Functional Electrical Stimulation – lower extremity

Author, Year PEDro Score, Country	Sample size	Intervention	Outcome and significance: (+) significant (-) not significant
Alon and Ring, 2003 PEDro score: 5	5	FES during daily exercise (treatment group) vs. Daily exercise alone (control group) **Treatment details**: Sessions increased in duration to 120 mins/day for 2 months	**At 2 months (post-treatment):** (+) 10 meter walk test time (+) 10 meter walk test speed (+) Cadence (statistical data not reported)
Ambrosini et al., 2011 PEDro score: 8	8	FES-induced cycling (FES group) Vs. Placebo FES cycling (control group) **Treatment details**: 20x 25-minute sessions 5x/week for 4 weeks	**At 4 weeks (post-treatment):** (+) Motricity Index (-) 50m walking test* (+) Trunk Control Test (+) Upright Motor Control Test (+) pedaling unbalance between the paretic and non-paretic limbs **At 3-5 months post-treatment (follow-up):** (+) Motricity Index (-) 50m walking test (+) Trunk Control Test (+) Upright Motor Control Test (-) pedaling unbalance between the paretic and non-paretic limbs *subgroup analysis of patients with ischaemic stroke revealed a significant between-group difference in favour of the FES group.

Functional Electrical Stimulation – lower extremity

Author, Year PEDro Score, Country	Sample size	Intervention	Outcome and significance: (+) significant (-) not significant
Bogataj et al., 1995 PEDro score: 6	6	3 weeks of multi-channel FES followed by 3 weeks of conventional therapy vs. 3 weeks of conventional therapy followed by 3 wks of multi-channel FES	**At 3 weeks:** (+) Fugl-Meyer (+) Trajectories of centre of pressure (TCP) **At 6 weeks:** (-) Fugl-Meyer (+) Trajectories of centre of pressure
Burridge and McLellan, 2000 PEDro score: 4	4	FES during swing phase of walking to promote ankle dorsiflexion **Treatment details**: Daily sessions for 3 months	**At 3 months (post-treatment):** (+) 10 meter walk test (+) Physiological Cost Index (PCI)
Burridge et al., 1997 PEDro score: 5	5	FES and physiotherapy vs. physiotherapy only	**At 4 to 5 weeks:** (-) Walking speed (-) Physiological Cost Index **At 12 to 13 weeks:** (+) Walking speed (mean change when measured without stimulation at start oftrial and with stimulation at end for the FES group) (+) Physiological Cost Index(mean change when measuredwithout stimulation at start ofthe trial and with stimulation at end)
Chen et al., 2005 PEDro score: 6	6	Electrical stimulation (ES) Vs. Placebo ES	**At 1 month (post-treatment):** (-) Modified Ashworth Scale (+) Fmax/Mmax ratio (+) H-reflex latency

Functional Electrical Stimulation – lower extremity

Author, Year PEDro Score, Country	Sample size	Intervention	Outcome and significance: (+) significant (-) not significant
		Treatment details: 20min/day, 6x/week for 1 month	(+) 10m walking time Results indicate significant improvement in the ES group. Between-group differences were not reported.
Cozean et al., 1988 PEDro score: 6	6	FES vs. electromyographic Biofeedback (BFB) vs. FES and BFB vs. physiotherapy only	**At 4 wks:** (+) Indexes of knee flexion & dorisflexion No group comparisons were made for walking speed
Daly et al., 2004 PEDro score: 4	4	FES and Physiotherapy vs. Physiotherapy only	**Post treatment and six month follow-up:** No between-group differences were reported
Daly et al., 2006 PEDro score: 7	7	FES with body weight supported treadmill training (BWSTT), coordination exercises, over-ground (OG) walking and home exercise program vs No FES with BWSTT, coordination exercises, OG walking and home exercise program (control)	**After 12 weeks:** (+) Tinetti Gait (gait components execution) (-) Fugl-Meyer (LE coordination) (+) Fugl-Meyer (Knee coordination) (-) Tinetti Balance (-) 6 MWT (-) Self-reported functional milestones
Daly et al., 2011 PEDro score: 7	7	FES Vs. No FES **Treatment details**: Intramuscular FES to 8 muscles. Both groups performed strengthening exercises, overground gait training and	**At 12 weeks (post-treatment):** (+) Gait Assessment and Intervention Tool (GAIT) (-) manual muscle testing* (-) isolated leg joint movement coordination (FM)* (-) 6-Minute Walking Distance Test (6MWT)*

