Authors	Title	Year	Kind	Neurotechnology	Intervention modality	Patient's number	Kind of stroke as reported	Design	Conclusions	Average ΔFM-UE pre-post intervention	Average FM-UE at baseline	Clinical outcome measures
Pollock, Farmer *et al*. 2014	Interventions for improving upper limb function after stroke.	2014	Review	Biofeedback, tDCs, TMS, ES, robotics, VR	-	18078	Stroke and others	-	Evidence is insufficient to show which are the most effective interventions for improving upper limb functions. Greater dose of an intervention is better than lesser dose. Need of larger randomized controlled trials.	-	-	-
Laffont, Bakhti *et al*. 2014	Innovative technologies applied to sensorimotor rehabilitation after stroke.	2014	Review	Functional ES, robotics, VR, modulation of sensory afferents, neurofeedback, tDCs, TMS	-	-	-	-	Description of the new technologies for rehabilitation.	-	-	-
Hatem, Saussez *et al*. 2016	Rehabilitation of motor function after stroke: a multiple systematic review focused on techniques to stimulate upper extremity recovery.	2016	Review	Transcutaneous electrical nerve stimulation, TMS, tDCs, DBS, robotics	-	41069	Stroke and others	-	The stroke rehabilitation field faces the challenge to tailor treatments. The interventions can be combined to achieve the maximal motor function recovery for each patient.	-	-	-
McCabe, Monkiewicz *et al*. 2015)	Comparison of robotics, functional electrical stimulation, and motor learning methods for treatment of persistent upper extremity dysfunction after stroke: A randomized controlled trial.	2015	Randomized trial	Robotics and functional ES	60 sessions (5 hours/day, 5 days a week)	39	Chronic Severe	3 groups: intensive motor learning vs intensive motor learning and robotics vs intensive motor learning and functional ES.	There was no significant difference in treatment response across groups. No adverse effects.	**9.9** for the intensive motor learning, **7.7** for the group with robotics, **8.8** for the group with functional ES.	23.6 – 23.5 – 23.6	Arm Motor Ability test (primary); **Fugl-Meyer** (secondary).
Robotics												
Wu, Guarino *et al*. 2016	Long-term effectiveness of intensive therapy in chronic stroke.	2016	Multicenter, randomized controlled clinical trial (VA-ROBOTICS)	Robotics (InMotion2)	12 sessions (4 blocks of 3 weeks)	127	Chronic Moderate-to-severe	3 groups: robotics vs usual care vs intensive usual care.	Motor benefits from intensive therapy compared with usual care were observed at 12- and 36-weeks post therapy. Younger age and shorter time since stroke were associated with	**4.0** for intensive vs usual at 12 weeks and **3.8** at 36 weeks. **3.6** for robotic vs usual at 12 weeks and **5** at 36 weeks.	18.5 – 20.3	**Fugl Meyer** (primary), Modified Ashworth Scale, Wolf Motor Function test, Stroke Impact Scale (secondary)

									greater immediate and long-term improvement of motor functions.			
Colombo, Pisano *et al.* 2017	Comparison of exercise training effect with different robotic devices for upper limb rehabilitation: a retrospective study.	2017	Retrospective multi-center study	Robotics: comparison of three different devices for shoulder and elbow (Braccio di Ferro, InMotion2 and MEMOS)	10 sessions minimum (10 days within 3 weeks)	87	Chronic and subacute	3 groups: one adopting Braccio di Ferro, one the InMotion2 and one the MEMOS robot.	The motor function gains obtained during robot-assisted therapy of stroke patients seem to be independent of the type of robot device used for the training program.	**9.5** for Braccio di Ferro, **7.3** for InMotion2, **7.1** for MEMOS.	20.3 – 26.9 – 24.1	**Fugl Meyer,** Modified Ashworth Scale.
Veerbeek, Langbroek - Amersfoort *et al.* 2017	Effects of robot-assisted therapy for the upper limb after stroke.	2017	Systematic review and meta-analyses	Robotics	From 2 to 12 weeks (time of therapy between 0.5 and 90 hours)	1206	-	Evaluate the effects of robotics in comparison with nonrobotic treatment.	No serious adverse events were reported. Significant but small improvements in motor control and muscle strength of the paretic arm were found. No effects were found for upper limb capacity and basic ADL. Robots for shoulder/elbow showed small but significant effects on motor control and muscle strength, while robots for elbow/wrist had small but significant effects on motor control.	**2.0**	-	**Fugl-Meyer**, Chedoke-McMaster Stroke Assessment, Medical Research Council score, Motricity Index, Motor Power Scale, Modified Ashworth Scale, Action Research Arm Test, Wolf Motor Function Test, Arm Motor Ability Test, Box and Block test, Functional Independence measure, modified Rankin Scale, Barthel Index.
Tomi, Savic *et al.* 2017	ArmAssist robotic system versus matched conventional therapy for post-stroke upper limb rehabilitation: a randomized clinical trial	2017	Single blind, two arms parallel, randomized controlled trial	Robotics (ArmAssist, Tecnalia)	15 sessions (5 days/week for 3 weeks)	26	Subacute Moderate-to-severe	2 groups: robotics vs usual care.	Robotic group showed significantly greater improvements. There were no adverse events.	**18.0** for intervention group vs **7.5** for control group.	26.5 – 26.6	**Fugl-Meyer** (primary), Wolf Motor function Test and Barthel Index (secondary).

