Cochrane
Library

Cochrane Database of Systematic Reviews

Electromechanical-assisted training for walking after stroke (Review)

Mehrholz J, Thomas S, Werner C, Kugler J, Pohl M, Elsner B

Mehrholz J, Thomas S, Werner C, Kugler J, Pohl M, Elsner B.
Electromechanical-assisted training for walking after stroke.
Cochrane Database of Systematic Reviews 2017, Issue 5. Art. No.: CD006185.
DOI: [10.1002/14651858.CD006185.pub4](https://doi.org/10.1002/14651858.CD006185.pub4).

www.cochranelibrary.com

TABLE OF CONTENTS

HEADER	1
ABSTRACT	1
PLAIN LANGUAGE SUMMARY	2
SUMMARY OF FINDINGS	3
BACKGROUND	5
OBJECTIVES	5
METHODS	5
RESULTS	8
Figure 1.	9
Figure 2.	12
DISCUSSION	18
Figure 3.	19
Figure 4.	20
AUTHORS' CONCLUSIONS	21
ACKNOWLEDGEMENTS	21
REFERENCES	22
CHARACTERISTICS OF STUDIES	29
DATA AND ANALYSES	84
Analysis 1.1. Comparison 1 Electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care), Outcome 1 Independent walking at the end of intervention phase, all electromechanical devices used.	85
Analysis 1.2. Comparison 1 Electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care), Outcome 2 Recovery of independent walking at follow-up after study end.	86
Analysis 1.3. Comparison 1 Electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care), Outcome 3 Walking velocity (metres per second) at the end of intervention phase.	86
Analysis 1.4. Comparison 1 Electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care), Outcome 4 Walking velocity (metres per second) at follow-up.	87
Analysis 1.5. Comparison 1 Electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care), Outcome 5 Walking capacity (metres walked in 6 minutes) at the end of intervention phase.	87
Analysis 1.6. Comparison 1 Electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care), Outcome 6 Walking capacity (metres walked in 6 minutes) at follow-up.	88
Analysis 1.7. Comparison 1 Electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care), Outcome 7 Acceptability of electromechanical-assisted gait training devices during intervention phase: dropouts.	88
Analysis 1.8. Comparison 1 Electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care), Outcome 8 Death from all causes until the end of intervention phase.	89
Analysis 2.1. Comparison 2 Planned sensitivity analysis by trial methodology, Outcome 1 Regaining independent walking ability.	90
Analysis 3.1. Comparison 3 Subgroup analysis comparing participants in acute and chronic phases of stroke, Outcome 1 Independent walking at the end of intervention phase, all electromechanical devices used.	93
Analysis 4.1. Comparison 4 Post hoc sensitivity analysis: ambulatory status at study onset, Outcome 1 Recovery of independent walking: ambulatory status at study onset.	95
Analysis 4.2. Comparison 4 Post hoc sensitivity analysis: ambulatory status at study onset, Outcome 2 Walking velocity: ambulatory status at study onset.	96
Analysis 5.1. Comparison 5 Post hoc sensitivity analysis: type of device, Outcome 1 Different devices for regaining walking ability.	98
Analysis 5.2. Comparison 5 Post hoc sensitivity analysis: type of device, Outcome 2 Different devices for regaining walking speed.	100
Analysis 5.3. Comparison 5 Post hoc sensitivity analysis: type of device, Outcome 3 Different devices for regaining walking capacity.	101
ADDITIONAL TABLES	101
APPENDICES	112
FEEDBACK	122
WHAT'S NEW	122
HISTORY	123

CONTRIBUTIONS OF AUTHORS	124
DECLARATIONS OF INTEREST	124
SOURCES OF SUPPORT	124
DIFFERENCES BETWEEN PROTOCOL AND REVIEW	124
INDEX TERMS	125

[Intervention Review]

Electromechanical-assisted training for walking after stroke

Jan Mehrholz¹, Simone Thomas², Cordula Werner³, Joachim Kugler¹, Marcus Pohl⁴, Bernhard Elsner⁵

¹Department of Public Health, Dresden Medical School, Technical University Dresden, Dresden, Germany. ²Wissenschaftliches Institut, Klinik Bavaria Kreisch, Kreisch, Germany. ³Medicalpark, Schlaganfallzentrum Berlin, 13507 Berlin - Tegel, Germany. ⁴Neurological Rehabilitation, Helios Klinik Schloss Pulsnitz, Pulsnitz, Germany. ⁵Department of Public Health, Dresden Medical School, Technical University Dresden, Dresden, Germany

Contact address: Jan Mehrholz, Department of Public Health, Dresden Medical School, Technical University Dresden, Fetscherstr. 74, Dresden, 01307, Germany. jan.mehrholz@tu-dresden.de, jan.mehrholz@srh.de.

Editorial group: Cochrane Stroke Group

Publication status and date: New search for studies and content updated (conclusions changed), published in Issue 5, 2017.

Citation: Mehrholz J, Thomas S, Werner C, Kugler J, Pohl M, Elsner B. Electromechanical-assisted training for walking after stroke. *Cochrane Database of Systematic Reviews* 2017, Issue 5. Art. No.: CD006185. DOI: [10.1002/14651858.CD006185.pub4](https://doi.org/10.1002/14651858.CD006185.pub4).

Copyright © 2017 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.

ABSTRACT

Background

Electromechanical- and robotic-assisted gait-training devices are used in rehabilitation and might help to improve walking after stroke. This is an update of a Cochrane Review first published in 2007.

Objectives

To investigate the effects of automated electromechanical- and robotic-assisted gait-training devices for improving walking after stroke.

Search methods

We searched the Cochrane Stroke Group Trials Register (last searched 9 August 2016), the Cochrane Central Register of Controlled Trials (CENTRAL) (the Cochrane Library 2016, Issue 8), MEDLINE in Ovid (1950 to 15 August 2016), Embase (1980 to 15 August 2016), CINAHL (1982 to 15 August 2016), AMED (1985 to 15 August 2016), Web of Science (1899 to 16 August 2016), SPORTDiscus (1949 to 15 September 2012), the Physiotherapy Evidence Database (PEDro) (searched 16 August 2016), and the engineering databases COMPENDEX (1972 to 16 November 2012) and Inspec (1969 to 26 August 2016). We handsearched relevant conference proceedings, searched trials and research registers, checked reference lists, and contacted authors in an effort to identify further published, unpublished, and ongoing trials.

Selection criteria

We included all randomised controlled trials and randomised controlled cross-over trials in people over the age of 18 years diagnosed with stroke of any severity, at any stage, in any setting, evaluating electromechanical- and robotic-assisted gait training versus normal care.

Data collection and analysis

Two review authors independently selected trials for inclusion, assessed methodological quality and risk of bias, and extracted the data. The primary outcome was the proportion of participants walking independently at follow-up.

Main results

We included 36 trials involving 1472 participants in this review update. Electromechanical-assisted gait training in combination with physiotherapy increased the odds of participants becoming independent in walking (odds ratio (random effects) 1.94, 95% confidence interval (CI) 1.39 to 2.71; $P < 0.001$; $I^2 = 8\%$; moderate-quality evidence) but did not significantly increase walking velocity (mean difference (MD) 0.04 m/s, 95% CI 0.00 to 0.09; $P = 0.08$; $I^2 = 65\%$; low-quality evidence) or walking capacity (MD 5.84 metres walked in 6 minutes, 95% CI -16.73 to 28.40; $P = 0.61$; $I^2 = 53\%$; very low-quality evidence). The results must be interpreted with caution because 1) some trials investigated people who were independent in walking at the start of the study, 2) we found variations between the trials with respect

Electromechanical-assisted training for walking after stroke (Review)

Copyright © 2017 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.

to devices used and duration and frequency of treatment, and 3) some trials included devices with functional electrical stimulation. Our planned subgroup analysis suggested that people in the acute phase may benefit, but people in the chronic phase may not benefit from electromechanical-assisted gait training. Post hoc analysis showed that people who are non-ambulatory at intervention onset may benefit, but ambulatory people may not benefit from this type of training. Post hoc analysis showed no differences between the types of devices used in studies regarding ability to walk, but significant differences were found between devices in terms of walking velocity.

Authors' conclusions

People who receive electromechanical-assisted gait training in combination with physiotherapy after stroke are more likely to achieve independent walking than people who receive gait training without these devices. We concluded that seven patients need to be treated to prevent one dependency in walking. Specifically, people in the first three months after stroke and those who are not able to walk seem to benefit most from this type of intervention. The role of the type of device is still not clear. Further research should consist of large definitive pragmatic phase III trials undertaken to address specific questions about the most effective frequency and duration of electromechanical-assisted gait training as well as how long any benefit may last.

PLAIN LANGUAGE SUMMARY

Automated training devices for improving walking after stroke

Review question

Do machine- and robot-assisted walking training devices improve walking after stroke?

Background

Many people who have had a stroke have difficulties walking, and improving walking is one of the main goals of rehabilitation. Automated training devices assist walking practice.

Search date

The review is current to August 2016.

Study characteristics

We included 36 studies involving a total of 1472 participants over the age of 18 years with acute, postacute, or chronic ischaemic or haemorrhagic stroke. The mean age in the included studies ranged from 48 years to 76 years. The majority of studies were conducted in an inpatient setting.

Key results

We found moderate-quality evidence that electromechanical-assisted gait training combined with physiotherapy when compared with physiotherapy alone may improve recovery of independent walking in people after stroke.

We determined that for every seven patients treated with electromechanical- and robotic-assisted gait training devices, just one prevention of dependency in walking occurs.

Specifically, people in the first three months after stroke and those who are not able to walk appear to benefit most from this type of intervention. The importance of the type of device is still not clear. Further research should address what frequency or duration of walking training might be most effective and how long the benefit lasts. It also remains unclear how such devices should be used in routine rehabilitation.

Quality of the evidence

The quality of the evidence for automated electromechanical- and robotic-assisted gait-training devices for improving walking after stroke was moderate. The quality of evidence was low for walking speed, very low for walking capacity, and low for adverse events and people discontinuing treatment.

SUMMARY OF FINDINGS

Summary of findings for the main comparison. Electromechanical- and robotic-assisted gait training plus physiotherapy compared to physiotherapy (or usual care) for walking after stroke

Electromechanical- and robotic-assisted gait training plus physiotherapy compared to physiotherapy (or usual care) for walking after stroke

Patient or population: walking after stroke

Setting: inpatient and outpatient setting

Intervention: electromechanical- and robotic-assisted gait training plus physiotherapy

Comparison: physiotherapy (or usual care)

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	Nº of participants (studies)	Quality of the evidence (GRADE)	Comments
	Risk with physiotherapy (or usual care)	Risk with electromechanical- and robotic-assisted gait training plus physiotherapy				
Independent walking at the end of intervention phase, all electromechanical devices used Assessed with FAC	Study population		OR 1.94 (1.39 to 2.71)	1472 (36 RCTs)	⊕⊕⊕⊖ MODERATE ¹	
	457 per 1000	615 per 1000 (530 to 693)				
Recovery of independent walking at follow-up after study end Assessed with FAC	Study population		OR 1.93 (0.72 to 5.13)	496 (6 RCTs)	⊕⊕⊕⊖ MODERATE ¹	
	551 per 1000	703 per 1000 (469 to 863)				
Walking velocity (metres per second) at the end of intervention phase Assessed with timed measures of gait Scale: 0 to infinity	The mean walking velocity (metres per second) at the end of intervention phase was 0.	MD 0.04 higher (0 to 0.09 higher)	-	985 (24 RCTs)	⊕⊕⊖⊖ LOW ^{1 2}	
Walking velocity (metres per second) at follow-up Assessed with timed measures of gait Scale: 0 to infinity	The mean walking velocity (metres per second) at follow-up was 0.	MD 0.07 higher (0.05 lower to 0.19 higher)	-	578 (9 RCTs)	⊕⊕⊕⊖ MODERATE ¹	

Walking capacity (metres walked in 6 minutes) at the end of intervention phase Assessed with timed measures of gait Scale: 0 to infinity	The mean walking capacity (metres walked in 6 minutes) at the end of intervention phase was 0.	MD 5.84 higher (16.73 lower to 28.40 higher)	-	594 (12 RCTs)	⊕⊕⊕⊕ VERY LOW ^{1 3 4}
Walking capacity (metres walked in 6 minutes) at follow-up	The mean walking capacity (metres walked in 6 minutes) at follow-up was 0.	MD 0.82 lower (32.17 lower to 30.53 higher)	-	463 (7 RCTs)	⊕⊕⊕⊕ VERY LOW ^{1 2 4}
Acceptability of electro-mechanical-assisted gait-training devices during intervention phase Assessed with number of dropouts	Study population		OR 0.67 (0.43 to 1.05)	1472 (36 RCTs)	⊕⊕⊕⊕ LOW ^{1 5}
	131 per 1000	92 per 1000 (61 to 136)			

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: confidence interval; **FAC:** Functional Ambulation Category; **MD:** mean difference; **OR:** odds ratio; **RCT:** randomised controlled trial; **RR:** risk ratio

GRADE Working Group grades of evidence

High quality: We are very confident that the true effect lies close to that of the estimate of the effect.

Moderate quality: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.

Low quality: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect.

Very low quality: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect.

¹Downgraded due to several ratings of 'unclear' and 'high' risk of bias.

²Downgraded due to statistical heterogeneity and no overlap of several confidence intervals.

³Downgraded because the 95% confidence interval includes no effect and the upper confidence limit crosses the minimal important difference.

⁴Downgraded due to funnel plot asymmetry.

⁵Downgraded because the total number of events (157) is less than 300 (a threshold rule-of-thumb value).

BACKGROUND

Description of the condition

A stroke is a sudden, non-convulsive loss of neurological function due to an ischaemic or haemorrhagic intracranial vascular event (WHO 2006). In general, cerebrovascular accidents are classified by anatomic location in the brain, vascular distribution, aetiology, age of the affected individual, and haemorrhagic versus non-haemorrhagic nature (Adams 1993). Stroke is a leading cause of death and serious long-term disability in adults. Three months after stroke, 20% of people remain wheelchair bound, and approximately 70% walk at a reduced velocity and capacity (Jorgensen 1995). Restoration of walking ability and gait rehabilitation are therefore highly relevant for people who are unable to walk independently after stroke (Bohannon 1991), as well as for their relatives. To restore gait, modern concepts of rehabilitation favour a repetitive task-specific approach (Carr 2003; French 2007). In recent years it has also been shown that higher intensities of walking practice (resulting in more repetitions trained) resulted in better outcomes for people after stroke (Kwakkel 1999; Van Peppen 2004).