Functional Electrical Stimulation – lower extremity

Author, Year PEDro Score, Country	Sample size	Intervention	Outcome and significance: (+) significant (-) not significant
		body-weight supported treadmill training for 1.5 hours/day 4x/week for 12 weeks.	(-) FIM - Locomotion & Mobility subtest (FIM-L&M)* **At 6 months (follow-up):** (+) Gait Assessment and Intervention Tool (GAIT) * Both groups demonstrated significant improvements at post-treatment; between-group differences were not reported.
Embrey et al., 2010 PEDro score: 4	4 (crossover trial)	FES then no FES Vs. No FES then FES **Treatment details**: FES stimulator was worn for 6-8 hours/day, 7 days/week for 3 months. FES was automatically delivered to the plantar and dorsiflexors during walking. Participants in both groups were required to walk for 1 hour/day, 6 days/week.	**At 3 months (cross-over point):** (+) 6 Minute Walk Test (-) Emory Functional Ambulation Profile* (+) Stroke Impact Scale (-) Modified Ashworth Scale (-) plantar flexor muscle strength (+) dorsiflexor muscle strength * difference between groups approached significance
Ferrante et al., 2008 PEDro score: 6	6	FES and standard rehabilitation vs. standard rehabilitation only	**After 4 weeks:** (+) Maximum isometric voluntary contraction of the quadriceps (MIVC) (+) Sit to stand ability (3 different rising speeds) (-) 50 m walking test (-) Muscle strength (-) Motricity Index (MI)

Functional Electrical Stimulation – lower extremity

Author, Year PEDro Score, Country	Sample size	Intervention	Outcome and significance: (+) significant (-) not significant
			(-) Upright Motor Control Test (UMC) (-) Trunk Control Test (TCT)
Glanz et al., 1996 PEDro score: N/A; Meta-analysis	This is a meta-analysis.		
Granat et al., 1996 PEDro score: 5	5	Continuous daily FES (treatment condition) vs. Standard rehabilitation (control condition) **Treatment details**: Patients used the stimulators at home daily 7 days/week for 4 weeks. Each participant had a 4 week control period followed by a 4 week treatment period	**At week 11 (post-treatment):** (+) Swing symmetry on linoleum (-) Swing symmetry on carpet, uneven ground (-) Heel strike on linoleum, carpet, uneven ground (+) Foot inversion on linoleum, carpet, uneven ground (+) Barthel Index (-) Walking speed on linoleum, carpet, uneven ground *No between-condition statistics were reported for walking speed, however, the authors state that there was an improvement in walking speed with stimulation.
Janssen et al., 2008 PEDro score: 6	6	Cycling exercise with maximally tolerable electrical stimulation evoking muscle contractions (ES-LCE) vs. Control group: cycling exercise with sensible electrical stimulation not evoking muscle contractions (LCE)	**At 6 weeks:** (-) VO2peak (aerobic capacity) (-) PO2max (maximal power output) (-) Lower limb muscle strength (-) Six-Minute Walk Test (6MWT) (-) Berg Balance Scale (BBS) (-) Rivermead Mobility Index (RMI)

Functional Electrical Stimulation – lower extremity

Author, Year PEDro Score, Country	Sample size	Intervention	Outcome and significance: (+) significant (-) not significant
			(-) Maximal Isometric Voluntary Contraction (MIVC) of knee
Johnson et al., 2004 PEDro score: 6	6	Physiotherapy combined with botulinum toxin type A (BTX) and FES vs. physiotherapy (control)	**After 12 week treatment**: (+) Walking Speed (+) Rivermead Motor Assessment (RMA) (-) Medical Outcomes Study 36-Item Short Form Health Survey (SF-36) (+) Physiological Cost Index (PCI) (-) Modified Ashworth Scale (MAS)
Kesar et al., 2011 PEDro score: N/A (quasi-experimental design study)	N/A Quasi-experimental design study	Each participant experienced each of the following 4 conditions: Walking at a faster than self-selected speed (FAST) vs. Walking at a self-selected speed (SS) vs. Walking at a faster than self-selected speed with FES (FAST-FES) vs. Walking at a self-selected speed with FES (SS-FES) **Treatment details**: 18 x 40-second trials in total (includes all 4 conditions) with a 5 min rest between trials	**At 18 trials*:** FAST vs. SS (+) Peak AGRF (+) Trailing limb angle (-) Peak knee flexion (-) Percent propulsion FAST-FES vs. SS-FES: (+) Peak AGRF (+) Trailing limb angle (+) Peak knee flexion (-) Percent propulsion FAST-FES vs. FAST (+) Peak AGRF (-) Trailing limb angle (-) Peak knee flexion (-) Percent propulsion