Shin, Park *et al.* 2017	Cognitive-motor interference on upper extremity motor performance in a robot-assisted planar reaching task among patients with stroke.	2017	Prospective study	Robotics (InMotion2)	20 sessions (5 times/week for 4 weeks). 640 repetitions.	22	Chronic Moderate-to-severe	Single group performing the task in 3 conditions: without a concurrent cognitive task, during digit span test, during controlled oral word association test.	Effect of cognitive-motor interference on upper extremity performance using a robotic-guided rehabilitation system.	-	28.6	-
Orihuela-Espina, Roldán et al. 2016	Robot training for hand motor recovery in subacute stroke patients: a randomized controlled trial.	2016	Randomized controlled trial	Robotics (Amadeo, Tyromotion)	40 sessions (5 times/week for 2-3 weeks). 12000 repetitions.	17	Subacute Severe	2 groups: robotics vs occupational therapy.	Robotic therapy may be used during subacute stages of stroke.	**5.6** for robotic-assisted and **1.5** for the occupational therapy.	3.4 – 5.3 (only hand section)	**Fugl-Meyer** and Motricity Index (primary).
Hesse, Heß *et al*. 2014	Effect on arm function and cost of robot-assisted group therapy in subacute patients with stroke and a moderately to severely affected arm: a randomized controlled trial.	2014	Randomized controlled trial	Robotics	20 sessions (5 days/week for 4 weeks).	50	Subacute	2 groups: robotics+individual arm therapy vs individual arm therapy.	Robotic therapy was equivalent to individual arm therapy, but its cost was lower.	**11.1** for the group with robotics and **14.6** for the control group.	14.6 – 16.5	**Fugl-Meyer** (primary), Modified Ashworth Scale, Action Research Arm Test, Box and Block Test, Medical Research Council scores and Barthel Index (secondary).
Klamroth-Marganska, Blanco *et al.* 2014	Three-dimensional, task-specific robot therapy of the arm after stroke: a multicentre, parallel-group randomised trial.	2014	Multicentre, parallel-group randomized controlled trial	Robotics (ARMin)	24 sessions (3 times/week for 8 weeks).	77	Chronic Moderate-to-severe	2 groups: robotics vs conventional therapy.	Patients assigned to robotic therapy had significantly greater improvements in motor function in the affected arm than the conventional therapy group. No serious adverse events related to the study occurred.	**3.4** for robotics and **2.6** for conventional therapy.	20.2 – 20.3	**Fugl-Meyer** (primary), Wolf Motor Function Test, Motor Activity Log, Stroke Impact Scale, Goal Attainment Scale, Modified Ashwort Scale.
Muscular Electrical Stimulation												
Vafadar, Côté *et al.* 2015	Effectiveness of functional electrical stimulation in	2015	Review with meta-analysis	ES on shoulder muscles between 10 and 50 Hz.	-	531	-	-	Initiating the functional ES treatment	-	-	-

	improving clinical outcomes in the upper arm following stroke: a systematic review and meta-analysis.								early after stroke can significantly reduce the level of shoulder subluxation mostly during the treatment period, not after a follow-up period. Functional ES does not have any effect on pain and in the restoration of motor function in the upper arm compared to conventional therapy alone.			
Liu, Gao *et al.* 2015	Effects of motor imagery combined with functional electrical stimulation on upper limb motor function of patients with acute ischemic stroke.	2015	Clinical study	Functional ES for wrist dorsiflexion	-	40	Acute Ischemic	2 groups: functional ES vs functional ES combined with motor imagery.	Improvements were significantly higher in the group receiving functional ES in combination with motor imagery than in the functional ES group.	**8.4** for functional ES and **14.6** for functional ES+motor imagery.	18.6 – 18.2	**Fugl-Meyer**, Action Research Arm Test, Active range of motion.
Knutson and Chae, 2015a	Contralaterally controlled fes for chronic upper limb hemiplegia: Single site RCT.	2015	Clinical study	ES for hand opening	120 sessions (10 times/week for 12 weeks)	72	Chronic	2 groups: contralateral controlled functional ES vs cyclic neuromuscular ES.	The two groups were not equivalent: the first group showed higher scores for the Box and Block. The method of delivering ES affects outcomes.	-	-	Box and Block Test (primary), **Fugl-Meyer** and Arm Motor Abilities test (secondary).
Quandt and Hummel 2014	The influence of functional electrical stimulation on hand motor recovery in stroke patients: a review.	2014	Review	Functional ES on hand and finger function	-	-	-	-	A strong evidence supporting an advantage of functional ES over physical therapy or no therapy is still missing. Protocols across studies are highly heterogeneous. Optimal stimulation parameters, seem to be highly individual and influenced by pathology.	-	-	-