Description of the intervention

As an adjunct to overground gait training (States 2009), in recent years treadmill training has been introduced for the rehabilitation of people after stroke (Mehrholtz 2014). Treadmill training with and without partial body weight support enables the repetitive practice of complex gait cycles for these people. However, one disadvantage of treadmill training might be the effort required by therapists to set the paretic limbs and to control weight shift, thereby possibly limiting the intensity of therapy, especially in more severely disabled people. Automated electromechanical gait machines were developed to reduce dependence on therapists. They consist of either a robot-driven exoskeleton orthosis or an electromechanical solution, with two driven foot plates simulating the phases of gait (Colombo 2000; Hesse 1999).

One example of automated electromechanical gait rehabilitation is the Lokomat (Colombo 2000). A robotic gait orthosis combined with a harness-supported body weight system is used together with a treadmill. The main difference from treadmill training is that the patient's legs are guided by the robotic device according to a preprogrammed gait pattern. A computer-controlled robotic gait orthosis guides the patient, and the process of gait training is automated.

A second example is the Gait Trainer GT I, which is based on a double crank and rocker gear system (Hesse 1999). In contrast to a treadmill, the electromechanical Gait Trainer GT I consists of two foot plates positioned on two bars, two rockers, and two cranks, which provide the propulsion. The harness-secured patient is positioned on the foot plates, which symmetrically simulate the stance and swing phases of walking (Hesse 1999). A servo-controlled motor guides the patient during walking exercise. Vertical and horizontal movements of the trunk are controlled in a phase-dependent manner. Again, the main difference from treadmill training is that the process of gait training is automated and is supported by an electromechanical solution.

Other similar electromechanical devices that have been developed in recent years include the Haptic Walker (Schmidt 2005),

the Anklebot (MIT 2005), and the LOPES (Lower Extremity Powered Exoskeleton) (Veneman 2005). More recently, new so-called powered mobile solutions, Buesing 2015, Stein 2014, Watanabe 2014, and ankle robots, Forrester 2014, Waldman 2013, to improve walking have been described in the literature.

How the intervention might work

Electromechanical devices (such as those previously described) can be used to give non-ambulatory patients intensive practice (in terms of high repetitions) of complex gait cycles. The advantage of these electromechanical devices compared with treadmill training with partial body weight support may be the reduced effort required of therapists, as they no longer need to set the paretic limbs or assist trunk movements (Hesse 2003).

Why it is important to do this review

Scientific evidence for the benefits of the above-mentioned technologies may have changed since our Cochrane Review was first published in 2007 (Mehrholtz 2007), and so an update of the review was required to justify the large equipment and human resource costs needed to implement electromechanical-assisted gait devices, as well as to confirm the safety and acceptance of this method of training. The aim of this review was therefore to provide an update of the best available evidence about the above-mentioned approach.

OBJECTIVES

To investigate the effects of automated electromechanical- and robotic-assisted gait-training devices for improving walking after stroke.

METHODS

Criteria for considering studies for this review

Types of studies

We searched for all randomised controlled trials and randomised controlled cross-over trials for inclusion in this review. If we included randomised controlled cross-over trials, we planned to analyse only the first period as a parallel-group trial.

Types of participants

We included studies with participants of any gender over 18 years of age after stroke, using the World Health Organization (WHO) definition of stroke or a clinical definition of stroke if the WHO definition was not specifically stated (WHO 2006).

Types of interventions

We included all trials that evaluated electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care) for regaining and improving walking after stroke. We also included automated electromechanical devices that were used in combination with therapies such as functional electrical stimulation applied to the legs during gait training (compared with therapies not using electromechanical devices). We defined an automated electromechanical device as any device with an electromechanical solution designed to assist stepping cycles by supporting body weight and automating the walking therapy process in people after stroke. This category included any mechanical or computerised device designed to

improve walking function. We also searched for electromechanical devices such as robots for gait training after stroke (MIT 2005; Schmidt 2005; Veneman 2005).

Electromechanical devices can principally be differentiated into end-effector and exoskeleton devices. Examples of end-effector devices are the LokoHelp (Freivogel 2009), the Haptic Walker (Schmidt 2005), and the Gait Trainer GT I (Hesse 1999). The definition of an end-effector principle is that a patient's feet are placed on foot plates, whose trajectories simulate the stance and swing phases during gait training (Hesse 2010). An example of exoskeleton devices is the Lokomat (Colombo 2000). Such exoskeletons are outfitted with programmable drives or passive elements, which move the knees and hips during the phases of gait (Hesse 2010).

We did not include non-weight-bearing interventions such as non-interactive devices that deliver continuous passive motion only (Nuyens 2002). We excluded trials testing the effectiveness of treadmill training or other approaches such as repetitive task training in physiotherapy or electrical stimulation alone (French 2016; Pollock 2014), to prevent duplication with other Cochrane Reviews and protocols (e.g. Mehrholz 2014).

Types of outcome measures

Primary outcomes

Regaining the ability to walk is a very important goal for people after stroke (Bohannon 1988). We therefore defined the primary outcome as the ability to walk independently. We measured the ability to walk with the Functional Ambulation Category (FAC) (Holden 1984). A FAC score of 4 or 5 indicated independent walking over a 15-metre surface, irrespective of aids used such as a cane. A FAC score of less than 4 indicates dependency in walking (supervision or assistance, or both must be given in performing walking).

If the included studies did not report FAC scores, we used alternative indicators of independent walking, such as:

- a score of 3 on the ambulation item of the Barthel Index (Wade 1988); or
- a score of 6 or 7 for the walking item of the Functional Independence Measure (Hamilton 1994); or
- a 'yes' response to the item 'walking inside, with an aid if necessary (but with no standby help)' or 'yes' to 'walking on uneven ground' in the Rivermead Mobility Index (Collen 1991).

Secondary outcomes

We defined secondary outcomes as measures of activity limitations. We used walking speed (in metres per second), walking capacity (metres walked in 6 minutes), and the Rivermead Mobility Index score as relevant measures of activity limitations, if stated by the trialists. Additionally, we used death from all causes as a secondary outcome.

Adverse outcomes

We investigated the safety of electromechanical-assisted gait-training devices with the incidence of adverse outcomes such as thrombosis, major cardiovascular events, injuries, pain, and any other reported adverse events. To measure the acceptance of electromechanical-assisted gait-training devices in walking

therapies, we used visual analogue scales or withdrawal from the study for any reason (dropout rates), or both during the study period, depending on data provided by the study authors.

Depending on the above-stated categories and the availability of variables used in the included trials, we discussed and reached consensus on which outcome measures should be included in the analysis.

Search methods for identification of studies

See the 'Specialized register' section in the [Cochrane Stroke Group](#) module. We searched for trials in all languages and arranged for translation of relevant papers published in languages other than English.

Electronic searches

We searched the Cochrane Stroke Group Trials Register (last searched August 2016) and the following electronic bibliographic databases:

- The Cochrane Central Register of Controlled Trials (CENTRAL) (the Cochrane Library, Issue 8, 2016) ([Appendix 1](#));
- MEDLINE in Ovid (1950 to 15 August 2016) ([Appendix 2](#));
- Embase (1980 to 15 August 2016) ([Appendix 3](#));
- CINAHL (Cumulative Index to Nursing and Allied Health Literature) in EBSCO (1982 to 15 August 2016) ([Appendix 4](#));
- AMED (Allied and Complementary Medicine Database) (1985 to 15 August 2016) ([Appendix 5](#));
- Web of Science (Science Citation Index Expanded, Social Sciences Citation Index, Arts and Humanities Citation Index) (1899 to 16 August 2016) ([Appendix 6](#));
- PEDro (Physiotherapy Evidence Database) (searched 16 August 2016) ([Appendix 7](#));
- COMPENDEX (1972 to 16 November 2012) ([Appendix 8](#));
- SPORTDiscus (1949 to 15 September 2012) ([Appendix 9](#)); and
- Inspec (1969 to 26 August 2016) ([Appendix 10](#)).

We developed the search strategies with the help of the Cochrane Stroke Group Information Specialist and adapted the MEDLINE search strategy for the other databases.

We identified and searched the following ongoing trials and research registers:

- International Standard Randomised Controlled Trial Number Register at www.isrctn.com/ (searched August 2016);
- ClinicalTrials.gov at www.clinicaltrials.gov (searched 27 August 2016);
- Stroke Trials Register at www.strokecenter.org (searched 27 August 2016); and
- World Health Organization International Clinical Trials Registry Platform (WHO ICTRP) at apps.who.int/trialsearch/ (searched 27 August 2016) ([Appendix 11](#)).

Searching other resources

We also:

- handsearched the following relevant conference proceedings:
 - * World Congress of NeuroRehabilitation (2002, 2006, 2008, 2010, 2012, 2014, and 2016);
 - * World Congress of Physical Medicine and Rehabilitation (2001, 2003, 2005, 2007, 2009, 2011, 2013, and 2015);
 - * World Congress of Physical Therapy (2003, 2007, 2011, and 2015);
 - * Deutsche Gesellschaft für Neurotraumatologie und Klinische Neurorehabilitation (2001 to 2015);
 - * Deutsche Gesellschaft für Neurologie (2000 to 2016);
 - * Deutsche Gesellschaft für Neurorehabilitation (1999 to 2016); and
 - * Asia-Oceanian Conference of Physical & Rehabilitation Medicine (2008 to 2016).
- screened reference lists of all relevant articles; and
- contacted trialists, experts, and researchers in our field of study.

Data collection and analysis

Selection of studies

Two review authors (JM, BE) independently read the titles and abstracts of the identified references and eliminated obviously irrelevant studies. We obtained the full text for the remaining studies. Based on our inclusion criteria (types of studies, participants, aims of interventions, outcome measures), the same two review authors independently ranked these studies as relevant, irrelevant, or possibly relevant. We excluded all trials ranked initially as irrelevant but included all other trials at this stage. We excluded all trials of specific treatment components, such as electrical stimulation as stand-alone treatment, treadmill training, and continuous passive motion treatment, because these have been the subject of other Cochrane Reviews (e.g. [Mehrholtz 2014](#)). We resolved any disagreements through discussion between all four review authors. If we required further information to reach consensus, we contacted trialists in an attempt to obtain the missing information. We recorded the selection process in sufficient detail to complete a PRISMA flow diagram, and listed all studies that did not match our inclusion criteria regarding types of studies, participants, and aims of interventions in the [Characteristics of excluded studies](#) table.

Data extraction and management

Two review authors (JM, BE) independently extracted trial and outcome data from the selected trials. We established the characteristics of unpublished trials through correspondence with the trial co-ordinator or principal investigator. If any review author was involved in any of the selected studies, another review author not involved in the study extracted the study information. If there was any doubt as to whether a study should be excluded, we retrieved the full text of the article. In cases of disagreement between the two review authors, a third review author (JK) reviewed the information to decide on inclusion or exclusion of a study. We used checklists to independently record the following details.

- Methods of generating the randomisation schedule.
- Method of concealment of allocation.
- Blinding of assessors.

- Use of an intention-to-treat analysis (all participants initially randomly assigned were included in the analyses as allocated to groups).
- Adverse events and dropouts for all reasons.
- Important imbalance in prognostic factors.
- Participants (country, number of participants, age, gender, type of stroke, time from stroke onset to entry to the study, inclusion and exclusion criteria).
- Comparison (details of the intervention in treatment and control groups, details of co-intervention(s) in both groups, duration of treatment).
- Outcomes and time points of measures (number of participants in each group and outcome, regardless of compliance).

The two review authors checked all of the extracted data for agreement, with a third review author (JK) arbitrating any items for which consensus could not be reached. If necessary, we contacted trialists to request more information, clarification, and missing data.

Assessment of risk of bias in included studies

Two review authors (JM, MP) independently evaluated the methodological quality of the included trials using the Cochrane 'Risk of bias' tool, as described in Chapter 8 of the *Cochrane Handbook for Systematic Reviews of Interventions* ([Higgins 2011a](#)).

We checked all methodological quality assessments for agreement between review authors. We resolved disagreements by discussion. If one of the review authors was a co-author of an included trial, another review author (BE or JK) conducted the methodological quality assessment for this trial in this case.

Measures of treatment effect

We planned to compare electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care) for primary and secondary outcome parameters. We used the effect measures odds ratio (OR) or mean difference (MD) in the meta-analyses.

Unit of analysis issues

We analysed binary (dichotomous) outcomes with an OR, random-effects model with 95% confidence intervals (CIs). We analysed continuous outcomes with MDs, using the same outcome scale. We used a random-effects model for all analyses. We used Cochrane Review Manager 5 software for all statistical comparisons, ([RevMan 2014](#)).

Dealing with missing data

In the case of missing outcome data, we attempted to analyse data according to the intention-to-treat approach. We contacted the trial co-ordinator or principal investigator if data were missing.

Assessment of heterogeneity

We used the I^2 statistic to assess heterogeneity. We used a random-effects model, regardless of the level of heterogeneity.

Assessment of reporting biases

We inspected funnel plots to assess the risk of publication bias.

Data synthesis

GRADE and 'Summary of findings' table

We created two 'Summary of findings' tables using the following outcomes.

- Primary outcome measure: Independent walking at the end of intervention phase, all electromechanical devices used. Scale from 0 to infinity.
- Primary outcome measure: Recovery of independent walking at follow-up after study end. Scale from 0 to infinity.
- Primary outcome measure: Walking velocity (metres per second) at the end of intervention phase. Scale from 0 to infinity.
- Secondary outcome measure: Walking velocity (metres per second) at follow-up. Scale from 0 to infinity.
- Secondary outcome measure: Walking capacity (metres walked in 6 minutes) at the end of intervention phase. Scale from 0 to infinity.
- Secondary outcome measure: Walking capacity (metres walked in 6 minutes) at follow-up. Scale from 0 to infinity.
- Secondary outcome measure: Acceptability of electromechanical-assisted gait-training devices during intervention phase: number of dropouts.

We used the five GRADE considerations (study limitations, consistency of effect, imprecision, indirectness, and publication bias) to assess the quality of a body of evidence as it relates to the studies that contribute data to the meta-analyses for the prespecified outcomes (Atkins 2004). We used methods and recommendations described in Section 8.5 and Chapter 12 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011b), employing GRADEpro GDT software (GRADEpro GDT). We justified all decisions to down- or upgrade the quality of studies using footnotes, and made comments to aid the reader's understanding of the review where necessary.

Subgroup analysis and investigation of heterogeneity

As planned in our protocol (Mehrholtz 2006), we performed a formal subgroup analysis following the guidance in the *Cochrane Handbook for Systematic Reviews of Interventions* (Deeks 2011),

comparing participants treated in the acute and subacute phases of their stroke (within three months) with participants treated in the chronic phase (longer than three months).

Sensitivity analysis

As planned in our protocol, we performed a sensitivity analysis of methodological quality for each included study.

We carried out the following sensitivity analyses by including only those studies:

- with an adequate sequence generation process;
- with adequate concealed allocation;
- with blinded assessors for the primary outcome; and
- without incomplete outcome data.

