention, short-term follow-up, and long-term follow-up.	**tDCS + rehab vs. Sham + rehab:** Post intervention (n=7): SMD=0.11, 95% CI -0.17 to 0.38, I^2=0%, p=0.44. Short-term follow-up (n=2): SMD=0.27, 95% CI -0.40 to 0.95, I^2=0%, p=0.43. Long-term follow-up (n=2): SMD=0.23, 95% CI-0.17 to 0.62, I^2=79%, p=0.26. **Anodal tDCS + rehab vs. sham + rehab:**

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
					Post intervention (n=3): SMD=0.01, 95% CI -0.39 to 0.41, I^2=0%, p=0.98. **Cathodal tDCS + rehab vs. sham + rehab:** Post intervention (n=3): SMD=0.1, 95% CI -0.26 to 0.47, I^2=0%, p=0.59. **Bihemispheric tDCS + rehab vs. sham + rehab:** Post intervention (n=2): SMD=0.17, 95% CI -0.5 to 0.84, I^2=0%, p=0.62.
Elsner et al. 2016 **Germany** **Systematic review and meta-analysis**	N/A	32 studies (748 subjects within all phases of stroke onset) to December 2015.	Comparisons were made between tDCS versus sham stimulation, and between tDCS versus PT.	**Primary Outcomes:** Measures of ADL. **Secondary Outcomes:** Upper limb motor function outcomes, lower limb motor function outcomes, muscle strength, cognitive assessments, dropouts, adverse events.	**Upper limb motor function:** Post intervention (n=12): SMD=0.11, 95% CI -0.17 to 0.39, I^2=41%, p=0.43. Follow-up (n=4): SMD=0.01, 95% CI -0.48 to 0.5, I^2=55%, p=0.96. **Dropouts, adverse events, deaths:** During intervention (n=23): SMD=0.1, 95% CI -0.02 to 0.03, I^2=0%, p=0.85. **Acute/subacute phase (1wk-4wk post onset):** Post intervention (n=4): SMD=0.22, 95% CI -0.07 to 0.51, I^2=0%, p=0.13. **Post acute phase (1mo-6mo post onset):** Post intervention (n=2): SMD=0.3, 95% CI -0.22 to 0.82, I^2=56%, p=0.26. **Chronic phase (beyond 6mo):** Post intervention (n=4): SMD=-0.01, 95% CI -0.41 to 0.4, I^2=0%, o=0.98.
Triccas et al. 2015 **UK** **RCT**	CA: ☑ Blinding: Assessor ☑ Patient ☑ ITT: ☒	23 post stroke patients (12 sub-acute, 11 chronic)	Participants were stratified based on their chronicity (subacute and chronic). Each group then randomized participants to receive tDCS and robot therapy, or sham tDCS and robot therapy. Each session lasted approximately 1hr15min, totaling to 18	**Primary Outcomes:** Fugl Meyer Assessment (FMA-UE). **Secondary Outcomes:** Action Research Arm Test (ARAT), Motor Activity Log (MAL), Stroke Impact Scale (SIS). Outcomes were assessed	No significant difference was found for FMA-UE, MAL, SIS, and the ARAT between tDCS and sham stimulation at post-intervention and at follow-up. **Subacute group (both tDCS and sham):** FMA-UE: post intervention (p <0.001), follow-up (p=0.001) ARAT: post intervention (p=0.03), follow-up (n.s.) MAL: post intervention (p<0.05), follow-up (p<0.05) SIS: post intervention (p=0.01), follow-up (p<0.001)