Kim, Lee *et al*. 2014	Effect of functional electrical stimulation with mirror therapy on upper extremity motor function in poststroke patients.	2014	Clinical study	Functional ES with mirror therapy for hand	20 sessions (5 times/week for 4 weeks)	23	Moderate to Severe	2 groups: conventional+functional ES with mirror therapy vs conventional.	Motor functions of the upper extremities were superior in functional ES with mirror therapy respect to conventional.	**14.8** for the interventional group and **7.9** for the control group.	11.8 – 9.4	**Fugl-Meyer,** Brunnstrom's motor recovery stage, Manual Function Test, Box and Block Test.
Carda, Biasiucci *et al.* 2017	Electrically assisted movement therapy in chronic stroke patients with severe upper limb paresis: a pilot, single-blind, randomized crossover study.	2017	Pilot, single-blind, randomized crossover study	Functional ES for hand modulated by a custom device controlled through the patient's unaffected hand	10 sessions (5 times/week for 2 weeks)	11	Chronic Severe	2 groups: functional ES vs conventional.	The intervention produced a clinically important impairment reduction.	**6.5** for the intervention and **1.0** for the control (median values).	11.0 – 13.2	**Fugl-Meyer**, Wolf Motor Function Test, Resistance to Passive Movement Scale, Motor Activity Log.
Wilson, Page *et al.* 2016	Upper-limb recovery after stroke: a randomized controlled trial comparing EMG-triggered, cyclic, and sensory electrical stimulation.	2016	Multicenter, single-blind, multi-arm parallel-randomized controlled trial	Neuromuscular ES for hand	80 sessions (twice/day, for 5 days/week for 8 weeks)	122	Subacute Severe	3 groups: Cyclic ES vs EMG-triggered ES vs sensory ES.	EMG-triggered, cyclic, and sensory ES exhibited significant improvement of impairment and functional limitations. Improvements were likely the result of spontaneous recovery. No difference was observed based on the type of electrical stimulation that was administered.	**7.1** for cyclic, **4.9** for EMG-triggered and **6.8** for sensory ES.	27.5 – 29.8 – 26.8	**Fugl-Meyer** (primary), modified Arm Motor Ability Test.(secondary).
Dorsch, Ada *et al.* 2014	EMG-triggered electrical stimulation is a feasible intervention to apply to multiple arm muscles in people early after stroke but does not improve strength and activity more than usual therapy: a randomized feasibility trial.	2014	Prospective randomized trial	EMG-triggered electrical stimulation on shoulder flexors, elbow and wrist extensors and thumb abductors	20 sessions (5 days/week for 4 weeks)	33	Acute	2 groups: ES vs usual arm therapy.	There was no significant effect of the EMG-triggered electrical stimulation in addition to usual arm therapy.	-	-	Motor Assessment Scale.

Schick, Schlake *et al.* 2017	Synergy effects of combined multichannel EMG-triggered electrical stimulation and mirror therapy in subacute stroke patients with severe or very severe arm/hand paresis.	2017	Randomized, controlled, multicenter study	Bilateral EMG-triggered multi-channel electrostimulation (finger extensors/flexors)	15 sessions (5 times/week for 3 weeks)	33	Acute Severe	2 groups: mirror therapy+ES vs ES	The addition of the mirror therapy to the electrostimulation is beneficial.	**13.1** for the group with mirror therapy and **10.5** for the group with electrostimulation.	16.6 – 16.2	**Fugl-Meyer** (primary), Rivermead Assessment of Somatosensory Performance, Box and Block Test, Goal Attainment Scaling, Barthel Index.
Knutson, Fu *et al.* 2015b	Neuromuscular electrical stimulation for motor restoration in hemiplegia.	2015	Review	Most common therapeutic and neuroprosthetics application of neuromuscular electrical stimulation	-	-	-	-	Evidences of effectiveness for cyclic, EMG-triggered, switch-triggered and contralaterally controlled neuromuscular ES.	-	-	-
Eraifej, Clark *et al.* 2017	Effectiveness of upper limb functional electrical stimulation after stroke for the improvement of activities of daily living and motor function: a systematic review and meta-analysis.	2017	Review	Upper limb functional ES	-	431	General	2 groups: functional ES+standard care vs standard care.	Functional ES applied within 2 months show significant benefit on ADL. Because of low quality evidences, no conclusion can be drawn about the effectiveness of functional ES and its optimal time window.	-	-	-
Brain stimulation (invasive)												
Plow and Machado 2014	Invasive neurostimulation in stroke rehabilitation.	2014	Review	Invasive brain stimulation	15 to 30 sessions (2.5-3 hours/day for 3 to 6 weeks)	-	Severe cortical and subcortical	-	Description of novel approaches, findings from neuroimaging and neurophysiology for ideal targeting, new localization schemes, and bypass strategies that indirectly target peri-lesional circuitry. Stimulation may modulate mechanisms differentially across phases of recovery.	Max **10**	Minimum 30.5	**Fugl-Meyer** and Arm Motor Ability.