We considered it necessary to do a further sensitivity analysis by removing the largest study, Pohl 2007, because some of the review authors (JM, MP, and CW) were investigators in this large trial. We carried out this sensitivity analysis by including all studies without the largest study (Pohl 2007).

We performed two further (post hoc) sensitivity analyses.

- Ambulatory status at start of study (including only studies that included an independent walker; including only studies that included dependent and independent walkers; and including only studies that included a dependent walker).
- Type of device used in trials (including only studies that used end-effector devices and including only studies that used exoskeleton devices).

RESULTS

Description of studies

See the [Characteristics of included studies](#), [Characteristics of excluded studies](#), and [Characteristics of ongoing studies](#) tables.

Results of the search

Figure 1 shows the flow diagram of the selection of studies for this update.

Figure 1. Study flow diagram.

Figure 1. (Continued)

Searches of the electronic databases and trials registers generated 7083 new unique references for screening. After excluding non-relevant citations, we obtained the full text of 55 new papers, and from these identified and included 13 new trials in the review.

Included studies

We included 36 trials involving a total of 1472 participants (see the [Characteristics of included studies](#), [Figure 1](#), [Table 1](#), and [Table 2](#)). All included studies investigated the effects of electromechanical- or robotic-assisted gait-training devices in improving walking after stroke.

For one of the included studies published only as an abstract we obtained at least some results through correspondence with the trial co-ordinator or principal investigator ([Mayr 2008](#)). Another study was not yet published, but the results of the trial were

presented orally, and we were able to obtain a handout with information about the study from the principal investigator ([Aschbacher 2006](#)).

A detailed description of all participant characteristics can be found in [Table 1](#) and [Table 2](#) (see also the [Characteristics of included studies](#)). The mean age in the included studies ranged from 48 years, in [Kyung 2008](#), to 76 years, in [Watanabe 2014](#) ([Table 1](#)). More males than females were included the studies (approximately 60% males). More participants with ischaemic stroke than haemorrhagic stroke lesions (approximately 70% ischaemic stroke) were included, and almost as many participants with left-sided hemiparesis compared with participants with right-sided hemiparesis (approximately 50% left-sided) were included in the studies (see [Table 1](#) and [Table 2](#)).

Twelve studies provided information about baseline stroke severity (Table 2), of which seven used the Barthel Index score, ranging from 20 Barthel Index points, in Kim 2015, to 75 of 100 Barthel Index points, in Dias 2006 (Table 2). Details of all inclusion and exclusion criteria used in the studies can be found in the [Characteristics of included studies](#) table.

The duration of study intervention (time frame during which experimental interventions were applied) was heterogeneous, ranging from 10 days, in Chang 2012, to eight weeks, in Mayr 2008. The study intervention period for most studies was three or four weeks (Table 2). Fifteen of the 36 studies included participants who could walk independently at the start of the study; a further nine studies included participants who were dependent and independent walkers (Analysis 4.1); and 12 studies included only non-ambulatory participants (Analysis 4.1). The experimental intervention in 17 studies was the robotic-assisted device Lokomat, and the experimental intervention in nine studies was the electromechanical-assisted device Gait Trainer; a detailed description of devices used in studies can be found in Table 2.

Frequency (in terms of therapy provided per week) of treatment ranged from two or three times a week, in Tanaka 2012, to five times a week (Table 2). Intensity (in terms of duration of experimental therapy provided) of treatment ranged from 20 minutes, in Werner 2002, to 60 minutes, in Forrester 2014. In many studies, details of the interventions were unclear or incomplete, for example details about the intensity of the experimental treatment were unclear in some studies (Table 2). Except for Tanaka 2012 and Picelli 2016, the gait training time did not differ between control and experimental groups in the included studies. Eleven

included studies used a follow-up assessment after the study ended (Buesing 2015; Chua 2016; Dias 2006; Hidler 2009; Hornby 2008; Peurala 2005; Peurala 2009; Pohl 2007; Schwartz 2006; Stein 2014; Waldman 2013). Most studies investigated improvement in walking function as a primary outcome for analysis and used the Functional Ambulation Category (FAC) or comparable scales to assess independent walking. Furthermore, frequently investigated outcomes included assessment of walking function using gait velocity in metres per second. A more detailed description of the primary and secondary outcomes for each trial can be found in the [Characteristics of included studies](#) table.

We found the highest dropout rates for all reasons at the end of the treatment phase to be 23%, in Hornby 2008, and 29%, in Kyung 2008. Seventeen trialists reported no dropouts at scheduled follow-up (Analysis 1.7; Table 2).

Excluded studies

We excluded 24 studies (see [Characteristics of excluded studies](#) and Figure 1 for further information).

Ongoing studies and studies awaiting assessment

We identified 16 ongoing studies (see [Characteristics of ongoing studies](#)). Thirteen studies for which we were unable to make contact with the trialists are still awaiting assessment (see [Characteristics of studies awaiting classification](#)).

Risk of bias in included studies

The risk of bias in included studies is described in greater detail in [Characteristics of included studies](#) and Figure 2.

Figure 2. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)
Aschbacher 2006	?	?	?	?
Bang 2016	+	+	+	+
Brincks 2011	+	+	-	+
Buesing 2015	+	-	+	+
Chang 2012	?	?	-	?
Cho 2015	?	-	-	?
Chua 2016	+	+	+	+
Dias 2006	?	+	-	+
Fisher 2008	?	?	+	+
Forrester 2014	?	-	-	-
Geroi 2011	+	+	-	+

Figure 2. (Continued)

Geroin 2011	+	+	-	+
Han 2016	?	?	+	-
Hidler 2009	+	?	-	-
Hornby 2008	+	+	-	-
Husemann 2007	+	+	+	?
Kim 2015	?	?	-	-
Kyung 2008	?	?	?	?
Mayr 2008	+	+	+	-
Morone 2011	+	+	+	+
Noser 2012	?	?	+	?
Ochi 2015	?	?	+	+
Peurala 2005	+	+	-	?
Peurala 2009	+	+	-	?
Picelli 2016	+	+	+	+
Pohl 2007	+	+	+	+
Saltuari 2004	+	?	?	+
Schwartz 2006	?	?	-	-
Stein 2014	?	?	+	-
Tanaka 2012	+	?	-	?
Tong 2006	+	+	+	?
Ucar 2014	+	?	+	?

Figure 2. (Continued)

Ucar 2014	+	?	+	?
Van Nunen 2012	?	+	-	?
Waldman 2013	?	-	-	?
Watanabe 2014	+	?	-	-
Werner 2002	+	+	+	+
Westlake 2009	?	+	-	+

We wrote to the trialists of all included studies and studies awaiting assessment to request clarification of design features or for missing information to complete the quality ratings. We sent the correspondence via email or letter, followed by reminders every month if we received no response. Most trialists provided at least some of the requested data, but we were not able to obtain all of the required data.

Two review authors (JM, MP) used the 'Risk of bias' assessment tool to independently assess the methodological quality of the studies for the domains random sequence generation, allocation concealment, blinding of outcome assessment, and incomplete outcome data for all of the included trials except two (Pohl 2007; Werner 2002), which two other review authors (BE, JK) rated in an interview with the trialists. The review authors discussed all disagreements and sought arbitration by another review author (JK or BE) if necessary.

Allocation

Of the 36 included studies, 20 described adequate random sequence generation, and 17 described adequate allocation concealment.

Blinding

Of the 36 included studies, 6 reported blinding of the primary outcome assessment.

Incomplete outcome data

Of the 36 included studies, 14 reported incomplete outcome data (attrition bias).

Selective reporting

For the majority of studies, particularly the older trials, we did not find study protocols. Where study protocols were available, there was no evidence of selective reporting of outcomes relevant to this review.

Other potential sources of bias

Five out of 36 included trials used a cross-over design with random allocation to the order of treatment sequences (Brincks 2011; Cho 2015; Saltuari 2004; Tanaka 2012; Werner 2002). We analysed only

the first intervention period as a parallel-group trial in this review. All other included studies used a parallel-group design with true randomisation to group allocation.

Three studies used two experimental groups and one control group (Geroïn 2011; Peurala 2005; Tong 2006), and one study used one experimental group and two control groups (Peurala 2009). In the former three studies (Geroïn 2011; Peurala 2005; Tong 2006), additional functional electrical stimulation of leg muscles (or transcranial stimulation of the brain in Geroïn 2011) during gait training was applied in one of the treatment groups. Because functional electrical stimulation or transcranial stimulation of the brain was done as an adjunct during electromechanical-assisted gait training, and because the results in these experimental groups did not differ significantly, we combined the results of both experimental groups into one (collapsed) group and compared this with the results from the control group. In one study, an electromechanical-assisted device was used in the experimental group and was compared with two control groups that did not use a device (Peurala 2009). Because we were interested in the effects of electromechanical- and robotic-assisted gait-training devices for improving walking after stroke, we combined the results of both control groups without devices into one (collapsed control) group and compared this with results of the one experimental group.

Effects of interventions

See: [Summary of findings for the main comparison Electromechanical- and robotic-assisted gait training plus physiotherapy compared to physiotherapy \(or usual care\) for walking after stroke](#)

Independent walking at the end of the intervention phase, all electromechanical devices used

Thirty-six trials with a total of 1472 participants measured independent walking at study end, but for 21 included trials, no effect estimate (odds ratio (OR)) was feasible because no events (e.g. no participant reached the ability to walk) or only events (e.g. all participants regained walking) were reported (Analysis 1.1) (Deeks 2011).

The use of electromechanical devices in gait rehabilitation for people after stroke increased the chance of walking independently

(OR 1.94, 95% confidence interval (CI) 1.39 to 2.71; $P < 0.001$; level of heterogeneity $I^2 = 8\%$; moderate-quality evidence; [Summary of findings for the main comparison](#)). However, 15 out of 36 studies investigated at least some participants who were already independent in walking at the start of the study. A further nine studies included participants who were dependent and independent walkers, and 12 studies included only non-ambulatory participants ([Analysis 4.1](#)). Of the total population of 1472 participants, approximately 39% were independent and approximately 59% were dependent walkers at the start of the study.

Recovery of independent walking at follow-up after study end

Six trials with a total of 496 participants measured recovery of independent walking with follow-up after the study end ([Chua 2016](#); [Hidler 2009](#); [Hornby 2008](#); [Peurala 2009](#); [Pohl 2007](#); [Tong 2006](#)), but for two included trials (with 125 participants), no effect estimate (OR) was feasible because no events (e.g. no participant reached ability to walk) or only events (e.g. all participants regained walking) were reported ([Analysis 1.2](#)). The use of electromechanical devices for gait rehabilitation of people after stroke did not increase the chance of walking independently at follow-up after study end (OR 1.93, 95% CI 0.72 to 5.13; $P = 0.19$; level of heterogeneity $I^2 = 79\%$; moderate-quality evidence). However, some included trials investigated participants who were already independent in walking at the start of the study. We could draw no definitive conclusion regarding a longer-lasting effect of the use of electromechanical devices.

Walking velocity (metres per second) at the end of the intervention phase

Twenty-four trials with a total of 985 participants provided data for walking velocity (m/s) at study end ([Analysis 1.3](#)). The use of electromechanical devices for gait rehabilitation did not significantly increase walking velocity. The pooled mean difference (MD) (random-effects model) for walking velocity was 0.04 m/s (95% CI 0.00 to 0.09; $P = 0.08$; level of heterogeneity $I^2 = 65\%$; low-quality evidence). Participants who were unable to walk were regarded as having a walking velocity of zero metres per second.

Walking velocity (metres per second) at follow-up

Nine trials with a total of 578 participants provided data for walking velocity (m/s) at follow-up after study end ([Buesing 2015](#); [Chua 2016](#); [Hidler 2009](#); [Hornby 2008](#); [Kyung 2008](#); [Noser 2012](#); [Pohl 2007](#); [Stein 2014](#); [Tong 2006](#)). The use of electromechanical devices for gait rehabilitation did not significantly increase the walking velocity at follow-up after study end. The pooled MD (random-effects model) for walking velocity was 0.07 m/s (95% CI -0.05 to 0.19; $P = 0.26$; level of heterogeneity $I^2 = 80\%$; moderate-quality evidence; [Analysis 1.4](#)). Participants who were unable to walk were regarded as having a walking velocity of zero metres per second. We could draw no definitive conclusion regarding a longer-lasting effect of the use of electromechanical devices for walking velocity.

Walking capacity (metres walked in 6 minutes) at the end of the intervention phase

Twelve trials with a total of 594 participants provided data for walking capacity (metres walked in 6 minutes) at study end ([Chua 2016](#); [Hidler 2009](#); [Hornby 2008](#); [Noser 2012](#); [Peurala 2005](#); [Picelli 2016](#); [Pohl 2007](#); [Saltuari 2004](#); [Stein 2014](#); [Waldman 2013](#);

[Watanabe 2014](#); [Westlake 2009](#)). The use of electromechanical devices in gait rehabilitation did not increase the walking capacity of people after stroke. The pooled MD (random-effects model) for walking capacity was 5.84 metres walked in 6 minutes (95% CI -16.73 to 28.40; $P = 0.61$; level of heterogeneity $I^2 = 53\%$; very low-quality evidence; [Analysis 1.5](#)).

Walking capacity (metres walked in 6 minutes) at follow-up

Seven trials with a total of 463 participants provided data for walking capacity (metres walked in 6 minutes) at follow-up after study end ([Chua 2016](#); [Hidler 2009](#); [Hornby 2008](#); [Noser 2012](#); [Pohl 2007](#); [Stein 2014](#); [Waldman 2013](#)). The use of electromechanical devices for gait rehabilitation did not increase walking capacity at follow-up after study end. The pooled MD (random-effects model) for walking capacity was -0.82 metres walked in 6 minutes (95% CI -32.17 to 30.53; $P = 0.96$; level of heterogeneity $I^2 = 58\%$; very low-quality evidence; [Analysis 1.6](#)).

Death from all causes until the end of the intervention phase

Only three larger trials reported any deaths during the intervention period ([Chua 2016](#); [Hidler 2009](#); [Pohl 2007](#)). In [Pohl 2007](#) one participant in the control group died as the result of aspiration pneumonia, and one participant in the treatment group died due to recurrent stroke. In [Hidler 2009](#), the group in which the death occurred was not stated. We therefore used a worst-case (conservative) scenario and counted the one death for the experimental group. In the study of [Chua 2016](#) the deaths occurred after the treatment period. The use of electromechanical devices for gait rehabilitation of non-ambulatory people after stroke did not increase the risk of participants dying during the intervention period (risk difference (random-effects model) 0.00, 95% CI -0.01 to 0.02; $P = 0.77$; level of heterogeneity $I^2 = 0\%$; moderate-quality evidence; [Analysis 1.8](#)).