Functional Electrical Stimulation – lower extremity

Author, Year PEDro Score, Country	Sample size	Intervention	Outcome and significance: (+) significant (-) not significant
			*SS and FAST data were collected on the 1st, 2nd, 8th, 9th, 17th and 18th trials. SS-FES and FAST-FES data were collected on the 3rd-7th trials OR on the 10th-16th trials.
Kojovic et al., 2009 PEDro score: 5	5	Functional Electrical Therapy (FET) vs. Control Group (CON) Both groups participated in a standard rehabilitation program and 45 min of walking 5x/ week over 4 weeks.	**At post-treatment (4 weeks):** (+) Fugl-Meyer (FM) Lower Extremity Motor Assessment Scale (+) Barthel Index (BI) (+) Mean Walking Velocity (vmean) over a 6-m distance (+) Physiological Cost Index (PCI)
Kottink et al., 2007 PEDro score: 8	5	Implantable 2-channel peroneal nerve stimulator vs. Control group	**At 26 weeks:** (+) 6 min walking test (6MWT) (+) 10 meter walkway (-) % time spent stepping (-) % time spent standing (+) % time spent sitting/lying
Kottink et al., 2010 PEDro score: 7	7	FES (implantable two-channel peroneal nerve stimulator) for correction of foot drop Vs. Conventional walking device (ankle-foot orthoses, orthopedic shoes or no device)	**At 26 weeks:** (+) SF-36 Physical functioning (-) SF-36 Physical role functioning (-) SF-36 Bodily pain (-) SF-36 Social functioning (-) SF-36 Mental health (-) SF-36 Emotional role functioning (-) SF-36 Vitality (+) SF-36 General health

Functional Electrical Stimulation – lower extremity

Author, Year PEDro Score, Country	Sample size	Intervention	Outcome and significance: (+) significant (-) not significant
			(+) SF-36 Physical Component Summary (-) SF-36 Mental Component Summary (-) SF-36 – mean preference-based summary index (-)DIP – Symptoms (+) DIP – Mobility (+) DIP – Self care (-) DIP – Social activities (-) DIP – Communication (+) DIP – Psychological status (+) EQ-5D – mean preference-based summary index
MacDonell et al., 1994 PEDro score: 5	5	FES and physiotherapy vs. physiotherapy only (control)	**At 4 wks:** (-) Barthel Index (-) Fugl-Meyer Lower Extremity Motor Assessment Scale (-) Massachusetts General Hospital Functional Ambulation Classification (MGH FAC) (-) Electrophysiological testing **At 8 wk follow-up:** (-) Barthel Index (-) Fugl-Meyer Lower Extremity Motor Assessment Scale (-) Massachusetts General Hospital Functional Ambulation

Functional Electrical Stimulation – lower extremity

Author, Year PEDro Score, Country	Sample size	Intervention	Outcome and significance: (+) significant (-) not significant
			Classification (MGH FAC) (-) Electrophysiological testing
Newsam et al., 2004 PEDro score: 4	4	Electric stimulation facilitation program of the quadriceps during weight-bearing and ambulatory activities combined with standard physical therapy vs. standard physical therapy only	**After 3 weeks:** (-) Maximum voluntary isometric torque of quadriceps (+) Supramaximal contraction torque of quadriceps (+) Motor unit recruitment of quadriceps
Sabut et al., 2010a PEDro score: N/A; Pre-post design	N/A Pre-post design	FES and standard rehabilitation **Treatment details**: All participants completed walking sessions for 1 hour per day, 5 times per week over 12 weeks	**At 12 weeks (post-treatment):** (+) Mean absolute value of the TA EMG signal (+) Mean root mean square of the TA EMG signal (+) Median frequency of the TA EMG signal (+) Median amplitude of the TA EMG signal (+) Walking speed (+) Physiological cost index (PCI) (+) Oxygen consumption (+) Carbon dioxide production (+) Heart rate (+) Expiratory minute ventilation (+) Energy cost
Sabut et al., 2010b PEDro score: 5	5	FES and standard rehabilitation (treatment group) vs. Standard rehabilitation only (control group) **Treatment details**:	**At 12 weeks (post-treatment):** (-) Gait parameters (cadence, step length, step width, toe-in toe-out) (-) Physiological Cost Index (PCI) (-) Walking speed (10 meter walk-way)