Levy, Harvey et al. 2016	Epidural electrical stimulation for stroke rehabilitation.	2016	Prospective, multicenter, randomized, single-blinded trial (Everest trial)	Epidural electrical stimulation	26 sessions (2.5 hours/day for 5 days/week for 4 weeks and 3 days/week for 2 weeks)	94	Chronic Moderate - Severe	2 groups: epidural electrical stimulation vs conventional therapy.	No difference between the two groups post-rehabilitation. A better treatment response was observed in a subset of patients eliciting stimulation induced upper limb movements during motor threshold assessments performed prior to each rehabilitation session. Post-hoc comparisons indicated treatment effect differences at 24 weeks, with the control group showing significant decline in the combined primary outcome measure relative to the investigational group. Serious adverse events are reported.	**4.3** for investigational and **4.0** for control.	37.6 – 37.6	**Fugl-Meyer**, Arm Motor Ability Test,
Brain stimulation (noninvasive)												
Kubis 2016	Non-invasive brain stimulation to enhance post-stroke recovery.	2016	Review	TMS and tDCs	-	-	-	-	TMS and tDCs induce effects in the range of 10-20% of improvement. The meta-analysis conclusions do no match with those of individual clinical trials.	-	-	-
Cho, Lee *et al.* 2017	Dual-mode noninvasive brain stimulation over the bilateral primary motor cortices in stroke patients.	2017	Randomized, open-label, parallel design trial	Dual-mode stimulation using rTMS (10Hz on ipsilesional side) and tDCS (cathodal on the contralesional side)	100 sessions (10 daily sessions for 2 weeks)	30	Subacute Moderate	2 groups : dual mode stimulation vs rTMS only.	Dual-mode stimulation with the simultaneous application of 10 Hz rTMS and cathodal tDCS over the bilateral M1 was safe and superior to 10 Hz rTMS alone for improving motor	**11.0** for dual mode and **3.0** for only rTMS.	30.3 – 22.1	**Fugl-Meyer.**

									function in subacute stroke patients.			
D'Agata, Peila *et al.* 2016	Cognitive and neurophysiological effects of non-invasive brain stimulation in stroke patients after motor rehabilitation.	2016	Randomized double blind clinical study	Low frequency rTMS on contralesional side and dual site tDCs	200 sessions (10 daily sessions for 4 weeks)	34	Chronic	3 groups: rTMS vs tDCS vs sham.	rTMS was comparable to tDCS and more effective than sham. ERP improved in the stimulation's groups. More than one cycle (2-4 weeks) spaced out with a washout period should be used to obtain relevant results.	-	-	Action Research Arm Test.
Elsner, Kugler *et al*. 2015	Transcranial direct current stimulation (tDCS) for improving activities of daily living, and physical and cognitive functioning, in people after stroke.	2016	Review	tDCs	-	396	Acute, post-acute, chronic.	2 groups: tDCS vs sham or placebo.	Evidence of very low to moderate quality effectiveness of tDCS (anodal/cathodal/dual) versus control (sham/any other intervention) for improving ADL performance after stroke.	-	-	-
Ilić, Dubljanin-Raspopović *et al*. 2016	Effects of anodal tDCS and occupational therapy on fine motor skill deficits in patients with chronic stroke.	2016	Double blind sham controlled parallel design trial	tDCs (anodal on ipsilesional side)	10 sessions (in 2 weeks)	26	Chronic	2 groups: tDCS+occupational therapy vs sham+occupational therapy.	The intervention had no effect on handgrip strength or upper limb FM score.	-	48.8	Modified Jebsen Taylor Test of Hand Function (primary), **Fugl-Meyer** (secondary).
Del Felice, Daloli *et al*. 2016	Contralesional cathodal versus dual transcranial direct current stimulation for decreasing upper limb spasticity in chronic stroke individuals: a clinical and neurophysiological study.	2016	Cross-over, double-blinded	Dual and cathodal tDCs both preceded by 1 week of sham stimulation.	5 sessions (in one week)	10	Chronic ischemic	2 groups: cathodal vs dual tDCS,	Cathodal tDCs is slightly more effective than dual tDCs in reducing distal upper limb spasticity in chronic post-stroke subjects.	-	-	Medical Research Council Scale, Modified Ashworth Scale, finger flexion scale, Postural Assessment Scale for Stroke Patient, Action Research Arm Test, European Stroke Scale, Hamilton

												Rating Scale for Depression and Barthel Index.
Triccas, Burridge *et al*. 2016	Multiple sessions of transcranial direct current stimulation and upper extremity rehabilitation in stroke: A review and meta-analysis.	2016	Review	tDCs	From 3 to 30 sessions	371	Acute, sub-acute and chronic	-	So far, the evidence is not statistically significant, but is suggestive of, at best, a small beneficial effect of tDCs in reducing upper extremity impairment.	-	-	-
Fusco, Iosa *et al.* 2014	After vs. priming effects of anodal transcranial direct current stimulation on upper extremity motor recovery in patients with subacute stroke.	2014	Double-blind, randomized, sham-controlled, crossover trial	Anodal tDCs	2 sessions (2 days)	16	Subacute	2 groups: anodal tDCS vs sham.	Anodal and sham tDCs plus rehabilitation significantly improved manual dexterity. Post hoc analysis revealed a significant stimulation effect only for anodal tDCs. Hand force and behavioral features were unchanged.	-	-	Nine Hole Peg Test, Visual Analog Scale.
Rocha, Silva *et al.* 2016	The impact of transcranial direct current stimulation (tDCS) combined with modified constraint-induced movement therapy (mCIMT) on upper limb function in chronic stroke: a double-blind randomized controlled trial.	2016	Pilot double blind sham controlled and randomized trial	Anodal tDCs on affected hemisphere and cathodal tDCs on unaffected hemisphere	12 sessions	21	Chronic	3 groups: anodal tDCS+CIMT vs cathodal tDCS+CIMT vs CIMT alone	A merit of association of CIMT with brain stimulation to augment clinical gains was observed. Anodal tDCs seems to have greater impact than the cathodal tDCs in increasing the CIMT effects on motor functions of chronic stroke patients.	11 – 7 -4	44.6 - 51.6 - 51	**Fugl-Meyer**, Motor Activity Log Scale.
Allman, Amadi *et al.* 2016	Ipsilesional anodal tDCS enhances the functional benefits of rehabilitation in patients after stroke.	2016	Stratified, double-blind, sham-controlled, parallel-group randomized trial	Anodal tDCS	9 sessions (in 9 days)	24	Chronic Moderate	2 groups: anodal tDCS vs sham	Improvements that persisted for at least 3 months post-intervention were observed after anodal tDCs but not after sham treatment on the Action Research Arm Test	**11.4** for anodal tDCs and **9.1** for sham.	38.9 – 36.4	Action Research Arm Test, Wolf motor Function Test, and **Fugl-Meye**r.