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
			sessions over an 8wk period (approx. 2-3 sessions/wk).	at baseline, at post-intervention, and at 3mo follow-up.	**Chronic group (both tDCS and sham):** FMA-UE: post intervention (p=0.001), follow-up (n.s.) ARAT: post intervention (n.s.), follow-up (n.s.) MAL: post intervention (n.s.), follow-up (n.s.) SIS: post intervention (n.s.), follow-up (p=0.005) Adverse events reported: itching, tingling, warmth, burning, pain, light flashes, headaches.
Lee et al. 2014 **Korea** **RCT**	CA: ☒ Blinding: Assessor ☑ Patient ☒ ITT: ☒	59 subjects <1 mo post-stroke with impaired unilateral UE motor function.	Subjects were randomized into one of three groups: 1) Group A-cathodal tDCS, 2) Group B-virtual reality (VR), or 3) Group C-tDCS plus VR. In addition to their specified group treatments, all participants received standard therapy. In total, 15 treatments were received over a 3-wk period.	**Primary Outcomes:** Manual Muscle Test (MMT), Manual Function Test (MFT), Fugl-Meyer Assessment (FMA), Box and Block Test (BBT), Korean-Modified Barthel Index (K-MBI). Outcomes were assessed at pre- and post-treatment.	Changes in scores on the MFT and FMS were significantly different between the three groups (p=0.021, p=0.03 respectively). Improvement in Group C was significantly greater compared to Group A and B on MFT (Group C vs. Group A, p=0.016; Group C vs. Group B, p<0.01). Group B also had a significantly greater improvement in MFT score compared to Group A (p<0.01). FMS score improvement was significantly greater in Group C than Group A (p=0.013) and Group B (p<0.01). Further, Group A was significantly improved compared to Group B (p=0.035). In all three groups, significant increases were noted in the MMT (shoulder) and K-MBI. Only Group C showed a significant increase on the Box and Block Test (p-values were not provided).
Fusco et al. 2014 **Italy** **RCT**	CA: ☒ Blinding: Assessor ☑ Patient ☑ ITT: ☒	14 stroke patients, 19d post stroke onset.	Participants were randomized to the experimental group which received cathodal tDCS plus rehabilitation, or to the control group which received sham tDCS plus rehabilitation. The stimulation was provided for 10d.	**Primary Outcomes:** Canadian Neurological Scale (CNS), Barthel Index (BI), Nine Hole Peg Test (NHPT), dynamometry for pinch and grasp forces, Fulg Meyer Assessment (FMA-UE). Outcomes were assessed at baseline, after stimulation, 30d from ending of stimulation, and at	There were no significant differences between the groups on all outcome measures.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
				discharge.	
Khedr et al. 2013 **Egypt** **RCT**	CA: ☑ Blinding: Assessor ☑ Patient ☑ ITT: ☑	40 subjects with ischemic stroke resulting in acute hemiparesis, mean time since onset of stroke 12.9 days.	Subjects were randomized into one of three groups: 1) anodal tDCS over affected hemisphere, 2) cathode tDCS over unaffected hemisphere, or 3) sham stimulation. Treatment lasted 25 min for 6 consecutive days over the motor cortex hand area.	**Primary Outcomes:** Orgogozo's MCA scale (OMCASS), Barthel Index (BI), Friedman test. Outcomes were assessed at pre-, post-, 1, 2, and 3 months post treatment.	There was a significant time x group (real vs. sham) effect on the OMCASS (p=0.005) and BI (p=0.006). A significant time x group effect for anodal vs. sham was noted on OMCASS (p<0.001), BI (p=0.002) and marginally significant effect for cathodal vs. sham OMCASS (p=0.033) and BI (p=0.017). A significant improvement of strength was noticed in all groups post-treatment on the Friedman Test (p<0.0001). A greater improvement was found in the combined group than in the sham group for shoulder abduction, foot dorsiflexion, and hip flexion (p=0.005).
Wu et al. 2013 **USA** **RCT**	CA: ☒ Blinding: Assessor ☑ Patient ☑ ITT: ☑	90 subjects, 2-12 mo post-stroke with upper extremity spasticity.	Subjects were randomized into one of two groups: 1) tDCS to the primary sensorimotor cortex of the affected hemisphere with cathodal stimulation, or 2) sham stimulation to the same area. Stimulation sessions lasted 20 minutes/day, 5 days/week, for 4 wk. Both groups also received physiotherapy for two 30 min sessions per day, for 4 wk.	**Primary Outcomes:** Fugl-Meyer Assessment (FMA) of motor recovery, Barthel Index (BI) **Secondary Outcomes:** Modified Ashworth Scale (MAS) Outcomes were assessed pre-, post-treatment and follow up.	Post-intervention, compared to the sham group, the tDCS group showing greater improvements on FMA (p<0.001), and BI (p<0.05). At 4-week follow up, the tDCS showed significantly greater improvement on FMA (p<0.001) and BI (p<0.01) than the sham group.
rTMS					
Harvey et al. 2018 **USA** ***Navigated Inhibitory rTMS to Contralesional Hemisphere Trial***	CA: ☒ Blinding: Assessor ☑ Patient ☑ ITT: ☑	199 patients, recruited from 12 outpatient rehabilitation centres, ≥18 years with a unilateral ischemic or hemorrhagic stroke occurring within 3 to 12 months of enrollment,	Patients were randomized to receive 1 Hz active or sham rTMS to the noninjured motor cortex before each of 18, 60-minute therapy sessions, delivered over 6-weeks	**Primary outcome:** A 5-point change (considered clinically meaningful using Fugl Meyer Assessment scores (upper extremity) at 6 months following end of treatment.	167 patients completed the treatment. 67% of the experimental group and 65% of sham group improved ≥5 points on 6-month upper extremity Fugl-Meyer (p=0.76). At 6 months, there was also no difference between experimental and sham groups in the ARAT