Adverse outcomes: acceptability of electromechanical-assisted gait-training devices during the intervention phase in terms of dropouts

All trialists provided information about participants who dropped out from all causes during the trial period, but for 17 of the 36 included trials, no events/dropouts were reported ([Analysis 1.7](#)). The use of electromechanical devices for gait rehabilitation of non-ambulatory people after stroke did not increase the risk of participants dropping out (OR (random-effects model) 0.67, 95% CI 0.43 to 1.05; $P = 0.08$; level of heterogeneity $I^2 = 24\%$; low-quality evidence). The reasons for dropouts and all adverse events are described in detail for each trial in [Table 2](#).

Regaining independent walking ability: planned sensitivity analysis by trial methodology

To examine the robustness of the results, we specified variables in a sensitivity analysis that we believed could influence the size of the observed effect (adequate sequence generation process, adequate concealed allocation, blinded assessors for the primary outcome, incomplete outcome data, and excluding the largest study). As stated above, for some of the included trials, no effect estimate (OR) was feasible ([Analysis 2.1](#)).

Studies with adequate sequence generation process

We included 20 trials with a total of 949 participants with an adequate sequence generation process ([Figure 2](#)). The use

of electromechanical devices for gait rehabilitation of people after stroke increased the chance of walking independently (OR (random-effects model) 1.80, 95% CI 1.06 to 3.08; $P = 0.03$; level of heterogeneity $I^2 = 38\%$).

Studies with adequate concealed allocation

We included 17 trials with a total of 831 participants with adequate concealed allocation (Figure 2). The use of electromechanical devices for gait rehabilitation of people after stroke increased the chance of walking independently (OR (random-effects model) 1.87, 95% CI 1.12 to 3.12; $P = 0.02$; level of heterogeneity $I^2 = 37\%$).

Studies with blinded assessors for the primary outcome

Sixteen trials with a total of 762 participants had blinded assessors for the primary outcome (Figure 2). The use of electromechanical devices for gait rehabilitation of people after stroke increased the chance of walking independently (OR (random-effects model) 1.81, 95% CI 1.10 to 2.98; $P = 0.02$; level of heterogeneity $I^2 = 31\%$).

Studies with complete outcome data

Fourteen trials with a total of 590 participants adequately described complete outcome data (Figure 2). The use of electromechanical devices for gait rehabilitation of people after stroke increased the chance of walking independently (OR (random-effects model) 2.23, 95% CI 1.16 to 4.29; $P = 0.02$; level of heterogeneity $I^2 = 29\%$).

Excluding the largest study (Pohl 2007)

After excluding the largest study (Pohl 2007), 35 trials with a total of 1317 participants remained in this analysis. The use of electromechanical devices for gait rehabilitation of people after stroke increased the chance of walking independently (OR (random-effects model) 1.65, 95% CI 1.17 to 2.34; $P = 0.005$; level of heterogeneity $I^2 = 0\%$).

Subgroup analysis comparing participants in the acute and chronic phases of stroke

Independent walking at the end of the intervention phase, all electromechanical devices used

In our planned subgroup analysis comparing independent walking at the end of the intervention phase in people in the acute and chronic phases of stroke, we attempted to assign all included studies to one of two subgroups (acute and chronic phases).

Twenty trials with a total of 1143 participants investigated people in the acute or subacute phase, defined as less than or equal to three months after stroke (Analysis 3.1). As stated in the comparisons above, for some of the included trials no effect estimate (OR) was feasible (Analysis 3.1). The use of electromechanical devices for gait rehabilitation of people after stroke increased the chance of walking independently (OR (random-effects model) 1.90, 95% CI 1.38 to 2.63; $P < 0.001$; level of heterogeneity $I^2 = 5\%$).

Sixteen trials with a total of 461 participants investigated people in the chronic phase, defined as more than three months after stroke (Analysis 3.1). The use of electromechanical devices for gait rehabilitation of people after stroke did not increase the chance of walking independently (OR (random-effects model) 1.20, 95% CI 0.40 to 3.65; $P = 0.74$; level of heterogeneity $I^2 = 29\%$).

In a formal subgroup analysis, we did not find statistically significant differences in regaining independent walking between participants treated in the acute/subacute phase compared with participants treated in the chronic phase after stroke ($\text{Chi}^2 = 0.61$, $\text{df} = 1$; $P = 0.44$).

Post hoc sensitivity analysis by ambulatory status at study onset

Independent walking at the end of the intervention phase

To examine the robustness of the results and to explore the relationship between the main effect and walking status at the start of the study, we compared independent walking rates at the end of the intervention phase by ambulatory status at start of study.

Ambulatory participants at start of study

Fifteen trials with a total of 500 participants investigated independent walkers (Analysis 4.1). As stated in the comparisons above, for some of the included trials, no effect estimate (OR) was feasible; the conclusions are therefore based on one trial. The use of electromechanical devices for gait rehabilitation of people after stroke did not increase the chance of walking independently (OR (random-effects model) 1.38, 95% CI 0.45 to 4.20; $P = 0.57$; level of heterogeneity $I^2 = \text{not applicable}$).

Ambulatory and non-ambulatory participants at start of study

Nine trials with a total of 340 participants investigated a mixed population of dependent and independent walkers (Analysis 4.1). The use of electromechanical devices for gait rehabilitation of people after stroke increased the chance of walking independently (OR (random-effects model) 1.90, 95% CI 1.11 to 3.25; $P = 0.02$; level of heterogeneity $I^2 = 0\%$).

Non-ambulatory participants at start of study

Twelve trials with a total of 632 participants investigated dependent walkers (Analysis 4.1). The use of electromechanical devices for gait rehabilitation of people after stroke increased the chance of walking independently (OR (random-effects model) 1.90, 95% CI 1.04 to 3.48; $P = 0.04$; level of heterogeneity $I^2 = 45\%$).

In a subgroup analysis, we did not find statistically significant differences between people who were dependent or independent walkers at the start of the study in regaining independent walking ($\text{Chi}^2 = 0.28$, $\text{df} = 2$; $P = 0.87$).

Walking speed at the end of the intervention phase

To examine the robustness of the results and to explore the relationship between walking velocity and ambulatory status at the start of the study, we compared achieved walking velocity at the end of the intervention phase by ambulatory status at the start of the study.

Ambulatory participants at start of study

Ten trials with a total of 317 participants investigated independent walkers at the start of the study and provided data for walking velocity (m/s) at study end (Analysis 4.2). The use of electromechanical devices for gait rehabilitation did not significantly increase walking velocity. The pooled MD (random-effects model) for walking velocity was -0.02 m/s (95% CI -0.10 to 0.06; $P = 0.66$; level of heterogeneity $I^2 = 59\%$).

Ambulatory and non-ambulatory participants at start of study

Five trials with a total of 146 participants investigated dependent and independent walkers at the start of the study and provided data for walking velocity (m/s) at study end ([Analysis 4.2](#)). The use of electromechanical devices for gait rehabilitation did not significantly increase walking velocity. The pooled MD (random-effects model) for walking velocity was 0.03 m/s (95% CI -0.05 to 0.11; $P = 0.44$; level of heterogeneity $I^2 = 0\%$).

Non-ambulatory participants at start of study

Nine trials with a total of 522 participants investigated dependent walkers at the start of the study and provided data for walking velocity (m/s) at study end ([Analysis 4.2](#)). The use of electromechanical devices for gait rehabilitation significantly increased walking velocity. The pooled MD (random-effects model) for walking velocity was 0.10 m/s (95% CI 0.03 to 0.17; $P = 0.006$; level of heterogeneity $I^2 = 73\%$).

In a subgroup analysis, we did not find statistically significant differences in regaining independent walking between participants who were dependent or independent walkers at the start of the study ($\text{Chi}^2 = 4.55$, $df = 2$; $P = 0.10$).

Post hoc sensitivity analysis by type of electromechanical device

Independent walking at the end of the intervention phase

To examine the robustness of the results and to explore the relationship between independent walking and type of electromechanical device, we compared achieved independent walking rates at the end of the intervention phase by type of electromechanical device.

End-effector devices

Eleven trials with a total of 598 participants used an end-effector device as the experimental intervention ([Table 2](#)). As stated in the comparisons above, for some of the included trials, no effect estimate (OR) was feasible ([Analysis 5.1](#)). The use of electromechanical devices for gait rehabilitation of people after stroke did not increase the chance of walking independently (OR (random-effects model) 1.90, 95% CI 0.99 to 3.63; $P = 0.05$; level of heterogeneity $I^2 = 50\%$).

Exoskeleton devices

Sixteen trials with a total of 585 participants used an exoskeleton device as the experimental intervention ([Table 2](#)). The use of electromechanical devices for gait rehabilitation of people after stroke increased the chance of walking independently (OR (random-effects model) 2.05, 95% CI 1.21 to 3.50; $P = 0.008$; level of heterogeneity $I^2 = 0\%$).

We did not find statistically significant differences in regaining independent walking between participants treated with end-effector or exoskeleton devices ($\text{Chi}^2 = 0.04$, $df = 1$; $P = 0.85$).

Mobile devices

Three trials with a total of 106 participants used powered mobile devices as the experimental intervention ([Table 2](#)), but the effects on walking ability were not estimable.

Ankle devices

Two trials with a total of 63 participants used ankle devices while sitting as the experimental intervention ([Table 2](#)), but the effects on walking ability were not estimable.

We did not find statistically significant differences in regaining independent walking by type of electromechanical device (end-effector, exoskeleton, mobile or ankle device) ($\text{Chi}^2 = 0.04$, $df = 1$; $P = 0.85$).

Walking speed at the end of the intervention phase

To examine the robustness of the results and to explore the relationship between independent walking and type of electromechanical device, we compared the walking speed at the end of the intervention phase by type of electromechanical device.

End-effector devices

Nine trials with a total of 519 participants used an end-effector device as the experimental intervention and provided data for walking velocity (m/s) at study end ([Analysis 5.2](#)). The use of electromechanical devices for gait rehabilitation significantly increased walking velocity. The pooled MD (random-effects model) for walking velocity was 0.11 m/s (95% CI 0.04 to 0.18; $P = 0.003$; level of heterogeneity $I^2 = 73\%$).

Exoskeleton devices

Twelve trials with a total of 360 participants used an exoskeleton device as the experimental intervention and provided data for walking velocity (m/s) at study end ([Analysis 5.2](#)). The use of electromechanical devices for gait rehabilitation did not increase walking velocity. The pooled MD (random-effects model) for walking velocity was -0.02 m/s (95% CI -0.08 to 0.04; $P = 0.60$; level of heterogeneity $I^2 = 44\%$).

In a formal subgroup analysis, we found statistically significant differences in improvement in walking velocity between participants treated with an end-effector device or an exoskeleton device ($\text{Chi}^2 = 6.79$, $df = 1$; $P = 0.009$; $I^2 = 85.3\%$).

Mobile devices

Three trials with a total of 106 participants used powered mobile devices as the experimental intervention and provided data for walking velocity (m/s) at study end ([Analysis 5.2](#)). The use of electromechanical devices for gait rehabilitation did not increase walking velocity. The pooled MD (random-effects model) for walking velocity was 0.02 m/s (95% CI -0.11 to 0.15; $P = 0.78$; level of heterogeneity $I^2 = 0\%$).

Ankle devices

One trial with 39 participants used an ankle mobile device as the experimental intervention and provided data for walking velocity (m/s) at study end ([Analysis 5.2](#)). The use of electromechanical devices for gait rehabilitation increased walking velocity. The MD (random-effects model) for walking velocity was 0.04 m/s (95% CI 0.01 to 0.07; $P = 0.02$; level of heterogeneity not applicable).

In a subgroup analysis, we did not find statistically significant differences in improvement in walking velocity by type of electromechanical device (end-effector, exoskeleton, mobile or ankle device) ($\text{Chi}^2 = 6.56$, $df = 3$; $P = 0.09$; $I^2 = 54.3\%$).

Walking capacity at the end of the intervention phase

To examine the robustness of the results and to explore the relationship between independent walking and type of electromechanical device, we compared the walking capacity at the end of the intervention phase by type of electromechanical device.

End-effector devices

Four trials with a total of 328 participants used an end-effector device as the experimental intervention and provided data for walking capacity (metres) at study end ([Analysis 5.3](#)). The use of electromechanical devices for gait rehabilitation significantly increased walking capacity. The pooled MD (random-effects model) for walking capacity was 27.5 m (95% CI 3.63 to 51.36; $P = 0.02$; level of heterogeneity $I^2 = 4\%$).

Exoskeleton devices

Five trials with a total of 186 participants used an exoskeleton device as the experimental intervention and provided data for walking capacity (metres) at study end ([Analysis 5.3](#)). The use of electromechanical devices for gait rehabilitation did not increase walking capacity. The pooled MD (random-effects model) for walking capacity was -15.64 m (95% CI -46.34 to 15.05; $P = 0.32$; level of heterogeneity $I^2 = 51\%$).

In a formal subgroup analysis, we found statistically significant differences in improvement in walking capacity between participants treated with an end-effector device or an exoskeleton device ($\text{Chi}^2 = 4.73$, $\text{df} = 1$; $P = 0.03$; $I^2 = 78.9\%$).

Mobile devices

Two trials with a total of 56 participants used powered mobile devices as the experimental intervention and provided data for walking capacity (metres) at study end ([Analysis 5.3](#)). The use of electromechanical devices for gait rehabilitation did not increase walking capacity. The pooled MD (random-effects model) for walking capacity was 20.06 m (95% CI -39.52 to 79.63; $P = 0.51$; level of heterogeneity $I^2 = 0\%$).

Ankle devices

One trial with 24 participants used an ankle mobile device as the experimental intervention and provided data for walking capacity (metres) at study end ([Analysis 5.3](#)). The use of electromechanical devices for gait rehabilitation did not increase walking capacity. The MD (random-effects model) for walking capacity was 8.0 m (95% CI -83.03 to 99.03; $P = 0.86$; level of heterogeneity not applicable).

In a subgroup analysis, we did not find statistically significant differences in improvement in walking capacity between participants treated by type of electromechanical device (end-effector, exoskeleton, mobile or ankle device) ($\text{Chi}^2 = 4.81$, $\text{df} = 3$; $P = 0.19$; $I^2 = 37.7\%$).

DISCUSSION

Summary of main results

The aim of this review was to evaluate the effects of electromechanical- and robotic-assisted gait-training devices (with body weight support) for improving walking after stroke. We sought to estimate the likelihood or chance of becoming independent

in walking as a result of these interventions, which is a main rehabilitation goal for people who have had a stroke ([Bohannon 1988](#); [Bohannon 1991](#)).

We included 36 trials with a total of 1472 participants and found evidence that the use of electromechanical-assisted devices in combination with physiotherapy in rehabilitation settings may improve walking function after stroke.

Furthermore, adverse events, dropouts, and deaths do not appear to be more frequent in participants who received electromechanical- or robotic-assisted gait training, which indicates that the use of electromechanical-assisted gait-training devices was safe and acceptable to most participants included in the trials analysed by this review.