Functional Electrical Stimulation – lower extremity

Author, Year PEDro Score, Country	Sample size	Intervention	Outcome and significance: (+) significant (-) not significant
		30 min. session per day, 5 times a week over 12 weeks	
Sheffler et al., 2006 PEDro score: 5	5	TPNS (FES) vs. AFO vs. no devcice	**Post Treatment (2 days):** (+) Modified Emory Functional Ambulation Profile (+) Patient subjective experience with TPNS (FES)
Solopova et al., 2011. PEDro score: n/a (quasi-experimental design study)	n/a (quasiexperimental study)	FES with assisted passive/active locomotor-like leg movements and progressive limb loading Vs. Conventional rehabilitation alone (control) **Treatment details**: 30 minutes/day, 5 days/week for 2 weeks.	**At 2 weeks (post-treatment):** (+) Barthel Index (+) National Institutes of Health Stroke Scale (NIHSS) (+) European Stroke Scale (ESS) (+) Fugl Meyer Assessment (FMA) (+) EMG – ipsilateral rectus femoris (RF) (+) EMG – ipsilateral biceps femoris (BF) (-) EMG – contralateral RF (-) EMG – contralateral BF (+) MVC – paretic extensor (+) MVC – nonparetic extensor (+) MVC – paretic flexor (-) MVC – nonparetic flexor (+) ankle range of movement (-) knee range of movement
Stein et al., 2006 PEDro score: 2	5	Surface electrode FES on common peroneal nerve and tibialis anterior Pre-post trial (no control group)	**At 3 months: (in stroke patients only):** (-) Walking speed (-) Physiological Cost Index

Functional Electrical Stimulation – lower extremity

Author, Year PEDro Score, Country	Sample size	Intervention	Outcome and significance: (+) significant (-) not significant
Tong et al., 2006 PEDro score: 6	6	Conventional gait training (CGT) vs. gait training using an electromechanical gait trainer (EGT), vs. gait training using an electromechanical gait trainer with functional electric stimulation (EGT-FES).	**At 4 weeks:** (-) Barthel Index (+) Motricity Index Leg Subscale (+) Functional Ambulatory Category (+) 5m Walking Speed Test (+) Elderly Mobility Scale (-) FIM Instrument Score (-) Berg Balance Scale
Winchester et al., 1983 PEDro score: 5	5	FES (Positional feedback stimulation training + cyclical stimulation) and standard rehabilitation (treatment group) vs. Standard rehabilitation only (control group) **Treatment details**: 30 min/day positional feedback stimulation training + 4x 30mins/day cyclical stimulation, 5 times a week for 4 weeks	**At 1 week (during treatment):** (-) Knee extension torque (-) Knee active range of motion **At 2 weeks (during treatment):** (-) Knee extension torque (+) Knee active range of motion **At 3 weeks (during treatment):** (+) Knee extension torque (-) Knee active range of motion **At 4 weeks (post-treatment):** (+) Knee extension torque (-) Knee active range of motion of the knee (-) Quadriceps spasticity (-) Quadriceps muscle girth (-) Knee joint position sense

Functional Electrical Stimulation – lower extremity

Author, Year PEDro Score, Country	Sample size	Intervention	Outcome and significance: (+) significant (-) not significant
Yan et al., 2005 PEDro score: 7	7	FES and standard rehabilitation vs. standard rehabilitation and placebo stimulation vs. standard rehabilitation alone	**At 3 wks:** (+) Composite Spasticity Scale (CSS) (+) % increases in maximum isometric voluntary contraction (MIVC) torque (+) Ankle plantarflexion (+) EMG co-contractions during dorsiflexion (-) Timed "Up and Go" (TUG) **At 8 wk follow-up:** (-) Composite Spasticity Scale (CSS) (+) % increases in maximum isometric voluntary contraction (MIVC) torque (-) Ankle plantarflexion (-) EMG co-contractions during dorsiflexion (-) Timed "Up and Go" (TUG)
Yavuzer et al., 2006 PEDro score: 8	8	FES and conventional rehabilitation vs. conventional rehabilitation only	**At 4 weeks:** (-) Brunnstrom stages of motor recovery (-) Gait Kinematics
Yavuzer et al., 2007 PEDro score: 7	7	Sensory-amplitude electric stimulation (SES) VS. control group	**At 4 weeks:** (-) Brunnstrom stages for the lower extremity (-) Walking velocity (-) Step length (-) % of stance phase (paretic side) (-) Several other kinematic measures of gait
Yeh et al., 2010 PEDro score: 8	8 Randomized cross-over design study	FES and cycling vs.	**At 2 days (post-treatment):** (+) Modified Ashworth Scale (MAS)

Functional Electrical Stimulation – lower extremity

Author, Year PEDro Score, Country	Sample size	Intervention	Outcome and significance: (+) significant (-) not significant
		Cycling only **Treatment details**: Each participant completed 20 mins. of either cycling with or without FES. They completed the opposite treatment on the second experimental day.	(+) Pendulum Test-relaxation index (+) Pendulum Test-peak velocity