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
(NICHE)		and with a Chedoke assessment stage of 3-6 for both arm and hand. Mean age was 58.7 tears, 65.3% were men.		**Secondary outcomes:** Action Research Arm Test (ARAT) and Wolf Motor Function Test (WMFT) testing hand speed and dexterity.	(p=0.80) or WMF (p=0.55)
Yang et al. 2017 **Hong Kong** **RCT**	CA: ☑ Blinding: Assessor ☑ Patient ☑ ITT: ☑	60 inpatients in the subacute phase of stroke recovery (rTMS+SC group: 36.6d, rTMS group: 37.5d, control group: 42.5d)	Patients were randomly assigned to three groups: rTMS with sensory cueing (rTMS+SC), rTMS, and conventional rehabilitation. rTMS was provided at 1Hz over the contralesional hemisphere, while vibration cueing was emitted using a wristwatch device on the hemiplegic arm, wore for 5d/wk, for 2wk. All participants received conventional rehabilitation.	**Primary Outcomes:** Behavioral Inattention Test (BIT), Catherine Bergego Scale (CBS). **Secondary Outcomes:** Fugl Meyer Assessment (FMA-UE), Action Research Arm Test (ARAT), Barthel Index (BI). Outcomes were assessed at baseline, after the intervention, and at 6wk follow-up.	There were no significant differences between groups on the ARAT, FMA-UE, and the BI.
Du et al. 2016 **China** **RCT**	CA: ☑ Blinding: Assessor ☑ Patient ☑ ITT: ☑	69 fist ever ischemic stroke with motor deficits in the acute stage of stroke recovery (rTMS-3Hz group: 7d; rTMS-1Hz group: 6d; control group: 8d).	Participants were randomized to receive either received 1200 10s pulses of 3Hz ipsilesional rTMS (rTMS-3Hz group), or 1200 30s pulses of 1Hz contralesional rTMS (rTMS-1Hz group), or sham stimulation (control group). Each patient received daily rTMS for 5 days.	**Primary Outcomes:** Fugl Meyer Assessment (FMA-UE) **Secondary Outcomes:** Medical Research Council scale (MRC), National Institute of Health Stroke Scale (NIHSS), Modified Rankin Scale (mRS), Barthel Index (BI). Outcomes were conducted at baseline, post-intervention, 5d post intervention, 2mo and at 3mo follow-up.	FMA-UE: rTMS-1Hz vs. sham (p=0.046). No other significant between-group differences were found. MRC: rTMS-1Hz vs. sham at 2mo (p=0.002), and at 3mo (p=0.001). NIHSS: rTMS-3Hz vs. sham (p=0.042), rTMS-1Hz vs. sham (p=0.017). No other significant between-group differences were found. BI: rTMS-3Hz vs. sham (p=0.019), rTMS-1Hz vs. sham (p=0.001). No other significant between-group differences were found. mRS: scores were significantly different between groups at 5d (p0.008), 2mo (p<0.001), and at 3mo (p=0.006).

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Graef et al. 2016 **Brazil** **Systematic review and meta-analysis**	N/A	11 RCTs (199 subjects) evaluated the effect of rTMS on upper limb motor function. 8 RCTs were conducted in the chronic stage of stroke recovery, and 2 were in the acute stage. 8 RCTs were included in the meta-analysis.	Intervention comparators include: rTMS combined with other therapies versus sham rTMS combined with other therapies or CIMT. Total stimulation sessions ranged from 8 to 22.	**Primary Outcomes:** Fugl Meyer Assessment (FMA-UE), Wolf Motor Function Test-function score (WMFT-FAS), Wolf Motor Function Test-time score (WMFT-TIME), Action Research Arm Test (ARAT), Box and Block Test (BBT).	FMA-UE (n=4): MD=0.5, 95% CI -0.2 to 3.20, I^2=0%, p=0.72. 1 acute RCT included in the analysis. WMFT-FAS (n=3): MD=3.60, 95% CI -3.73 to 10.94, I^2=53%, p=0.34. 1 acute RCT included in the analysis. WMFT-TIME (n=4): MD=0.73, 95% CI -0.93 to 2.39, I^2=0%, p=0.72. 1 acute RCT included in the analysis. ARAT (n=3): MD=-0.32, 95% CI -6.26 to 5.62, I^2=0%, p=0.92. 1 acute RCT included in the analysis. BBT (n=2): MD=2.87, 95% CI -3.59 to 9.33, I^2=0%, p=0.38. Adverse events: No reporting.
Hosomi et al. 2016 **Japan** **RCT**	CA: ☒ Blinding: Assessor ☑ Patient ☑ ITT: ☒	41 participants from 2 rehabilitation hospital in the subacute stroke phase (rTMS group: 46.1d; sham group: 45.1d)	Participants were randomly assigned to either the experimental group which received real rTMS or to the control group to receive sham-rTMS. Each intervention session consisted of 10 5-Hz rTMS (real or sham) applied to the ipsilesional primary motor cortex. The stimulation was provided daily for a total of 10 sessions (12d). All participants received standard rehabilitation therapy on a daily basis.	**Primary Outcomes:** Fugl Meyer Assessment-total, proximal and distal (FMA-UE, FMA-p, FMA-d), Brunnstrom's stages for hand and arm (BRS-Hand; BRS-Arm), hand grip, National Institute of Health Stroke Scale (NIHSS), Functional Independence Measure (FIM), finger tapping motion. Assessment for all evaluations except finger tapping was provided at baseline, after 5d of stimulation, after 12d of stimulation, and on day 29 post randomization.	By 29d, improvements in the rTMS group were significantly greater in the BRS-Hand compared to the sham group (p=0.037). No differences were found on the BRS-Arm at this time point. No significant difference between the two groups was found for finger tapping motion. Both groups improved on the FMA (all scales), NIHSS total score, and FIM. No between group analyses were conducted to determine potential differences. Hand grip strength improved only in the rTMS group (p=0.041).
Li et al. 2016	CA: ☒	127 participants with upper-limb dysfunction	Participants received either low frequency	**Primary Outcomes:** Fugl-Meyer Assessment	There was a significant increase in the LF-rTMS and HF-rTMS compared to the sham stimulation