The exclusion of certain patient groups, such as people over 80 years of age, people with unstable cardiovascular conditions, people with cognitive and communication deficits, and people with a limited range of motion in the lower limb joints at the start of the intervention, may limit the general applicability of the findings. However, using the results from the primary outcomes, it is possible to explore the apparent effectiveness of electromechanical-assisted devices for regaining walking ability. Of 761 participants in the treatment group, 412 (54%) were walking independently at the end of the intervention phase. We used the primary outcome of independently walking at the end of the intervention phase for all included participants (OR 1.94) to calculate the number needed to treat for an additional beneficial outcome (NNTB). Together with our control event rate of 45% (325 out of 711 control participants were independently walking), we calculated an NNTB of 7 (95% CI 6 to 8) ([Sackett 1996](#)). This means that every seventh dependency in walking ability after stroke could be avoided with the use of electromechanical-assisted devices. However, the optimum amount of electromechanical-assisted gait training (optimal frequency, optimal duration in the use of assistive technologies and timing of application) remains unclear.

It appears that people in the acute and subacute phases after stroke profit more than people treated more than three months poststroke from this type of therapy ([Analysis 3.1](#)). This means that people may benefit more from electromechanical- and robotic-assisted gait training in the first three months after stroke than after three months poststroke.

We argue that 582 (39%) of the 1472 included participants were independently walking at baseline (see [Description of studies](#) and the [Characteristics of included studies](#) table). Because people who are already ambulatory cannot regain or recover independent walking, our effect estimate could have been influenced by performance bias. We therefore performed two further sensitivity analyses by ambulatory status at the start of the study ([Analysis 4.1](#) and [Analysis 4.2](#)).

We found that studies that included mainly dependent walkers (i.e. participants who were non-ambulatory at the start of the study) were more likely to report that these participants were able to walk at study end and to reach greater walking velocities at the end of the intervention phase compared with participants who were already ambulatory at the start of the study ([Analysis 4.1](#); [Analysis 4.2](#)). This means that ambulatory people do not benefit from electromechanical- and robotic-assisted gait training.

We found that the ability to walk at study end was not dependent on the type of device used in the studies (Analysis 5.1). However, walking velocities at the end of the intervention phase were higher when end-effector devices were used compared with participants who received training by an exoskeleton device (Analysis 5.2), meaning that the type of device used could play a role in improving walking function after stroke. This is in line with the former version of this review from 2013, Mehrholz 2013, and another review that compared the effects of different types of devices on walking ability after stroke (Mehrholz 2012a). However, in the absence of a direct

empirical comparison between electromechanical-assisted gait-training devices, this point warrants further investigation.

Overall completeness and applicability of evidence

In all systematic reviews the risk of publication bias is present. However, we performed an extensive search for relevant literature in electronic databases and handsearched conference abstracts. Additionally, we contacted and asked authors, trialists, and experts in the field for other unpublished and ongoing trials.

Upon visual inspection, we did not detect graphical evidence of publication bias (see Figure 3 and Figure 4).

Figure 3. Funnel plot of comparison: 1 Electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care), outcome: 1.1 Independent walking at the end of intervention phase, all electromechanical devices used.

Figure 4. Funnel plot of comparison: 1 Electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care), outcome: 1.3 Walking velocity (metres per second) at the end of intervention phase.

Given that we found several ongoing studies of substantial size, it is possible that these ongoing studies could potentially impact our overall conclusion when they are included in the review (see [Characteristics of ongoing studies](#)).

It is not clear whether the observed differences between experimental and control groups depend on the intensity of therapy, in terms of repetitions of gait practice. Time devoted to therapy is a crude measure of intensity. A 30-minute therapy session could include no walking practice or high-intensity walking practice with many steps taken. Reviews of the effectiveness of arm robotic therapy suggest that the positive benefit of robotic therapy may be lost when the intensity of practice is matched between experimental and control groups ([Mehrholtz 2012b](#)). However, the numbers of repetitions in the experimental and control groups were not exactly counted in any of the included studies. Further studies should therefore ascertain whether the benefits described here are still apparent when the intensity of gait practice (e.g. step repetitions) is exactly matched between groups.

It should be mentioned that we do not know yet whether these devices provide any cost benefit. Further studies should investigate, under the premise that gait practice is matched in terms of objective measures of intensity, the long-term costs of regaining walking ability and the cost-effectiveness of these devices.

Quality of the evidence

There was heterogeneity between the trials in terms of trial design (two arms, three arms, parallel-group or cross-over trial, duration of follow-up, and selection criteria for participants), characteristics of the therapy interventions (especially duration of the intervention), and participant characteristics (length of time since stroke onset and stroke severity at baseline). We noted methodological differences in the mechanisms of randomisation and in the allocation concealment methods used, as well as in the blinding of primary outcomes and the presence or use of intention-to-treat analysis.

After examining the effects of methodological quality on the odds of independence in walking, we found that the benefits were relatively robust when we removed trials with an inadequate sequence generation process, inadequate concealed allocation, no blinded assessors for the primary outcome, and incomplete outcome data ([Analysis 2.1](#)). However, we found that the odds of independence in walking were slightly lower after the largest included study ([Pohl 2007](#), N = 155) was removed, but a statistically significant and clinically relevant benefit for participants is still observed.

Although the methodological quality of the included trials seemed generally good to moderate ([Figure 2](#)), trials investigating electromechanical- and robotic-assisted gait-training devices are subject to potential methodological limitations. These include inability to blind the therapist and participants, so-called

contamination (provision of the intervention to the control group), and co-intervention (when the same therapist unintentionally provides additional care to either treatment or comparison group). All these potential methodological limitations introduce the possibility of performance bias. However, as discussed previously, this was not supported in our sensitivity analyses by methodological quality.

The quality of the evidence for automated electromechanical- and robotic-assisted gait-training devices for improving walking after stroke was moderate. The quality of the evidence was low for walking speed, very low for walking capacity, and low for adverse events and people discontinuing treatment.

Potential biases in the review process

In all systematic reviews the risk of publication bias is present. However, we performed an extensive search for relevant literature in electronic databases and handsearched conference abstracts. Additionally, we contacted and asked authors, trialists, and experts in the field for other unpublished and ongoing trials.

Upon visual inspection, we did not detect graphical evidence of publication bias (see [Figure 3](#) and [Figure 4](#)).

Given that we found several ongoing studies of substantial size, it is possible that these ongoing studies could potentially impact our overall conclusion (see [Characteristics of ongoing studies](#)).

Agreements and disagreements with other studies or reviews

The most recent and relevant review describes the effects of new so-called powered mobile solutions ([Louie 2016](#)). We included three studies of mobile devices in this update. When pooling these results, we did not find significant improvements in walking speed and walking capacity; this result is in agreement with the recent review of [Louie 2016](#). Additionally, there are two new studies describing the effects of ankle robots ([Forrester 2014](#); [Waldman 2013](#)) to improve walking were described. When pooling these studies, we did not find significant improvements in walking speed and walking capacity. We are not aware of any systematic review about this type of devices so far.

AUTHORS' CONCLUSIONS

Implications for practice

This systematic review provides moderate-quality evidence that the use of electromechanical-assisted gait-training devices in

combination with physiotherapy increases the chance of regaining independent walking ability in people after stroke. These results could be interpreted as preventing one participant from remaining dependent in walking after stroke for every seven treated. However, this apparent benefit for patients is not supported by our secondary outcomes. Gait-training devices were associated with neither improvements in walking velocity nor walking capacity (low- to very low-quality evidence). It appears that the greatest benefits with regard to independence in walking and walking speed were achieved in participants who were non-ambulatory at the start of the study and in those for whom the intervention was applied early poststroke.

Implications for research

There is still a need for well-designed, large-scale, multicentre studies to evaluate the benefits and harms of electromechanical-assisted gait training for walking after stroke, including only non-ambulatory people in the very early stages after stroke. Comparisons between different devices are also currently lacking. Future research should include estimates of the costs (or savings) associated with electromechanical gait training. Further analyses should investigate whether non-ambulatory or ambulatory people benefit most, and trials should include outcome measures in the activities of daily living and quality of life domains. In future updates of this review we will consider investigating the effects of different control interventions using subgroup analysis. Additionally, in the next update we will compare the effects of different duration and intensity of treatment (e.g. less than versus more than four weeks; five days per week versus less than five days).

ACKNOWLEDGEMENTS

We thank Brenda Thomas for help with developing the search strategy and for providing us with relevant trials and systematic reviews from CINAHL, AMED, SPORTDiscus, and Inspec; Hazel Fraser for providing us with relevant information about trials and systematic reviews from the Cochrane Stroke Group Trials Register; and Gabi Voigt for conducting research and for providing us with many helpful studies. We thank Stanley Fisher, Carmen Krewer, Jorge Lians, Andreas Mayer, Stefan Hesse, Joseph Hidler, George Hornby, Yun-Hee Kim, Zeev Meiner, Sinnika Peurala, Leopold Saltuari, Isabella Schwartz, Raymond Tong, John Brincks, Michael van Nunen, and Naoki Tanaka for providing additional information or unpublished data for their trials.

REFERENCES

References to studies included in this review

Aschbacher 2006 {unpublished data only}

Aschbacher B. Comparing gait training in patients after stroke with task oriented physiotherapy or robot-assisted treadmill training: a feasibility study. Unpublished 2006.

Bang 2016 {published data only}

Bang DH, Shin WS. Effects of robot-assisted gait training on spatiotemporal gait parameters and balance in patients with chronic stroke: a randomized controlled pilot trial. *NeuroRehabilitation* 2016;**38**:343-9.

Brincks 2011 {published data only}

Brincks J. The order of gait training, including Lokomat® and Physiotherapy, does not influence gait symmetry in subacute ambulatory persons with stroke. Physiotherapy, Supplement S1, 16th World Congress of Physical Therapy, 2011 June 20-23, Amsterdam. World Confederation of Physical Therapy, 2011; Vol. 97. [Number: RR-PO-208-17-Tue]

Buesing 2015 {published data only}

Buesing C, Fisch G, O'Donnell M, Shahidi I, Thomas L, Mummidisetty CK, et al. Effects of a wearable exoskeleton stride management assist system (SMA) on spatiotemporal gait characteristics in individuals after stroke: a randomized controlled trial. *Journal of NeuroEngineering and Rehabilitation* 2015; Vol. 12, issue 69.

Chang 2012 {published data only}

* Chang WH, Kim MS, Huh JP, Lee PK, Kim YH. Effects of robot-assisted gait training on cardiopulmonary fitness in subacute stroke patients: a randomized controlled study. *Neurorehabilitation and Neural Repair* 2012;**26**(4):318-24.

Kim M, Kim YH, Lee PKW, Hyong MK, Jung PH. Effect of robot-assisted gait therapy on cardiopulmonary fitness in subacute stroke patients. *Neurorehabilitation and Neural Repair* 2008;**22**:594.

Cho 2015 {published data only}

Cho DY, Park SW, Lee MJ, Park DS, Kim EJ. Effects of robot-assisted gait training on the balance and gait of chronic stroke patients: focus on dependent ambulators. *Journal of Physical Therapy Science* 2015;**27**(10):3053-7. [0915-5287]

Chua 2016 {published data only}

Chua J, Culpan J, Menon E. Efficacy of an electromechanical gait trainer poststroke in Singapore: a randomized controlled trial. *Archives of Physical Medicine and Rehabilitation* 2016;**97**:683-90.

Dias 2006 {published data only}

* Dias D, Laíns J, Pereira A, Nunes R, Caldas J, Amaral C, et al. Partial body weight support in chronic hemiplegics: a randomized control trial. *Europa Medicophysica* 2007;**43**(4):499-504.

Fisher 2008 {published and unpublished data}

* Fisher S. Use of autoambulator for mobility improvement in patients with central nervous system (CNS) injury or disease. *Neurorehabilitation and Neural Repair* 2008;**22**:556.

Fisher S, Lucas L, Thrasher TA. Robot-assisted gait training for patients with hemiparesis due to stroke. *Topics in Stroke Rehabilitation* 2011;**18**(3):269-76.

Forrester 2014 {published data only}

Forrester LW, Roy A, Krywonis A, Kehs G, Krebs HI, Macko RF. Modular ankle robotics training in early subacute stroke: a randomized controlled pilot study. *Neurorehabilitation and Neural Repair* 2014; Vol. 28, issue 7:678-87. [1552-6844]

Geroiin 2011 {published data only}

Geroiin C, Picelli A, Munari D, Waldner A, Tomelleri C, Smania N. Combined transcranial direct current stimulation and robot-assisted gait training in patients with chronic stroke: a preliminary comparison. *Clinical Rehabilitation* 2011;**25**(6):537-48.

Han 2016 {published data only}

Han EY, Im SH, Kim BR, Seo MJ, Kim MO. Robot-assisted gait training improves brachial-ankle pulse wave velocity and peak aerobic capacity in subacute stroke patients with totally dependent ambulation: Randomized controlled trial. *Medicine* 2016;**95**:e5078.

Hidler 2009 {published data only (unpublished sought but not used)}

Hidler J, Nichols D, Pelliccio M, Brady K, Campbell DD, Kahn JH, et al. Multicenter randomized clinical trial evaluating the effectiveness of the Lokomat in subacute stroke. *Neurorehabilitation and Neural Repair* 2009;**23**(1):5-13.

Hornby 2008 {published data only}

Hornby TG, Campbell DD, Kahn JH, Demott T, Moore JL, Roth HR. Enhanced gait-related improvements after therapist-versus robotic-assisted locomotor training in subjects with chronic stroke: a randomized controlled study. *Stroke* 2008;**39**(6):1786-92.

Husemann 2007 {published data only}

Husemann B, Müller F, Krewer C, Laß A, Gille C, Heller S, et al. Effects of locomotion training with assistance of a driven gait orthosis in hemiparetic patients after stroke. *Neurologie & Rehabilitation* 2004;**10**(4):25.

* Husemann B, Müller F, Krewer C, Laß A, Gille C, Heller S, et al. Effects of locomotion training with assistance of a robot-driven gait orthosis in hemiparetic patients after stroke: a randomized controlled pilot study. *Stroke* 2007;**38**(2):349-54.

Kim 2015 {published data only}

Kim S-Y, Yang L, Park IJ, Kim EJ, Park MS, You SH, et al. Effects of innovative WALKBOT robotic-assisted locomotor training on balance and gait recovery in hemiparetic stroke: a prospective, randomized, experimenter blinded case control study with a

four-week follow-up. *IEEE Transactions on Neural Systems & Rehabilitation Engineering* 2015;**23**(4):636-42. [1558-0210]

Kyung 2008 {published and unpublished data}

Jung KH, Ha HG, Shin HJ, Ohn SH, Sung DH, Lee PKW, et al. Effects of robot-assisted gait therapy on locomotor recovery in stroke patients. *Journal of Korean Academy of Rehabilitation Medicine* 2008;**32**:258-66.