									and Wolf Motor Function Test.			
Koh, Lin *et al*. 2017	Effects of transcranial direct current stimulation with sensory modulation on stroke motor rehabilitation: a randomized controlled trial.	2017	Randomized controlled trial	Bilateral tDCs with sensory modulation (cutaneous anesthesia) and passive wrist and finger movements	24 sessions (3 times a week for 8 weeks)	25	Chronic Moderate to severe	2 groups: tDCs with sensory modulation and passive movements vs sham tDCs with sensory modulation and passive movements	No differences between the two groups.	**6.0** for the tDCs and **1.3** for the sham tDCs.	20.4 – 27.2	**Fugl-Meyer** and Modified Ashworth Scale (primary), Action Research Arm Test, Barthel Index (secondary).
Figlewski, Blicher *et al.* 2017	Transcranial direct current stimulation potentiates improvements in functional ability in patients with chronic stroke receiving constraint-induced movement therapy.	2017	Randomized trial	Anodal tDCs and constraint induced movement therapy	9 sessions of 6 hours (in 9 consecutive workdays)	44	Chronic	2 groups: anodal tDCs+CIMT vs sham tDCs and CIMT	Anodal tDCs enhanced the effect of CIMT and lead to clinical important improvements in the quality of the paretic upper limb movements compared with CIMT and sham tDCs.	-	-	Wolf Motor Function Test
Lefaucheur, Antal *et al.* 2017	Evidence-based guidelines on the therapeutic use of transcranial direct current stimulation (tDCS)	2017	Review/Guidelines	Repeated tDCS	From 5 to 30 sessions	324	-	Repeated tDCS sessions with sham tDCS control procedure	The possibility of promoting motor stroke recovery by tDCS still needs to be demonstrated in large, multicentric clinical trials consisting of repeated sessions with prolonged follow-up. Now, it is possible to identify only some trends in predicting tDCS efficacy. The combination of tDCS with other therapies could result in synergistic effects.	-	-	-
O'Shea, Boudrias *et al.* 2014	Predicting behavioural response to TDCS in chronic motor stroke	2014	Clinical study	Anodal: over left M1; Cathodal: over right M1; Bilateral: anode over left M1 and cathode over right M1	4 sessions (one modality/day with 1-week interval)	13	Chronic	Bilateral TDCS versus Anodal, Cathodal and Sham TDCS	Superiority of Anodal or Cathodal over Bilateral TDCS in changing motor cortico-spinal excitability in the healthy brain and in	-	-	-

									speeding reaction time in chronic stroke.			
Chang, Uhm *et al*. 2016	Factors influencing the response to high-frequency repetitive transcranial magnetic stimulation in patients with subacute stroke.	2016	Clinical study	Repetitive TMS high frequency on affected hemisphere	10 sessions (1000 pulses/day for 10 days)	62	Subacute Moderate to severe	1 group	High frequency rTMS should be individually tailored according to the functional integrity of the corticospinal tract and the brain-derived neurotrophic factor genotype.	**13.7** for the good responder and **1.0** for the poor responders.	12.1	**Fugl-Meyer**
Tretriluxana, Kantak *et al*. 2015	Improvement in paretic arm reach-to-grasp following low frequency repetitive transcranial magnetic stimulation depends on object size: a pilot study.	2015	Clinical study	Low frequency repetitive TMS on non-lesioned side	2 sessions separated at least by 5 days	9	Chronic Mild to moderate	2 groups: rTMS vs sham rTMS	rTMS improved kinematics and coordination of reach-to-grasp for small objects.	-	53.9	-
Lefaucheur, André-Obadia *et al.* 2014	Evidence-based guidelines on the therapeutic use of repetitive transcranial magnetic stimulation (rTMS).	2014	Review/Guidelines	Repetitive high and low frequency TMS	From 1 up to 15 sessions	513	-	-	Level B recommendation (probable efficacy) is conferred for the effect of low frequency rTMS of the contralesional motor cortex on chronic motor stroke. Level C recommendation (possible efficacy) is conferred for low frequency rTMS of the contralesional motor cortex and high frequency rTMS of the ipsilesional motor cortex on (post-) acute stroke.	-	-	-
Brain Computer/Machine Interfaces												
Soekadar, Birbaumer *et al*. 2015	Brain-machine interfaces in neurorehabilitation of stroke.	2015	Review	BCI/BMI, functional ES, robotics	-	196	-	-	Brain machine interfaces are powerful tools that can enable to regain movements. The combination of BMI with invasive or non-invasive brain	-	-	-