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
China **RCT**	Blinding: Assessor ☒ Patient ☑ ITT: ☒	during the subacute phase of stroke (HF-rTMS group: 1.36mo, LF-rTMS group; 1.86mo, sham rTMS group: 1.58mo)	rTMS (1Hz), high frequency rTMS (10Hz), or sham stimulation daily for 20min, 5d/wk for 2wk.	(FMA-UE), Wolf Motor Function Test (WMFT). Outcomes were assessed at pre- and post-intervention.	regarding FMA-UE scores. There were no significant between group differences on the WMFT.
Kim et al. 2014 **Korea** **RCT**	CA: ☑ Blinding: Assessor ☑ ITT: ☑	31 subjects post stroke with a score <2 on the Modified Ashworth Scale, and a score higher than fair on the Manual Muscle test.	Subjects were randomly assigned to either rTMS (10 sec, 10 Hz), or rTMS with sessions lasting 10 min, 5x/wk for 4 wk. Subjects also received 30 min of task orientation training (maneuvering of objects along with increasing the number of repetitions and difficulty).	**Primary Outcomes:** Motor Function Test (MFT) Outcomes were assessed at baseline and 4 wk follow-up.	There was a significant improvement in MFT at 4 weeks in the rTMS group (13.20±5.00 to 22.20±2.86, p<0.05). The sham rTMS also demonstrated an improvement in MFT but to a smaller degree at 4 weeks (14.20±2.82 to 16.90±2.13, p<0.05). Improvements in the rTMS group were significantly greater compared to the sham rTMS group (p<0.05).
Le et al. 2014 **China** **Systematic Review and Meta-Analysis**	N/A	8 RCTs (273 subjects, >18 yr) published in English between 1990 and 2012 that examined the effect of rTMS on hand function and plasticity of the motor cortex; time since stroke onset ranged from 5 days to 10.7 years.	The frequency of rTMS ranged from 1 Hz to 25 Hz. Stimulation sites of low-frequency rTMS were primary motor cortex and premotor cortex whereas high-frequency rTMS occurred at M1. Seven studies examined rTMS compared to a control and in the remaining study it was compared to constraint induced movement therapy. Treatments duration ranged from 1 day to 10 days, with a frequency of 0.4-1 sec to 25 min.	**Primary Outcomes:** Finger dexterity, hand function	Finger coordination and hand function (at 3Hz) demonstrated a significant standard mean difference of 0.58 (p=0.01) and -0.82 (p=0.007), respectfully. No improvement was demonstrated for hand function at 10Hz (p=0.34) compared to control groups.
Wang et al. 2014 **China** **RCT**	CA: ☑ Blinding Assessor: ☑	48 subjects 2-6 post stroke with a grade of 3 or more on the distal Medical Research Council Scale (MRC).	Subjects were randomized into one of three groups: 1) Group A received rTMS (10 sessions, 1 Hz) over the	**Primary Outcomes:** MRC proximal and distal, Fugl-Meyer Assessment (FMA), Wolf Motor Functioning Test (WMFT)	Group A showed the largest improvement out of the three experimental groups. Group A demonstrated various improvements: MRC (proximal) from 2.6±1.5 to 3.9±1.0 (p<0.01), MRC (distal from 2.3±1.6 to 3.4±1.4 (p<0.05), FMA from 26.2±21.6 to

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
	ITT: ☑		unaffected hemisphere and then intermittent theta burst stimulation (iTBS) over the affected area (3 sessions, 50Hz), 2) Group B received had the same protocol as Group A but in the reverse order, 3) Group C received sham stimulation in the same order as Group A. Treatment lasted 4 wk. All subjects also received physiotherapy for one hour (task orientation).	Outcomes were assessed at baseline, post intervention, and at 3 month follow-up.	36.6±24.0 ($p<0.001$), and WMFT from 30.4±14.5 to 40.3±29.1 ($p<0.001$). Group B demonstrated less improvement on motor skills than Group A with MRC (proximal) of 2.6±1.3 to 3.8±1.5 ($p<0.01$), MRC (distal) of 2.4±1.3 to 3.7±1.3, FMA of 28.4±24.1 to 34.7±28.3 ($p<0.01$), and WMFT of 30.9±15.7 to 36.5±23.5 ($p<0.05$). FMA was particularly improved in Group A but not in other groups. Group C in comparison to the other groups showed the least improvement.