* Kyung HJ, Kim YH. Effects of robot-assisted gait therapy on locomotor recovery in stroke patients. Asia-Oceanian Conference of Physical & Rehabilitation Medicine; 2008 May 16-19; Nanjing, China. 2008.

Mayr 2008 {published and unpublished data}

Mayr A, Quirbach E, Picelli A, Kofler M, Smania N, Saltuari L. Effect of early robot-assisted gait retraining in nonambulatory patients with stroke: a single-blind randomized controlled trial. Unpublished 2016.

Mayr A, Saltuari L, Quirbach E. Impact of Lokomat training on gait rehabilitation. *Neurorehabilitation and Neural Repair* 2008;**22**(5):596.

Morone 2011 {published and unpublished data}

Morone G, Bragoni M, Iosa M, De Angelis D, Venturiero V, Coiro P, et al. Who may benefit from robotic-assisted gait training? A randomized clinical trial in patients with subacute stroke. *Neurorehabilitation and Neural Repair* 2011;**25**(7):636-44.

Noser 2012 {published data only (unpublished sought but not used)}

* NCT00975156. NCT00975156 [Improving ambulation post stroke with robotic training]. clinicaltrials.gov/show/NCT00975156 (first received: 10 September 2009).

Ochi 2015 {published data only}

Ochi M, Wada F, Saeki S, Hachisuka K. Gait training in subacute non-ambulatory stroke patients using a full weight-bearing gait-assistance robot: a prospective, randomized, open, blinded-endpoint trial. *Journal of the Neurological Sciences* 2015; Vol. 353, issue 1-2:130-6. [1878-5883]

Peurala 2005 {published data only}

* Peurala S, Tarkka I, Pitkanen K, Sivenius J. The effectiveness of body weight-supported gait training and floor walking in patients with chronic stroke. *Archives of Physical Medicine and Rehabilitation* 2005;**86**:1557-64.

Peurala SH, Pitkanen K, Sivenius J, Tarkka I. Body-weight supported gait exercise compared with floor walking in chronic stroke patients. *Archives of Physical Medicine and Rehabilitation* 2004;**85**:E7.

Peurala SH, Pitkanen K, Sivenius J, Tarkka IM. Body-weight supported gait trainer exercises with or without functional electrical stimulation improves gait in patients with chronic stroke. *Neurorehabilitation and Neural Repair* 2006;**20**(1):98.

Peurala 2009 {published and unpublished data}

Peurala SH, Airaksinen O, Huuskonen P, Jäkälä P, Juhakoski M, Sandell K, et al. Effects of intensive therapy using Gait

Trainer or floorwalking exercises early after stroke. *Journal of Rehabilitation Medicine* 2009;**41**(3):166-73.

Picelli 2016 {published data only}

* Picelli A, Bacciga M, Melotti C, Marchina E, Verzini E, Ferrari F, et al. Combined effects of robot-assisted gait training and botulinum toxin type A effect on spastic equinus foot in patients with chronic stroke: a pilot, single blind, randomized controlled trial. *European Journal of Physical and Rehabilitation Medicine* 2016; Vol. 52, issue 6:759-766. [PUBMED: 27098300]

Pohl 2007 {published data only}

Pohl M, Werner C, Holzgraefe M, Kroczeck G, Mehrholz J, Wingendorf I, et al. Repetitive locomotor training and physiotherapy improve walking and basic activities of daily living in subacute, non-ambulatory stroke patients: a single-blind, randomised multi-centre trial (DEutsche GAngtrainerStudie, DEGAS). *Clinical Rehabilitation* 2007;**21**(1):17-27.

Saltuari 2004 {published data only}

Saltuari L. Efficiency of Lokomat training in stroke patients. *Neurologie & Rehabilitation* 2004;**10**(4):S4.

Schwartz 2006 {unpublished data only}

Schwartz I, Katz-Leurer M, Fisher I, Sajin A, Shochina M, Meiner Z. The effectiveness of early locomotor therapy in patients with first CVA. Collaborative Evaluation of Rehabilitation in Stroke Across Europe (CERISE) Congress; 2006 February 10-11; Leuven, Belgium. 2006.

Stein 2014 {published data only}

Stein J, Bishop L, Stein DJ, Wong CK. Gait training with a robotic leg brace after stroke. *American Journal of Physical Medicine & Rehabilitation* 2014;**93**(11):987-94. [0894-9115]

Tanaka 2012 {published data only}

Tanaka N, Saitou H, Takao T, Iizuka N, Okuno J, Yano H, et al. Effects of gait rehabilitation with a footpad-type locomotion interface in patients with chronic post-stroke hemiparesis: a pilot study. *Clinical Rehabilitation* 2012;**26**(8):686-95.

Tong 2006 {published and unpublished data}

Li LSW, Tong RYU, Ng MFW, So EFM. Effectiveness of gait trainer in stroke rehabilitation. *Journal of the Neurological Sciences* 2005;**238**(Suppl 1):S81.

Ng MFW, Tong RKY, Li LSW. A pilot study of randomized clinical controlled trial of gait training in subacute stroke patients with partial body-weight support electromechanical gait trainer and functional electrical stimulation: six-month follow-up. *Stroke* 2008;**39**:154-60.

Ng MFW, Tong RKY, So EFM, Li LSW. The therapeutic effect of electromechanical gait trainer and functional electrical stimulation for patients with acute stroke. *Neurorehabilitation and Neural Repair* 2006;**20**(1):97 (Abstract F1D-7).

* Tong RKY, Ng MF, Li LS. Effectiveness of gait training using an electromechanical gait trainer, with and without functional electric stimulation, in subacute stroke: a randomized

controlled trial. *Archives of Physical Medicine and Rehabilitation* 2006;**87**(10):1298-304.

Ucar 2014 {published data only}

Uçar DE, Paker N, Buğdaycı D. Lokomat: a therapeutic chance for patients with chronic hemiplegia. *NeuroRehabilitation* 2014;**34**(3):447-53. [1053: 8135]

Van Nunen 2012 {published data only}

* Van Nunen M. RCT evaluating the effectiveness of robot-assisted treadmill training in restoring walking ability of stroke patients. 7th World Congress of Neurological Rehabilitation; 2012 May 16-19; Melbourne, Australia. Melbourne: World Federation for Neurorehabilitation, 2012:210. [Abstract ID: 537, Poster No. 296]

Van Nunen MPM, Gerrits KHL, Konijnenbelt M, Janssen TWJ, de Haan A. Recovery of walking ability using a robotic device in subacute stroke patients: a randomized controlled study. *Disability & Rehabilitation: Assistive Technology* 2015;**10**(2):141-8. [1748-3107]

Waldman 2013 {published data only}

Waldman G, Yang C-Y, Ren Y, Liu L, Guo X, Harvey RL, et al. Effects of robot-guided passive stretching and active movement training of ankle and mobility impairments in stroke. *NeuroRehabilitation*. IOS Press, 2013; Vol. 32, issue 3:625-34. [1053-8135]

Watanabe 2014 {published data only}

Watanabe H, Tanaka N, Inuta T, Saitou H, Yanagi H. Locomotion improvement using a hybrid assistive limb in recovery phase stroke patients: a randomized controlled pilot study. *Archives of Physical Medicine and Rehabilitation* 2014;**95**(11):2006-12. [0003: 9993]

Werner 2002 {published data only}

Werner C, Von Frankenberg S, Treig T, Konrad M, Hesse S. Treadmill training with partial body weight support and an electromechanical gait trainer for restoration of gait in subacute stroke patients: a randomized crossover study. *Stroke* 2002;**33**(12):2895-901.

Westlake 2009 {published data only}

Westlake K, Patten C. Pilot study of Lokomat versus manual-assisted treadmill training for locomotor recovery post-stroke. *Journal of NeuroEngineering and Rehabilitation* 2009;**6**:18. [DOI: [10.1186/1743-0003-6-18](https://doi.org/10.1186/1743-0003-6-18)]

References to studies excluded from this review

Bae 2014 {published data only}

Bae Y, Ko Y, Chang W, Lee J, Lee K, Park Y, et al. Effects of robot-assisted gait training combined with functional electrical stimulation on recovery of locomotor mobility in chronic stroke patients: a randomized controlled trial. *Journal of Physical Therapy Science* 2014; Vol. 26, issue 12:1949-53. [0915: 5287]

Byun 2011 {published data only}

Byun SD, Jung TD, Kim CH, Lee YS. Effects of the sliding rehabilitation machine on balance and gait in chronic stroke

patients - a controlled clinical trial. *Clinical Rehabilitation* 2011;**25**(5):408-15. [1477-0873: (Electronic)]

Caldwell 2000 {published data only}

Caldwell C, Medley A. Effects of bicycling, treadmill, and variable surfaces on gait in people following a CVA. *Neurology Report* 2000;**24**(5):203.

Danzl 2013 {published data only}

Danzl MM, Chelette KC, Lee K, Lykins D, Sawaki L. Brain stimulation paired with novel locomotor training with robotic gait orthosis in chronic stroke: a feasibility study. *NeuroRehabilitation* 2013;**33**(1):67-76. [1053-8135]

David 2006 {published data only}

David D, Regnaud JP, Lejaille M, Louis A, Bussel B, Lofasso F. Oxygen consumption during machine-assisted and unassisted walking: a pilot study in hemiplegic and healthy humans. *Archives of Physical Medicine and Rehabilitation* 2006;**87**:482-9.

Forrester 2016 {published data only}

Forrester LW, Roy A, Hafer-Macko C, Krebs HI, Macko RF. Task-specific ankle robotics gait training after stroke: a randomized pilot study. *Journal of NeuroEngineering and Rehabilitation* 2016; Vol. 13, issue 51.

Gong 2003 {published data only}

Gong S, Zhang J. Effect of early rehabilitation training on daily life activity of patients with hemiplegia after stroke. *Chinese Journal of Clinical Rehabilitation* 2003;**7**(5):848-9.

Goodman 2014 {published data only}

Goodman R, Rietsehel J, Roy A, Jung B, Diaz J, Macko R, et al. Increased reward in ankle robotics training enhances motor control and cortical efficiency in stroke. *Journal of Rehabilitation Research and Development* 2014; Vol. 51, issue 2:213-7. [0748: 7711]

Hesse 2001 {published data only}

Hesse S, Werner C, Uhlenbrock D, von Frankenberg S, Bardeleben A, Brandl-Hesse B. An electromechanical gait trainer for restoration of gait in hemiparetic stroke patients: preliminary results. *Neurorehabilitation and Neural Repair* 2001;**15**:37-48.

Hsieh 2014 {published data only}

Hsieh YW, Lin KC, Horng YS, Wu CY, Wu TC, Ku FL. Sequential combination of robot-assisted therapy and constraint-induced therapy in stroke rehabilitation: a randomized controlled trial. *Journal of Neurology* 2014, (5):1037-45.

Mirelman 2009 {published data only}

Mirelman A, Bonato P, Deutsch JE. Effects of training with a robot-virtual reality system compared with a robot alone on the gait of individuals after stroke. *Stroke* 2009;**40**(1):169-74.

Morone 2016 {published data only}

Morone G, Annicchiarico R, Iosa M, Federici A, Paolucci S, Cortes U, et al. Overground walking training with the i-Walker, a robotic servo-assistive device, enhances balance in patients

with subacute stroke: a randomized controlled trial. *Journal of NeuroEngineering and Rehabilitation* 2016;**13**(47).

NCT01337960 {published data only}

NCT01337960. Ankle robotics training after stroke. clinicaltrials.gov/show/NCT01337960 (first received 15 April 2011).

Page 2008 {published data only}

Page SJ, Levine P, Teepen J, Hartman EC. Resistance-based, reciprocal upper and lower limb locomotor training in chronic stroke: a randomized, controlled crossover study. *Clinical Rehabilitation* 2008;**22**(7):610-7.

Park 2015 {published data only}

Park BS, Kim MY, Lee LK, Yang SM, Lee WD, Kim J. Effects of conventional overground gait training and a gait trainer with partial body weight support on spatiotemporal gait parameters of patients after stroke. *Journal of Physical Therapy Science* 2015;**27**:1603-7.

Patten 2006 {published data only}

* Westlake KP, Patten C. Pilot study of Lokomat versus manual-assisted treadmill training for locomotor recovery post-stroke. *Journal of NeuroEngineering and Rehabilitation* 2009;**6**:18.

Pennati 2015 {published data only}

Pennati GV, Da Re C, Messineo I, Bonaiuti D. How could robotic training and botulinum toxin be combined in chronic post stroke upper limb spasticity? A pilot study. *European Journal of Physical & Rehabilitation Medicine* 2015;**51**(4):381-7. [1973-9095]

Picelli 2015 {published data only}

Picelli A, Chemello E, Castellazzi P, Roncari L, Waldner A, Saltuari L, et al. Combined effects of transcranial direct current stimulation (tDCS) and transcutaneous spinal direct current stimulation (tsDCS) on robot-assisted gait training in patients with chronic stroke: a pilot, double blind, randomized controlled trial. *Restorative Neurology & Neuroscience* 2015;**33**(3):357-68. [1878-3627]

Pitkanen 2002 {published data only}

* Pitkanen K, Tarkka I, Sivenius J. Walking training with partial body weight support versus conventional walking training of chronic stroke patients: preliminary findings. *Neurorehabilitation and Neural Repair* 2001;**15**(4; Supplement Abstracts 3rd World Conference On Neurorehabilitation; April 2-6, 2002 Venice, Italy):312. [<http://journals.sagepub.com/doi/pdf/10.1177/154596830101500402>]

Richards 1993 {published data only}

Richards CL, Malouin F, Wood-Dauphinee S, Williams JI, Bouchard JP, Brunet D. Task-specific physical therapy for optimization of gait recovery in acute stroke patients. *Archives of Physical Medicine and Rehabilitation* 1993;**74**:612-20.

Richards 2004 {published data only}

Richards CL, Malouin F, Bravo G, Dumas F, Wood-Dauphinee S. The role of technology in task-oriented training in persons with subacute stroke: a randomized controlled trial. *Neurorehabilitation and Neural Repair* 2004;**18**(4):199-211.

Shirakawa 2001 {published data only}

Shirakawa R, Uchida SU, Okajima YO, Sakaki TS, Shutou HS. Therapeutic effects of power-assist training combined with biofeedback on hemiplegia by Therapeutic Exercise Machine (TEM). 1st International Congress of International Society of Physical and Rehabilitation Medicine (ISPRM); 2001 July 7-13; Amsterdam. 2001.