									stimulation promises a better understanding of brain recovery and efficacy of neurorehabilitation.			
Ang, Chua *et al.* 2015a	A randomized controlled trial on EEG-based motor imagery brain-computer interface robotic rehabilitation for stroke.	2015	Single blind randomized controlled trial	BCI and robotics (InMotion2)	18 sessions (4 weeks)	26	Chronic Moderate-to-severe	2 groups: robotics vs robotics+BCI.	There were no significant inter-group differences at all time points during the study.	**4.5** for robotics and **6.3** for the robotics+BCI.	26.3 – 26.6	**Fugl-Meyer**
Morone, Pisotta *et al.* 2015	Proof of principle of a brain-computer interface approach to support post-stroke arm rehabilitation in hospitalized patients: design, acceptability, and usability.	2015	Proof-of-principle study	BCI for motor imagery	4 weeks	8	Subacute and Chronic Moderate to severe	1 group: BCI for motor imagery in addition to usual care.	An ecological BCI-based device to assist motor imagery practice was found to be feasible as an add-on intervention and tolerable by patients who were exposed to the system in the rehabilitation environment.	**9.4**	13.9	**Fugl-Meyer**, National Institute of Health Stroke Scale and Barthel Index.
van Dokkum, Ward *et al.* 2015)	Brain computer interfaces for neurorehabilitation – its current status as a rehabilitation strategy post-stroke.	2015	Update article/review	BCI/BMI, VR, orthosis, functional ES	-	-	-	-	Overview of BCI methods for neurorehabilitation.	-	-	-
Remsik, Young *et al.* 2016	A review of the progression and future implications of brain-computer interface therapies for restoration of distal upper extremity motor function after stroke.	2016	Review	BCI/BMI, functional ES, robotics, tDCs	From 1 to 22 sessions	495	-	-	Potential efficacy of motor imagery BCI in mild-to-moderate stroke for distal upper extremity motor functions. Promising results for BCI combined with functional ES and orthoses.	-	-	-
Ang, Guan *et al.* 2014	Brain-computer interface-based robotic end effector system for wrist and hand rehabilitation: results of a three-armed randomized controlled trial for chronic stroke.	2014	Randomized controlled trial	BCI and robotics (Haptic Knob)	18 sessions (3 times/week for 6 weeks)	21	Chronic Moderate	3 groups: BCI+robotics vs robotics vs standard treatment	All groups showed improvements, but no intergroup differences were found at any time point. The robotic group did not differ from standard while the BCI robotics showed significant higher motor gains	**7.2** for BCI robotics**, 7.3** for robotic only and **4.9** for standard treatment.	33.0 – 25.5 – 23.4	**Fugl-Meyer**

									at week 3, 12 and 24.			
Jang, Kim *et al.* 2016	Effects of brain-computer interface-controlled functional electrical stimulation training on shoulder subluxation for patients with stroke: a randomized controlled trial.	2015	Randomized trial	BCI and functional ES for shoulder subluxation	30 sessions (5 times/week for 6 weeks)	20	Chronic	2 groups : BCI+functional ES vs functional ES.	BCI-functional ES training may be effective in improving shoulder subluxation by facilitating motor recovery.	-	-	Modified Ashworth Scale and Manual Function Test
Kim, Kim *et al*. 2016	Effects of action observational training plus brain -computer interface -based functional electrical stimulation on paretic arm motor recovery in patient with stroke: a randomized controlled trial.	2016	Randomized controlled trial	BCI and functional ES (wrist extension)	20 sessions (5 times a week for 4 weeks)	30	Chronic Severe	2 groups : conventional+BCI+functional ES vs conventional.	Many clinical scores were significantly higher in the BCI-functional ES group.	**7.8** for the BCI-functional ES group and **2.9** for the conventional.	26.8 – 21.8	**Fugl-Meyer**, Motor Activity Log, Modified Barthel Index.
Ono, Shindo *et al.* 2014	Brain-computer interface with somatosensory feedback improves functional recovery from severe hemiplegia due to chronic stroke	2014	-	BCI and hand orthosis	12-20 sessions	12	Chronic Severe	2 groups: BCI + visual feedback vs BCI + hand-orthosis doing the movement	No changes in clinical scores and electromyographic activity were observed in visual feedback group after training, voluntary EMG activity was newly observed in the affected finger extensors in four cases and the clinical score of upper limb function in the affected side was also improved in three participants in somatosensory feedback group.	-	-	-
Li, Liu *et al.* 2014	Neurophysiological substrates of stroke patients with motor imagery-based brain-computer interface training	2014	Randomized controlled trial	BCI and functional ES on the extensor carpi radialis	24 sessions (3 times a week for 8 weeks)	15	Subacute and Chronic Severe	2 groups: motor imagery BCI + functional FES vs functional ES only	A significant improvement in the motor function of the upper extremity for the	**13.2** for BCI group and **6.7** for functional ES group.	13.0 – 11.7	**Fugl-Meyer** and Action Research Arm Test.