EMG-Biofeedback

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Langhorne et al. 2009 **UK** **Systematic review & meta-analysis**	N/A	4 trials (126 subjects) specific to upper extremity identified from a Cochrane review (Woodford & Price 2009) from 13 studies that examined EMG biofeedback for the recovery of motor function after stroke Subjects in these 4 studies were recruited an average of 2-8 weeks (n=1),4 months (n=2) and 19 months (n=1) following stroke	Treatment contrasts: Exercise program plus EMG-BFB or exercise plus placebo EMG-BFB 20-minute sessions 5 times a week for 4 weeks Physiotherapy alone vs. physiotherapy plus EMG-BFB 45-minute sessions 3 times a week for 5 weeks Physiotherapy alone vs. physiotherapy plus EMG-BFB for 12 weeks	Upper Extremity Function Test, ARAT Outcomes were assessed before and after treatment. 12-week follow-up in one study.	Arm function: SMD=0.41, 95% CI 0.05 to 0.77, $p<0.05$ (Author recommends that biofeedback should not be used on a routine basis) Adverse events: No reporting

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
			20 sessions of EMG-BFB plus physiotherapy or physiotherapy alone		

Virtual Reality

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Laver et al. 2017 **Australia** **Cochrane Review**	N/A	72 RCTs (2470 subjects), of which 22 RCTs (1038 subjects) evaluated upper limb motor function and activity.	Comparison of upper limb training programs using virtual reality or control condition (therapy only). 22 RCTs used commercially available gaming consoles: 1 RCT used Playstation EyeToy, 15 RCTs used Nintendo Wii, 4 RCTs used Microsoft Kinect, 2 RCTs used mixed gaming consoles, 8 RCTs, used GestureTek IREK, 1 RCT used Armeo, 1 RCT used CAREN and 1 RCT used Lokomat. Dosage of therapy varied: 22 RCTs delivered 6-10hr, 26 RCTs delivered 11-20hr, 7 RCTs delivered >21hr, or a combination of high intensity and low intensity.	**Primary Outcomes:** Fugl Meyer Assessment (FMA-UE), Motor Assessment Scale (MAS-UE), Action Research Arm Test (ARAT), Wolf Motor Function Test (WMFT), Box and Block Test (BBT), Jebsen Taylor Hand Function Test (JTHFT), grip strength. Outcomes were assessed before and after treatment in all studies.	Virtual reality vs. conventional therapy: Arm function (composite measure): SMD (n=22; 1038 subjects)=0.07, 95% CI -0.05 to 0.20, I^2=43%, p=0.25. FMA-UE (n=16; 599 subjects): MD=2.85, 95% CI 1.06 to 4.65, I^2=30%, p=0.0018. Grip strength (n=6; 266 subjects): SMD=-0.02, 95% CI -0.27 to 0.22, I^2=44%, p=0.25. Amount of Use (n=5; 161 subjects): SMD=-0.11, 95% CI -0.42 to 0.21, I^2=0%, p=0.5. Upper limb motor function up to 3mo follow-up (n=9; 366 subjects): SMD=0.11, 95% CI -0.10 to 0.32, I^2=0%, p=0.3. Upper limb function (stroke onset <6mo; n=7; 555 subjects): SMD=-0.06, 95% CI -0.23 to 0.11, I^2=65%, p=0.47. Adverse events: 23 studies reported data. 19 RCTs reported no significant adverse events. Reported adverse events include: transient dizziness and headache (2 RCT), pain cause by treatment (2 RCT), and hypertonicity (1 RCT).
Adie et al. 2017 **UK**	CA: ☑ Blinding: Assessor ☑	240 participants with arm weakness recruited within 6mo of stroke onset (experimental	Participants were randomized to the experimental group which received VR based	**Primary Outcomes:** Action Research Arm Test (ARAT) at 6wk.	There were no significant differences observed on any of the outcomes at any time point.

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RCT	Patients ☑ ITT: ☑	group: 57.3d, control group: 56.3d) from 10 stroke centres in the UK.	therapy, or to the control group and received tailored arm exercises. Both groups were instructed to exercise for up to 45min/d for 6wk in a seated position at home.	**Secondary Outcomes:** Action Research Arm Test (ARAT) at 6mo, Canadian Occupational Performance Measure (COPM), Stroke Impact Scale (SIS), Modified Rankin Scale (MRS), EQ-5D. Outcomes were assessed at baseline, after the intervention, and at 6mo.	
Brunner et al. 2017 **Denmark** **RCT** **VIRTUES trial**	CA: ☑ Blinding: Assessor ☑ Patients ☒ ITT: ☑	120 participants with upper extremity motor impairment within 12 weeks of stroke onset recruited from 5 rehabilitation institutions Time since stroke onset: virtual reality group=35d, control group=35d.	Participants were randomized either to the virtual reality group or to the control group. The training comprised of a minimum of 16 sessions (60min/session) over 4wk.	**Primary Outcome:** Action Research Arm Test (ARAT). **Secondary Outcome:** Box and Blocks Test (BBT), Functional Independence Measure (FIM). Outcomes were assessed at baseline, after the intervention, and at 3mo follow-up.	There were no significant between-group differences on any of the outcomes.
Kong et al. 2016 **Singapore** **RCT**	CA: ☑ Blinding: Assessor ☑ Patients ☒ ITT: ☑	105 individuals admitted to an inpatient rehabilitation program within 6wk of stroke onset.	Participants were randomized to the experimental group which received virtual reality and conventional rehabilitation, or to the conventional therapy group which only receive conventional therapy or to the control group which received only 1hr of occupational therapy daily. The experimental and conventional therapy groups received 12 sessions of therapy delivered 4x/wk over	**Primary Outcomes:** Fugl Meyer Assessment (FMA-UE) at 3wk. **Secondary Outcomes:** FMA-UE at 7 and 15wk, Action Research Arm Test (ARAT), Stroke Impact Scale (SIS), Functional Independence Measure (FIM), VAS pain. All outcomes were assessed at baseline, after the intervention, at 7 and at 15wk.	There was no significant difference between groups on the FMA-UE, ARAT, SIS, and FIM at any time point.