Skvortsova 2008 {published data only (unpublished sought but not used)}

Skvortsova VI, Ivanova GE, Kovrazhkina EA, Rumiantseva NA, Staritsyn AN, Suvorov Alu, et al. The use of a robot-assisted Gait Trainer GT1 in patients in the acute period of cerebral stroke: a pilot study. *Zhurnal nevrologii i psikiatrii imeni S.S. Korsakova* 2008;**Suppl 23**:28-34.

* Skvortsova VI, Ivanova GE, Kovrazhkina EA, Rumyantseva NA, Staritsyn AN, Sogomonyan EK. The efficacy of gait rehabilitation after stroke training with assistance of a robotic device gait trainer: a pilot study. *International Journal of Stroke* 2008;**3**(Suppl 3):355.

Stoller 2015 {published data only}

Stoller O, De Bruin ED, Schindelholtz M, Schuster-Amft C, De Bie RA, Hunt KJ. Feedback-controlled robotics-assisted treadmill exercise for cardiovascular training and assessment early after severe stroke. *Cerebrovascular Diseases* 2015;**39**:107. [1015-9770]

Stoller O, de Bruin E, Schindelholtz M, Schuster-Amft C, de Bie R, Hunt KJ. Efficacy of feedback-controlled robotics-assisted treadmill exercise to improve cardiovascular fitness early after stroke. *Journal of Neurologic Physical Therapy* 2015;**39**(3):156.

Wu 2014 {published data only}

Wu M, Landry J, Kim J, Schmit B, Yen S, MacDonald J. Robotic resistance/assistance training improves locomotor function in individuals poststroke: A randomized controlled study. *Archives of Physical Medicine and Rehabilitation* 2014; Vol. 95, issue 5:799-806. [0003: 9993]

References to studies awaiting assessment

Chernikova 2014 {published data only}

Chernikova LA, Klochkov AS. The influence of physical training with the use of a Lokomat robotic system on the walking ability of the patients with post-stroke hemiparesis. *Voprosy Kurortologii, Fizioterapii i Lechebnoi Fizicheskoi Kultury* 2014, issue 3:13-7. [0042-8787]

Globokar 2005 {published data only}

Globokar D. Gait trainer in neurorehabilitation of patients after stroke. 3rd World Congress of the International Society of Physical and Rehabilitation Medicine ISPRM; 2005 April 10-15; Sao Paulo, Brazil. Sao Paulo, Brazil, 2005:987-1.

Golyk 2006 {published data only (unpublished sought but not used)}

Golyk VA, Pivnyk AP, Ipatov AV. Constraint-induced movement therapy for walking improvement (comparison of two walking

training machine modifications' efficacy) for stroke patients. *European Journal of Neurology* 2006;**13**(Suppl 2):263.

Jang 2005 {published data only}

Jang SJ, Park SW, Kim ES, Wee HM, Kim YH. Electromechanical gait trainer for restoring gait in hemiparetic stroke patients. 3rd World Congress of the International Society of Physical and Rehabilitation Medicine ISPRM; 2005 April 10-15; Sao Paulo, Brazil. Sao Paulo, Brazil, 2005:909-1.

Kim 2001 {published data only}

Kim BO, Lee JJ, Cho KH, Kim SH. Gait training robot (gaiTrainer) in rehabilitation. 1st International Congress of International Society of Physical and Rehabilitation Medicine (ISPRM); 2001 July 7-13; Amsterdam. 2001. [Abstract Th.139.P]

Kim 2014 {published data only}

Kim JH, Park HI, Jang CH, Lim YH. Effects of robot-assisted therapy on lower limb in geriatric patients with subacute stroke. *European Geriatric Medicine* 2014; Vol. 5, issue Supplement 1:S174. [DOI: [10.1016/S1878-7649\(14\)70458-9](https://doi.org/10.1016/S1878-7649(14)70458-9)]

Koeneman 2004 {published data only (unpublished sought but not used)}

Koeneman JB. Air muscle device for ankle stroke rehabilitation. www.sbir.gov/sbirsearch/detail/210093 (accessed May 2017).

Mehrberg 2001 {published data only (unpublished sought but not used)}

Mehrberg RD, Flick C, Dervay J, Carmody J, Carrington C, Jermer M. Clinical evaluation of a new over ground partial body weight support assistive device in hemiparetic stroke patients. *Archives of Physical Medicine and Rehabilitation* 2001;**82**:1293 (Abstract 10).

Ohata 2015 {published data only}

Ohata K, Tsuboyama T, Watanabe A, Takahashi H. Gait training using new robotics device for patients with hemiplegia after stroke: a randomized cross-over trial. *Physiotherapy* 2015;**101**:eS1123-4. [0031-9406]

Sale 2012 {published data only}

NCT01678547. Robot Walking Rehabilitation in Stroke Patients. clinicaltrials.gov/show/NCT01678547 (date first received 31 August 2012. [NCT01678547]

Wu 2012 {published data only}

Wu H, Gu XD, Fu JM, Yao YH, Li JH, Xu ZS. Effects of rehabilitation robot for lower-limb on motor function in hemiplegic patients after stroke. *National Medical Journal of China* 2012, issue 37:2628-31.

Yoon 2015 {published data only}

Yoon Y, Seok TY, Yu K, Lee KJ, Kang SK, Yun SB. Gait training with the newly developed active-assistive system for gait is feasible for hemiplegic patients after stroke. *PM&R* 2015; Vol. 1:S115-6. [193-4148]

Zhu 2016 {published data only}

Zhu L, Song W, Liu L, Zhang R, Zhang Y. Rehabilitation effect of lower limb rehabilitation training robot combined with

task-oriented training on walking ability after stroke. *Chinese Journal of Cerebrovascular Diseases* 2016; Vol. 13, issue 5:240-4 and 248. [1672-5921]

References to ongoing studies

Louie 2015 {published data only}

* Louie DR, Eng JJ, Mortenson WB, Yao J. Use of a powered robotic exoskeleton to promote walking recovery after stroke: study protocol for a randomized controlled trial. *International Journal of Stroke*. 2015; Vol. 10, Supplement 4:89. [http://onlinelibrary.wiley.com/doi/10.1111/ijss.12633_2/pdf]

NCT00284115 {unpublished data only}

Brisso R, Laviolle B. Efficacy of a mechanical gait repetitive training technique in hemiparetic stroke patients. www.clinicaltrials.gov (last accessed September 2016).

NCT00530543 {published data only}

NCT00530543. Effects of gait training with assistance of a robot-driven gait orthosis in hemiparetic patients after stroke. clinicaltrials.gov 2007.

NCT01146587 {published data only}

Waldner A. Robot assisted therapy for acute stroke patients: a comparative study of GangTrainer GT I, Lokomat system and conventional physiotherapy. www.clinicaltrials.gov (last accessed September 2016).

NCT01187277 {published data only}

Chanubol R. Robotic versus conventional training on hemiplegic gait. www.clinicaltrials.gov (last accessed September 2016).

* Chanubol R, Wongphaet P, Werner C, Chavanich N, Panichareon L. Gait rehabilitation in subacute hemiparetic stroke: robot-assisted gait training versus conventional physical therapy. *Journal of the Neurological Sciences* 2013; Vol. 333, issue Suppl 1:e574.

NCT01678547 {published data only}

Sale P. Effect of robot assisted treatment on gait performance in stroke patients. www.clinicaltrials.gov (last accessed December 2012).

NCT01726998 {published data only}

NCT01726998. Effects of locomotion training with assistance of a robot-driven gait orthosis in hemiparetic patients after subacute stroke. www.clinicaltrials.gov 2014.

NCT02114450 {published data only}

NCT02114450. Human-machine system for the H2 lower limb exoskeleton. www.clinicaltrials.gov 2016.

NCT02471248 {published data only}

NCT02471248. Interactive exoskeleton robot for walking - ankle joint. www.clinicaltrials.gov 2016.

NCT02483676 {published data only}

NCT02483676. Ankle robot to reduce foot-drop in stroke. www.clinicaltrials.gov 2016.

NCT02545088 {published data only}

NCT02545088. New technology for individualised, intensive training of gait after stroke - study II (HAL-RCT-II). www.clinicaltrials.gov 2015.

NCT02680691 {published data only}

NCT02680691. Robot assisted gait training in patients with infratentorial stroke. www.clinicaltrials.gov 2016.

NCT02694302 {published data only}

NCT02694302. Clinical trial of robot-assisted-gait-training (RAGT) in stroke patients. www.clinicaltrials.gov 2016.

NCT02755415 {published data only}

NCT02755415. Clinical applicability of robot-assisted gait training system in acute stroke patients. www.clinicaltrials.gov 2016.

NCT02781831 {published data only}

NCT02781831. Robot-assisted gait training for patients with stroke. www.clinicaltrials.gov 2016.

NCT02843828 {published data only}

NCT02843828. Gait pattern analysis and feasibility of gait training with a walking assist robot in stroke patients and elderly adults. www.clinicaltrials.gov 2016.

Additional references
Adams 1993

Adams HP Jr, Bendixen BH, Kappelle LJ, Biller J, Love BB, Gordon DL, et al. Classification of subtype of acute ischemic stroke: definitions for use in a multicenter clinical trial (TOAST: Trial of Org 10172 in Acute Stroke Treatment). *Stroke* 1993;**24**(1):35-41.

Atkins 2004

Atkins D, Best D, Briss PA, Eccles M, Falck-Ytter Y, Flottorp S, et al. Grading quality of evidence and strength of recommendations. *BMJ* 2004;**328**:1490.

Bohannon 1988

Bohannon R. Rehabilitation goals of patients with hemiplegia. *International Journal of Rehabilitation Research* 1988;**11**(2):181-3.

Bohannon 1991

Bohannon RW, Horton MG, Wikholm JB. Importance of four variables of walking to patients with stroke. *International Journal of Rehabilitation Research* 1991;**14**:246-50.

Carr 2003

Carr J, Shepherd R. Stroke Rehabilitation: Guidelines for Exercises and Training. London: Butterworth Heinemann, 2003.

Collen 1991

Collen FM, Wade DT, Robb GF, Bradshaw CM. The Rivermead Mobility Index: a further development of the Rivermead Motor Assessment. *International Disability Studies* 1991;**13**(2):50-4.

Colombo 2000

Colombo G, Joerg M, Schreier R, Dietz V. Treadmill training of paraplegic patients using a robotic orthosis. *Journal of Rehabilitation Research and Development* 2000;**37**(6):693-700.

Deeks 2011

Deeks JJ, Higgins JPT, Altman DG. Chapter 9: Analysing data and undertaking meta-analyses. In: Higgins JPT, Green S (editors). *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from handbook.cochrane.org.

Freivogel 2009

Freivogel S, Schmalohr D, Mehrholz J. Improved walking ability and reduced therapeutic stress with an electromechanical gait device. *Journal of Rehabilitation Medicine* 2009;**41**:734-9.

French 2007

French B, Thomas LH, Leathley MJ, Sutton CJ, McAdam J, Forster A. Repetitive task training for improving functional ability after stroke. *Cochrane Database of Systematic Reviews* 2007, Issue 4. [DOI: [10.1002/14651858.CD006073.pub2](https://doi.org/10.1002/14651858.CD006073.pub2)]

French 2016

French B, Thomas LH, Coupe J, McMahon NE, Connell L, Harrison J, et al. Repetitive task training for improving functional ability after stroke. *Cochrane Database of Systematic Reviews* 2016, Issue 11. [DOI: [10.1002/14651858.CD006073.pub3](https://doi.org/10.1002/14651858.CD006073.pub3)]

GRADEpro GDT [Computer program]

McMaster University (developed by Evidence Prime, Inc.). Available from gradepr.org. GRADEpro GDT: GRADEpro Guideline Development Tool. McMaster University (developed by Evidence Prime, Inc.). Available from gradepr.org, 2015.

Hamilton 1994

Hamilton BB, Laughlin JA, Fiedler RC, Granger CV. Interrater reliability of the 7-level functional independence measure (FIM). *Scandinavian Journal of Rehabilitation Medicine* 1994;**26**(3):115-9.

Hesse 1999

Hesse S, Sarkodie-Gyan T, Uhlenbrock D. Development of an advanced mechanised gait trainer, controlling movement of the centre of mass, for restoring gait in non-ambulant subjects. *Biomedizinische Technik [Biomedical Engineering]* 1999;**44**(7-8):194-201.

Hesse 2003

Hesse S, Schmidt H, Werner C, Bardeleben A. Upper and lower extremity robotic devices for rehabilitation and for studying motor control. *Current Opinion in Neurology* 2003;**16**(6):705-10.

Hesse 2010

Hesse S, Waldner A, Tomelleri C. Innovative gait robot for the repetitive practice of floor walking and stair climbing up and down in stroke patients. *Journal of NeuroEngineering and Rehabilitation* 2010;**7**:30.

Higgins 2011a

Higgins JPT, Altman DG, Sterne JAC (editors). Chapter 8: Assessing risk of bias in included studies. In: Higgins JPT, Green S (editors). *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from handbook.cochrane.org.

Higgins 2011b

Schünemann HJ, Oxman AD, Vist GE, Higgins JPT, Deeks JJ, Glasziou P, et al. Chapter 12: Interpreting results and drawing conclusions. In: Higgins JPT, Green S (editors). *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from handbook.cochrane.org.

Holden 1984

Holden MK, Gill KM, Magliozzi MR, Nathan J, Piehl-Baker L. Clinical gait assessment in the neurologically impaired: reliability and meaningfulness. *Physical Therapy* 1984;**64**(1):35-40.

Jorgensen 1995

Jorgensen H, Nakayama H, Raaschou H, Olsen T. Recovery of walking function in stroke patients: the Copenhagen stroke study. *Archives of Physical Medicine and Rehabilitation* 1995;**76**:27-32.

Kelley 2013

Kelley CP, Childress J, Boake C, Noser EA. Over-ground and robotic-assisted locomotor training in adults with chronic stroke: a blinded randomized clinical trial. *Disability & Rehabilitation: Assistive Technology*. Philadelphia, Pennsylvania: Taylor & Francis Ltd, 2013; Vol. 8, issue 2:161-8. [1748-3107]

Kim 2008

Kim M, Kim YH, Lee PKWY, Hyong MK, Jung PH. Effect of robot-assisted gait therapy on cardiopulmonary fitness in subacute stroke patients. *Neurorehabilitation and Neural Repair* 2008;**22**:594.

Kwakkel 1999

Kwakkel G, Wagenaar RC, Twisk JW, Lankhorst GJ, Koetsier JC. Intensity of leg and arm training after primary middle-cerebral-artery stroke: a randomised trial. *Lancet* 1999;**354**(9174):191-6.

Louie 2016

Louie DR, Eng JJ. Powered robotic exoskeletons in post-stroke rehabilitation of gait: a scoping review. *Journal of NeuroEngineering and Rehabilitation* 2016; Vol. 13, issue 1:1-10. [MEDLINE: Louie2016; 1743-0003]

Mehrholtz 2012a

Mehrholtz J, Pohl M. Electromechanical-assisted gait training after stroke: a systematic review comparing end-effector and exoskeleton devices. *Journal of Rehabilitation Medicine* 2012;**44**(3):193-9.