									BCI group was confirmed with the activation of bilateral cerebral hemispheres. Additionally, event related desynchronization of the affected sensorimotor cortexes was significantly enhanced when compared to the pretraining course, which was only observed in the BCI group.			
Combination of neurotechnology-aided treatments												
Straudi, Fregni *et al.* 2016	tDCS and robotics on upper limb stroke rehabilitation: effect modification by stroke duration and type of stroke.	2016	Double-blinded clinical study	Bilateral tDCs and Robotics (REO, Motorika)	10 sessions (5 sessions/week over two weeks)	23	Moderate to severe	2 groups: robotics + bilateral tDCs and robotics + sham-tDCs	Stroke duration (acute versus 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.	**5.1** group with bilateral tDCs and **5.5** for the sham group.	24.0 – 21.4	**Fugl-Meyer**, Box and Block Test and Motor Activity Log.
Triccas, Burridge *et al.* 2015b	A double-blinded randomised controlled trial exploring the effect of anodal transcranial direct current stimulation and uni-lateral robot therapy for the impaired upper limb in sub-acute and chronic stroke.	2015	Randomized double-blinded pilot-controlled trial	anodal tDCs and robotics (Armeo Spring)	18 sessions (over eight weeks)	22	Subacute and chronic Moderate to severe	2 groups: robotics + anodal tDCs vs robotics + sham tDCs	Adding tDCs did not result in an additional effect on upper limb impairment in stroke. Robotic therapy may be of more benefit in the sub-acute than in the chronic phase.	**8.7** in the group with tDCs vs **7.7** in the sham group.	24.9 – 37.0	**Fugl-Meyer** (primary), Action Research Arm Test, Motor Activity Log-28 and Stroke Impact scale (secondary).
Di Lazzaro, Capone *et al.* 2016	Combining robotic training and non-invasive brain stimulation in severe upper limb-impaired chronic stroke patients.	2016	Double-blinded, semi-randomized, sham-controlled trial	Theta burst stimulation on affected hemisphere and robotics (InMotion2)	10 sessions (once/day for 10 days)	17	Chronic Severe	2 groups: TBS and robotics vs sham TBS and robotics	Robot-assisted rehabilitation produces a slight improvement in severe patients even years after stroke. The association with theta bursts	**3-4** for both groups.	14.5 – 12.5	**Fugl-Meyer**, National Institute of Health Stroke Scale, Ranking Scale, Barthel

									stimulation does not augment the clinical gain.			Index and Modified Ashworth Scale,
Triccas, Burridge *et al.* 2015a	A mixed-methods study exploring the combination of non-invasive brain stimulation and robot therapy for the impaired upper limb in stroke.	2015	Randomized controlled trial	Anodal tDCs and robotics (Armeo Spring)	18 sessions (over 8 weeks)	22	Subacute and chronic	2 groups: robotics +anodal tDCs vs robotics + sham	The intervention was feasible and the robot therapy for the arm is of benefit in the sub-acute and chronic phase. Adding tDCs did not result in an additional effect on upper limb impairment.	**10.3** for the subacute and **5.8** for the chronic group.	-	**Fugl-Meyer**
Simonetti, Zollo *et al.* 2017	Literature review on the effects of tDCs coupled with robotic therapy in post stroke upper limb rehabilitation.	2017	Review	tDCs (unilateral and bilateral, anodal and cathodal) and robotics: unilateral and bilateral, distal and proximal.	From 1 to 30 sessions	211	General	-	The heterogeneity and the restricted number of collected studies make difficult to perform a systematic review. The association of tDCs with robotic training has the same clinical gain derived from robotic therapy alone.	-	-	-
Rong, Li *et al.* 2017	A neuromuscular electrical stimulation (NMES) and robot hybrid system for multi-joint coordinated upper limb rehabilitation after stroke	2017	Clinical study	EMG-driven neuromuscular ES and robotics (MX 106 ROBOTIS)	20 sessions	11	Chronic Moderate	1 group	The EMG-driven neuromuscular ES-robotic system could improve the muscular coordination at the elbow, wrist and fingers.	**11**	30.1	Modified Ashworth Scale, **Fugl-Meyer**, Action Research Arm Test, Wolf Motor Function Test.
Lee, Lin *et al.* 2015	Effects of combining robot-assisted therapy with neuromuscular electrical stimulation on motor impairments, motor and daily function, and quality of life in patients with chronic stroke: a double-blinded randomized controlled trial.	2015	Randomized double blind sham-controlled trial	Neuromuscular ES and robotics (Bi-Manu-Track)	20 sessions (90 to 100 minutes/day, 5 days/week for 4 weeks)	39	Chronic Moderate	2 groups: robot+neuromuscular ES vs robot+sham neuromuscular ES	The addition of the stimulation to the robotic therapy induced significant benefits in reducing wrist flexor spasticity and in hand movement quality in patients with chronic stroke.	**3.9** for the group with the neuromuscular ES and **3.8** for the group with sham neuromuscular ES.	30.7 – 26.6	**Fugl-Meyer**, Modified Ashworth Scale, Wolf Motor Function Test, Motor Activity Log and Stroke Impact Scale.