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			3wk, with each session lasting 60min.		
Saposnik et al. 2016 **Canada** **RCT** **EVEREST trial**	CA: ☑ Blinding: Assessor ☑ Patients ☒ ITT: ☑	141 participants with first ever stroke within 3mo of stroke onset recruited from 14 inpatient stroke rehabilitation units in 4 countries.	Participants were randomly allocated to the experimental group which received virtual reality task-oriented training, or to the control group which received conventional rehabilitation including an active activity (i.e. playing Jenga, ball game, cards). The therapy was provided for 60min/sessions, for a total of 10 sessions over 2wk	**Primary Outcomes:** Wolf Motor Function Test (WMFT). **Secondary Outcomes:** Box and Blocks Test (BBT), Stroke Impact Scale (SIS), Barthel Index (BI), Functional Independence Measure (FIM), Modified Rankin Scale (MRS), grip strength. Outcomes were assessed at baseline, after the intervention and at 4wk post intervention.	No significant between-group difference on the WMFT, MRS, BI, SIS, FIM, grip strength was found at any time point. The BBT was higher in the active control group compared to the experimental group at post intervention (p=0.018).
Zheng et al. 2015 **China** **RCT**	CA: ☑ Blinding: Assessor ☑ Patients ☑ ITT: ☒	112 participants with hemiplegia. Time since stroke onset: experimental group=19.3d, control group=18.7d.	Participants were randomly allocated to the experimental group and received virtual reality combined with rTMS, or to the control group which received virtual reality therapy and sham rTMS. Training was provided for 6d/wk for 4wk.	**Primary Outcomes:** Fugl Meyer Assessment (FMA-UE), Wolf Motor Function Test (WMFT). **Secondary Outcomes:** Modified Barthel Index (BI), 36-Item Short Form Health Survey Questionnaire (SF-36). Assessments were conducted before and after treatment.	After treatment, the FMA-UE, WMFT, MBI, and SF-36 scores were higher in the experimental group than in the control group ($p<0.01$; $p<0.01$; $p<0.05$; $p<0.05$).
Kiper et al. 2014 **RCT** **Italy**	CA: ☒ Blind Assessor: ☒ ITT: ☑	44 subjects within one year of a first-ever stroke	Subjects were randomized into one of two groups: 1) reinforced feedback in virtual environment (RFVE) 1hr/day plus traditional rehabilitation (TR), or 2) TR only. Training occurred for 2 hr/day,	**Primary Outcomes:** Fugl-Meyer Upper Extremity Scale (F-M UE), Functional Independence Measure (FIM) Outcomes were assessed at baseline and at 4 wk follow-up.	F-M UE scores significantly increased in only the RFVE group ($p<0.001$) but not the TR group ($p<0.053$). FIM was significantly increased in both the RFVE ($p<0.001$) and TR groups ($p<0.006$).

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
			5x/wk, for 4 wk.		
Lee et al. 2014 **Korea** **RCT**	CA: ☒ Blinding: Assessor ☑ Patient ☒ ITT: ☒	59 subjects <1 mo post-stroke with impaired unilateral UE motor function.	Subjects were randomized into one of three groups: 1) Group A-cathodal tDCS, 2) Group B-virtual reality (VR), or 3) Group C- tDCS plus VR. In addition to their specified group treatments, all participants received standard therapy. In total, 15 treatments were received over a 3-wk period.	**Primary Outcomes:** Manual Muscle Test (MMT), Manual Function Test (MFT), Fugl-Meyer Assessment (FMA), Box and Block Test (BBT), Korean-Modified Barthel Index (K-MBI). Outcomes were assessed at pre- and post-treatment.	Changes in scores on the MFT and FMS were significantly different between the three groups (p=0.021, p=0.03 respectively). Improvement in Group C was significantly greater compared to Group A and B on MFT (Group C vs. Group A, p=0.016; Group C vs. Group B, p<0.01). Group B also had a significantly greater improvement in MFT score compared to Group A (p<0.01). FMS score improvement was significantly greater in Group C than Group A (p=0.013) and Group B (p<0.01). Further, Group A was significantly improved compared to Group B (p=0.035). In all three groups, significant increases were noted in the MMT (shoulder) and K-MBI. Only Group C showed a significant increase on the Box and Block Test (p-values were not provided).
Yin et al. 2014 **Singapore** **RCT**	Blinding: Assessor ☒ Patients ☑ ITT: ☒	23 post-stroke patients with Fugl-Meyer Assessment for the upper extremity (FMA) score of below 62 and Mini Mental State Examination (MMSE) 11 score of above 20.	Participants were randomized to one of two groups: 1) 30 minutes of non-immersive virtual reality training for nine weekdays within two weeks (five days a week) and conventional therapy, or 2) only conventional therapy.	**Primary Outcome:** Fugl-Meyer Assessment (FMA) Outcomes were assessed at baseline, post intervention and 1-month post intervention. Participants' feedback and adverse effects were recorded	All participants improved in FMA scores (mean change (SD) = 11.65 (8.56), p<0.001). These effects were sustained at one month after intervention (mean (SD) change from baseline = 18.67 (13.26), p<0.001). All other outcome measures showed similar patterns. There were no significant differences in improvement between both groups. Majority of the participants found VR training useful and enjoyable, with no serious adverse effects reported.
Sin et al. 2013 **Korea** **RCT**	CA: ☒ Blinding: Assessor ☑ Patients ☒ ITT: ☒	40 hemiplegic participants >6mo post-stroke with active range of motion of the shoulder, elbow, wrist, and fingers of more than 10 degrees	Participants were randomized into one of two groups: 1) virtual reality (VR) training using the Xbox Kinect for 30 min followed by standard occupational therapy for 30 min, or 2) standard occupational therapy	**Primary Outcomes:** Fugl- Meyer Assessment (FMA), Active Range of Motion (AROM) of upper extremity, Box and Block Test (BBT). Outcomes were assessed at pre- and post-intervention.	In both groups FMA motor function scores and BBT gross manual dexterity scores increased significantly (p<0.05). Between the two groups, FMA and BBT scores differed significantly (p<0.05), with the VR group experiencing a greater improvement. Significant improvements were seen in the AROM of flexion, extension and abduction of the shoulder; flexion of the elbow; and flexion and extension of the wrist. Significant differences

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			alone. Therapy was 3x/wk for 6 wks.		between the two groups were noted at follow up for the shoulder and flexion of the elbow (p<0.05).
Turolla et al. 2013 **Italy** **Prospective Controlled Trial**	N/A	376 post-stroke patients with hemiparesis, and a Motor Arm sub-score between 1 and 3 on the Italian version of the National Institute of Health Stroke Scale (It-NIHSS).	Participants were assigned to one of two of groups: 1) upper limb conventional (ULC) rehabilitation, or 2) reinforced feedback in the virtual environment (RFVE) group. Participants received 40 sessions of therapy 5x/wk for 4 wks.	**Primary Outcomes:** Fugl-Meyer Upper Extremity (FM-UE), Functional Independence Measure (FIM) Outcomes were assessed at pre- and post-intervention.	A significant improvement in the FM-UE scores were noted for both groups following treatment, a 4% increase in the ULC group (p<0.001), and a 10% increase in the RFVE group (p<0.001); FIM scores were significantly higher among the RFVE group compared to the ULC group post-treatment (p=0.007). An analysis based on Stroke to Rehabilitation Interval (SRI) sub-groups on the FM-UE scores **s**howed significant improvements for the RFVE group compared to the ULC group on all three sub-groups (p<0.001).
Saposnik et al. 2011 **Canada** **Systematic review and meta-analysis**	N/A	12 studies (5 RCTs) of which 4 recruited subjects in the acute or sub acute phase of stroke and 8 recruited subjects in the chronic phase.	Comparison of VR programs vs. conventional therapy. 8 studies used non-immersive systems. Treatment was provided for 1 hour each weekday in most studies, for 4-6 weeks.	**Primary Outcomes:** Fugl-Meyer Assessment **Secondary Outcomes:** Wolf Motor Function test (WMFT), Box & Block test, Jensen-Taylor Hand Function Test Timing of outcome assessment was not stated-assumed to have been done before and after treatment.	Improvement in Motor impairment: OR= 4.89, 95% CI 1.31 to 18.29, p<0.05. Results from 5 RCTs included. Improvement in Box & Block test: OR=0.49, 95% CI 0.091 to 2.65, p=ns. Results from 2 RCTs included. Improvement in WMFT (manual function): OR=1.012, 95% CI 0.28 to 5.90, p=ns. Results from 3 RCTs included. Adverse events: No reporting