Koyama, Tanabe *et al.* 2014	NMES with rTMS for moderate to severe dysfunction after stroke	2014	Clinical study	Neuromuscular ES (paretic wrist extensor muscles) and rTMS over the unaffected M1	24 sessions (880 times per session, twice a day for six days/week over 2 weeks)	15	Chronic Moderate to severe	1 group	Motor function improved with the combined treatment modality.	**4.3**	23.3	**Fugl-Meyer**, Wolf Motor Function Test and Box and Block.
Tosun, Türe *et al.* 2017	Effects of low-frequency repetitive transcranial magnetic stimulation and neuromuscular electrical stimulation on upper extremity motor recovery in the early period after stroke: a preliminary study.	2017	Assessor-blinded, randomized controlled study	Low frequency rTMS to the primary motor cortex of the unaffected side and neuromuscular ES (hand extensors muscles)	20 sessions (5 days a week for 4 weeks)	25	Acute/subacute Severe	3 groups: low frequency rTMS + physical therapy vs low frequency rTMS + neuromuscular ES+physical therapy vs physical therapy	Most of the clinical outcome scores improved significantly in all groups, however, no statistically significant difference was found between groups due to the small sample sizes.	**22.2** for the TMS group, **12.7** for the TMS+neuromuscular ES group, and 4.7 for the control group.	28.8 – 17.3 – 28.5	Brunnstrom Reovery Stages, **Fugl-Meyer**, Motricity Index, Modified Ashworth Scale and Barthel Index.
Sattler, Acket *et al.* 2015	Anodal tDCs combined with radial nerve stimulation promotes hand motor recovery in the acute phase after ischemic stroke.	2015	Double-blind controlled pilot study	Anodal tDCs over the ipsilesional motor cortex in association with repetitive peripheral nerve stimulation (radial nerve for wrist extension)	5 sessions (in 5 consecutive days)	20	Acute Mild to moderate	2 groups: tDCs +peripheral nerve stimulation vs peripheral nerve stimulation + sham tDCs.	Early cortical neurostimulation with anodal tDCs combined with repetitive peripheral nerve stimulation can promote hand motor recovery and the benefit is still present one month after stroke.	**6.6** for the tDCs+peripheral nerve stimulation group and **9.0** for the peripheral nerve stimulation group.	47.0 – 48.9	Jebsen Taylor Hand Function Test (primary), Nine Hole Peg Test, Hand Tapping Test and **Fugl-Meyer** (secondary)
Ang, Guan *et al.* 2015b	Facilitating effects of transcranial direct current stimulation on motor imagery brain-computer interface with robotic feedback for stroke rehabilitation.	2015	Randomized controlled trial	BCI motor imagery, dual mode tDCs and robotics (InMotion2)	10 sessions (over 2 weeks)	19	Chronic Moderate to severe	2 groups: BCI+robotics+tDCS vs BCI+robotic+sham tDCS.	No clinical differences between the two groups, but the real tDCs group showed higher online accuracy in the evaluation and EEG laterality coefficients.	**5.0** for the group with tDCs and **5.4** for the sham group.	35.3 – 32.6	**Fugl-Meyer**
Kasashima-Shindo, Fujiwara *et al.* 2015	Brain-computer interface training combined with transcranial direct current stimulation in patients with chronic severe hemiparesis: Proof of concept study.	2015	Not randomized controlled study	BCI, anodal tDCs and robotics (orthosis for finger extension)	10 sessions (5 times a week for 2 weeks)	18	Chronic Severe	2 groups: BCI+robotics+tDCs vs BCI+ robotics+sham tDCs	Event-related desynchronization was significantly increased in the tDCs group. The FM significantly increased in both groups. The FM improvement was maintained at 3 months only in the tDCs group.	**6** for the group with tDCs and **6.5** for the sham group.	27.6 – 23.4	**Fugl-Meyer**, Modified Ashworth Scale

Table Supplementary1. Summary of the studies included in the review. The studies including chronic severe stroke patients (average upper limb section of the upper limb FM score at baseline lower than 30) are reported in blue, those including chronic moderate to severe patients (average upper limb FM score at baseline between 30 and 45 including the extremes) in red. ΔFM-UE indicates the mean difference of the upper limb section of the Fugl-Meyer scale (0-66) between pre and post treatment, ADL is for activity of daily living, BCI is for brain computer interface, BMI is for brain machine interface, CIMT is for constrain induced movement therapy, DBS is for deep brain stimulation, EEG is for electroencephalograpy, EMG is for electromyography, ERP is for event related potential, ES is for electrical stimulation, FM is for Fugl-Meyer scale, M1 is for primary motor cortex, MAL is for Motor Activity Log scale, NMES is for neuromuscular electrical stimulation, rTMS is for repetitive transcranial magnetic stimulation, TBS is for theta burst stimulation, tDCs is for transcranial direct current stimulation, TMS is for transcranial magnetic stimulation and VR is for virtual reality.