Neurophysiological Approaches

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Van Vliet et al. 2005 **UK** **RCT**	CA: ☑ Blinding: assessor ☑ ITT:☒	120 patients admitted for stroke rehabilitation within 2 weeks of event. Inclusion criteria: able to tolerate at least ½ hour to complete the physical tasks required for initial	Comparison of Bobath based treatment (n=60) vs. motor relearning approach (n=60). Treatment was outpatient based and provided for as long as needed.	**Primary Outcomes:** Rivermead Motor Assessment (RMA), Motor Assessment Scale (MAS). **Secondary Outcomes:** 10-Hole Peg Test, 6 m walk test, MAS, BI, Extended	There were no significant differences between groups on any of the outcome measures at any assessment points. Data from 45 patients in the Bobath group and 42 patients in the Motor relearning group were available for analysis Median RMA (gross function) at baseline and 6 months: Bobath 2 to 8 vs. Motor relearning 1 to 8,

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		evaluation.	No details regarding the content of the treatment programs are provided. Therapy was based on written guidelines consisting of theoretical concepts and clinical objectives.	Activities of Daily Living, Nottingham Sensory Assessment. Outcomes were assessed at 1, 3 and 6 months after randomization.	p=0.61 Median RMA (arm) at baseline and 6 months: Bobath 4 to 10 vs. Motor relearning 4 to 8, p=0.64 Median MAS (Advance hand activities): at baseline and 6 months: Bobath 0 to 6 vs. Motor relearning 0 to 2, p=0.23 Median MAS (Upper arm): at baseline and 6 months: Bobath 3 to 5 vs. Motor relearning 3 to 4, p=0.53 Adverse events: Not reported
Luke et al. 2004 **Australia** **Systematic review and meta-analysis**	N/A	8 studies (5 RCTs) including samples sizes that ranged from 7 to 131 subjects. Time since stroke onset was less than 1 month in 3 studies, varied from 6 weeks to 9 years in 3 studies and was not stated in 2 studies.	Compared a pure Bobath program with a control program (no active control, Motor relearning program, PNF, Brunnstrom, functional retraining). Treatment programs were provided for 30 to 45 minutes 3 to 5 days per week for 3 to 20 weeks.	**Impairment outcomes**: muscle tone, finger oscillation test, VAS (shoulder pain), grip strength, isometric hand extension. **Activity outcomes**: Upper Extremity Function Test (UEFT), ARAT, BI, Rivermead Motor Assessment, Sodring Motor Evaluation Scale (SMES)Box & Block test, 9-Hole Peg test, Motor Assessment Scale (MAS). Outcomes were assessed before and after treatment. 12-week follow-up in one study.	**Impairment** Tone: SMD=0.46, 95% CI 0.01 to 0.91, p<0.05. Results from 1 study included. Finger Oscillation test: SMD= -0.02, 95% CI (-0.75 to 0.71, p>n/s. Results from 1 study included. **Activity** UEFT: SMD=0.17, 95% CI -0.56 to 0.90, p=n/s. Results from 1 study included. MAS: SMD=-0.29, 95% CI -0.80 to 0.21, p =n/s. Results from 1 study included. SMES: SMD= -0.32, 95% CI -0.83 to 0.19, p=n/s. Results from 1 study included. Adverse events: Not reported.
Langhammer & Stanghelle 2000 **Norway** **RCT**	CA: ☑ Blinding: assessor ☑ ITT:☒	61 patients with first-ever stroke admitted acutely to hospital.	Comparison of inpatient physiotherapy programs based on either the Bobath (n=28) or Motor Relearning approach (n=33). Treatment	**Primary Outcomes:** Motor Assessment Scale (MAS). **Secondary outcomes:** Sødring Motor Evaluation	Data from 24 patients in the Bobath group and 29 patients in the Motor relearning group were available for analysis. Subjects in both groups improved over the study period, but subjects in the Motor relearning group

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			sessions in both groups were provided for 40 minutes, 5 days a week during hospitalization. In addition, patients in both groups were treated by a comprehensive, multidisciplinary team. When possible, treatment continued following discharge (home or outpatient).	Scale (SMES), BI, Nottingham Health Profile. Outcomes were assessed 3 days after admission to hospital, two weeks later and at 3 months post stroke.	experienced greater improvement. Mean MAS scores at baseline and 3 months: 24 to 37 vs. 19 to 33, p=0.016; Mean SMES (part 2 sum scores): 47 to 65 vs. 39 to 58, p=0.018. Mean hospital LOS was significantly shorter for patients in the Motor relearning group (21 vs. 38 days, p=0.008). There were no significant differences between groups from baseline to 3 months for: SMES (part 1 or 3 sum scores) Or BI scores. Adverse events: Not reported

Abbreviations

CA: Concealed Allocation	CI: Confidence Interval
FES: Functional Electrical Stimulation	IQR: Interquartile Range
ITT: Intention to treat	N/A: Not Applicable
NMES: Neuromuscular Electrical Stimulation	OR: Odds Ratio
RCT: Randomized Controlled Trial	ROM = Range of Motion
rTDS: Repetitive Transcranial Direct Stimulation	rTMS: Repetitive Transcranial Magnetic Stimulation
SMD = Standardized Mean Difference	tDCS = transcranial direct current stimulation

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