Mehrholtz 2012b

Mehrholtz J, Hädrich A, Platz T, Kugler J, Pohl M. Electromechanical and robot-assisted arm training

for improving generic activities of daily living, arm function, and arm muscle strength after stroke. *Cochrane Database of Systematic Reviews* 2012, Issue 6. [DOI: [10.1002/14651858.CD006876.pub3](https://doi.org/10.1002/14651858.CD006876.pub3)]

Mehrholtz 2014

Mehrholtz J, Pohl M, Elsner B. Treadmill training and body weight support for walking after stroke. *Cochrane Database of Systematic Reviews* 2014, Issue 1. [DOI: [10.1002/14651858.CD002840.pub3](https://doi.org/10.1002/14651858.CD002840.pub3)]

MIT 2005

Massachusetts Institute of Technology. MIT develops Anklebot for stroke patients. web.mit.edu/newsoffice/2005/stroke-robot.html (accessed 20 December 2005).

Nuyens 2002

Nuyens GE, De Weerd WJ, Spaepen AJ Jr, Kiekens C, Feys HM. Reduction of spastic hypertonia during repeated passive knee movements in stroke patients. *Archives of Physical Medicine and Rehabilitation* 2002;**83**(7):930-5.

Pollock 2014

Pollock A, Farmer SE, Brady MC, Langhorne P, Mead GE, Mehrholz J. Interventions for improving upper limb function after stroke. *Cochrane Database of Systematic Reviews* 2014, Issue 11. [DOI: [10.1002/14651858.CD010820.pub2](https://doi.org/10.1002/14651858.CD010820.pub2)]

RevMan 2014 [Computer program]

The Nordic Cochrane Centre, The Cochrane Collaboration. Review Manager (RevMan). Version 5.3. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014.

Sackett 1996

Sackett DL, Deeks JJ, Altman DG. Down with odds ratios!. *Evidence-based Medicine* 1996;**1**:164-6.

Schmidt 2005

Schmidt H, Hesse S, Bernhardt R, Krüger J. HapticWalker - a novel haptic foot device. *ACM Transactions on Applied Perception* 2005;**2**(2):166-80.

States 2009

States RA, Pappas E, Salem Y. Overground physical therapy gait training for chronic stroke patients with mobility deficits. *Cochrane Database of Systematic Reviews* 2009, Issue 3. [DOI: [10.1002/14651858.CD006075.pub2](https://doi.org/10.1002/14651858.CD006075.pub2)]

Van Peppen 2004

Van Peppen RP, Kwakkel G, Wood-Dauphinee S, Hendriks HJ, Van der Wees PJ, Dekker J. The impact of physical therapy on functional outcomes after stroke: what's the evidence?. *Clinical Rehabilitation* 2004;**18**(8):833-62.

Veneman 2005

Veneman J, Kruidhof R, van der Helm FCT, van der Kooy H. Design of a Series Elastic- and Bowdencable-based actuation system for use as torque-actuator in exoskeleton-type training robots. International Conference on Rehabilitation Robotics; 2005 June 28-July 1; Chicago (IL). 2005.

Wade 1988

Wade DT, Collin C. The Barthel ADL Index: a standard measure of physical disability?. *International Disability Studies* 1988;**10**(2):64-7.

WHO 2006

World Health Organization. Cerebrovascular accident, stroke. www.who.int/topics/cerebrovascular_accident/en/ (accessed 1 February 2006).

References to other published versions of this review

Mehrholz 2006

Mehrholz J, Werner C, Kugler J, Pohl M. Electromechanical-assisted training for walking after stroke [Protocol].

Cochrane Database of Systematic Reviews 2006, Issue 4. [DOI: [10.1002/14651858.CD006185](https://doi.org/10.1002/14651858.CD006185)]

Mehrholz 2007

Mehrholz J, Werner C, Kugler J, Pohl M. Electromechanical-assisted training for walking after stroke. *Cochrane Database of Systematic Reviews* 2007, Issue 4. [DOI: [10.1002/14651858.CD006185.pub2](https://doi.org/10.1002/14651858.CD006185.pub2)]

Mehrholz 2013

Mehrholz J, Elsner B, Werner C, Kugler J, Pohl M. Electromechanical-assisted training for walking after stroke. *Cochrane Database of Systematic Reviews* 2013, Issue 7. [DOI: [10.1002/14651858.CD006185.pub3](https://doi.org/10.1002/14651858.CD006185.pub3)]

* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Aschbacher 2006

Methods	RCT Method of randomisation: not stated Blinding of outcome assessors: stated as 'yes' by the investigator Adverse events: not stated Deaths: not stated Dropouts: 4 (1 in treatment group, 3 in control group) ITT: unclear
Participants	Country: Switzerland 23 participants (12 in treatment group, 11 in control group) Not ambulatory at start of study Mean age: 57 to 67 years (control and treatment groups, respectively) Inclusion criteria: ≤ 3 months after stroke, ability to stand or walk 5 metres Exclusion criteria: orthopaedic problems, contractures, NYHA III-IV
Interventions	2 arms: <ul style="list-style-type: none"> Control group used task-oriented physiotherapy, 5 times a week for 3 weeks (2.5 hours a week) Experimental group used robotic-assisted treadmill training (Lokomat) for the same time and frequency
Outcomes	Outcomes were recorded at baseline and after 3 weeks and 6 months Primary outcomes: walking velocity, step length, endurance, walking ability (FAC) Secondary outcomes: isometric knee extension strength, patient acceptance and satisfaction (visual analogue scale)
Notes	Unpublished data

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method of randomisation not described

Aschbacher 2006 (Continued)

Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unclear
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear

Bang 2016

Methods	<p>RCT</p> <p>Method of randomisation: opaque, closed envelopes</p> <p>Blinding of outcome assessors: stated as 'yes' by the investigator</p> <p>Adverse events: not stated</p> <p>Deaths: not stated</p> <p>Dropouts: no</p>
Participants	<p>Country: Korea</p> <p>18 participants (9 in treatment group, 9 in control group)</p> <p>Ambulatory at start of study</p> <p>Mean age: 54 years (control and treatment group)</p> <p>Inclusion criteria: > 6 months after stroke, ability to walk over 10 meters, gait speed > 0.4 m/s, MMSE ≥ 24</p> <p>Exclusion criteria: uncontrolled health condition, comorbidity or disability other than stroke precluding gait training</p>
Interventions	<p>2 arms:</p> <ul style="list-style-type: none"> Experimental group used robotic-assisted treadmill training with body weight support (Lokomat) 5 times a week for 4 weeks (1 hour per day) Control group used conventional treadmill training without body weight support for the same time and frequency
Outcomes	<p>Outcomes were recorded at baseline and after 2 weeks.</p> <p>Outcome measures: gait speed, cadence, step length, double support period (GAITRite system), balance, level of balance confidence (ABC scale)</p>
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	The randomisation was performed by selection of an opaque, closed envelope in which the group assignment was written, which was given to the physical therapist.
Allocation concealment (selection bias)	Low risk	By sealed envelopes

Bang 2016 (Continued)

Blinding of outcome assessment (detection bias) All outcomes	Low risk	Described as blinded by an assessor not participating in study
Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropouts

Brincks 2011

Methods	Randomised cross-over trial Method of randomisation: shuffled envelopes Blinding of outcome assessors: no Adverse events: none Deaths: none Dropouts: none ITT: yes
Participants	Country: Denmark 13 participants (7 in treatment group, 6 in control group) All participants were ambulatory at start of study Mean age: 59 to 61 years (control and treatment groups, respectively) Inclusion criteria: unknown Exclusion criteria: unknown
Interventions	2 arms: <ul style="list-style-type: none">Group 1 received 3 weeks of robotic-assisted treadmill training (Lokomat), followed (after cross-over) by 3 weeks of physiotherapyGroup 2 received 3 weeks of physiotherapy followed (after cross-over) by 3 weeks of robotic-assisted treadmill training (Lokomat)
Outcomes	Outcomes were recorded at baseline, after 3 and 6 weeks Primary outcomes: single support stance time in impaired extremity and gait asymmetry and swing time ratio Secondary outcomes: walking speed
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Shuffling envelopes
Allocation concealment (selection bias)	Low risk	Using sealed, shuffled envelopes
Blinding of outcome assessment (detection bias) All outcomes	High risk	No blinding was done.
Incomplete outcome data (attrition bias) All outcomes	Low risk	ITT

Buesing 2015

Methods	<p>RCT</p> <p>Method of randomisation: random number generator</p> <p>Blinding of outcome assessors: stated as 'yes' by the investigator</p> <p>Adverse events: no adverse events</p> <p>Deaths: not stated</p> <p>Dropouts: none</p>
Participants	<p>Country: USA</p> <p>50 participants (25 in treatment group, 25 in control group)</p> <p>Ambulatory at start of study</p> <p>Mean age: 62 years experimental group and 60 years control group</p> <p>Inclusion criteria: > 12 months after stroke, medically stable, initial gait speed between 0.4 and 0.8 m/s, > 17 MMSE, sit unsupported for 30 s, walk ≥ 10 m with maximum 1 person, follow a 3-step command</p>
Interventions	<p>2 arms:</p> <ul style="list-style-type: none"> Experimental group: robot-assisted task-specific training (Stride Management Assist) 3 times a week for 6 to 8 weeks, 45 minutes per day (maximum of 18 visits) Control group: functional task-specific training for the same time and frequency
Outcomes	<p>Outcomes were recorded at baseline and after visit 10 and 18, 3-month follow-up</p> <p>Outcome measures: gait velocity, cadence, step time, step length, stride length, swing time, stance time, double support time (GAITRite)</p>
Notes	NCT01994395

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Method of randomisation described as "random number generator".
Allocation concealment (selection bias)	High risk	Allocation concealment not described.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Evaluated by a research physical therapist, who was blinded to the participant's training group
Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropouts

Chang 2012

Methods	<p>RCT</p> <p>Method of randomisation: not stated</p> <p>Blinding of outcome assessors: not stated</p> <p>Adverse events: not stated</p> <p>Deaths: not stated</p> <p>Dropouts: 3 (2 in experimental group, 1 in control group)</p>
---------	---

Chang 2012 (Continued)

ITT analysis: not described

Participants	<p>Country: Republic of Korea</p> <p>48 allocated participants (24 in treatment group, 24 in control group)</p> <p>38 participants were non-ambulatory at start of study</p> <p>Mean age: 58 years</p> <p>Inclusion criteria: first-ever stroke, stroke onset within 1 month, supratentorial lesion, age > 20 years and < 65 years, not an independent ambulator (FAC < 2), and ability to co-operate during exercise testing</p> <p>Exclusion criteria: people who met criteria for absolute and relative contraindications to exercise testing established by the American College of Sports Medicine (ACSM) were excluded. Also, people who met contraindications for Lokomat therapy or musculoskeletal disease involving the lower limbs, such as severe painful arthritis, osteoporosis, or joint contracture and other neurological diseases, were also excluded</p>
Interventions	<p>2 arms:</p> <ul style="list-style-type: none"> • Robotic gait trainer (Lokomat) 40 minutes per day, and 60 minutes conventional physiotherapy for 10 days • Conventional physiotherapy, same sessions of conventional gait training by physical therapist
Outcomes	<p>Outcomes were recorded at baseline and after training:</p> <ul style="list-style-type: none"> • FAC • Exercise and gas exchange capacity • Cardiopulmonary function • Fugl-Meyer Assessment • Motricity Index
Notes	<p>This study describes the same study protocol and participants as described in the study Kim 2008, but provides further explanation of participant characteristics; the ID Chang 2012 therefore replaces the formerly review used ID Kim 2008.</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method of randomisation is unclear.
Allocation concealment (selection bias)	Unclear risk	Method of concealment is unclear.
Blinding of outcome assessment (detection bias) All outcomes	High risk	No
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear

Cho 2015

Methods	<p>RCT, cross-over</p> <p>Method of randomisation: not stated</p> <p>Blinding of outcome assessors: not stated</p>
---------	--

Cho 2015 (Continued)

Adverse events: not stated
Deaths: not stated
Dropouts: not stated

ITT: not stated

Participants	<p>Country: Korea 20 participants (13 in treatment group, 7 in control group) Not ambulatory at start of study Mean age: 55 years in control and treatment group</p> <p>Inclusion criteria: onset period of > 6 months, FAC < 2, independent ambulation before stroke, ability to understand and execute RAGT, no orthopaedic or neurosurgical problems in the lower extremities</p> <p>Exclusion criteria: weight > 120 kg; femoral length < 35 cm or > 47 cm; history of low-extremity fracture after stroke, instability or subluxation of the hip joint, or pressure ulcers on the hips or lower extremities; any underlying disease preventing execution of RAGT</p>
Interventions	<p>2 arms:</p> <ul style="list-style-type: none"> Experimental group: robot-assisted gait training (Lokomat) 3 times per week, 4 weeks (30 minutes/day) and conventional physical therapy 5 times per week, 8 weeks (30 minutes/day) Control group: conventional physical therapy 5 times per week, 8 weeks (30 minutes/day)
Outcomes	<p>Outcomes were recorded at baseline and after 4 and 8 weeks:</p> <ul style="list-style-type: none"> Primary outcome measures: balance (Berg Balance Scale, Modified Functional Reach Test) Secondary outcome measures: walking ability (FAC), motor function (Modified Ashworth Scale, Fugl-Meyer Assessment of Lower Extremity, Motricity Index), activities of daily living (Modified Barthel Index)
Notes	Higher dose of intervention in experimental group compared to control group; group differences at baseline (modified forward reach)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method of randomisation not described.
Allocation concealment (selection bias)	High risk	Allocation not described.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not mentioned
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear

Chua 2016

Methods	<p>RCT Method of randomisation: computer-generated sequence Blinding of outcome assessors: stated as 'yes' by the investigator Adverse events: no</p>
---------	---

Electromechanical-assisted training for walking after stroke (Review)

Chua 2016 (Continued)

Deaths: yes
Dropouts: yes (7 in treatment group, 13 in control group)
ITT: yes

Participants	<p>Country: Singapore 108 participants (53 in treatment group, 53 in control group) Not ambulatory at start of study Mean age: 62 years experimental and 61 years control group</p> <p>Inclusion criteria: unilateral haemorrhagic/ischaemic stroke, age between 18 and 80 years, independent ambulation pre-stroke</p> <p>Exclusion criteria: > 8 weeks poststroke, FAC $\geq$ 4, cardiovascular instability, MMSE < 16, communication deficits, lower limb joint contractures</p>
Interventions	<p>2 arms:</p> <ul style="list-style-type: none"> Experimental group: electromechanical gait training (20 minutes) and conventional physiotherapy including stance/gait (25 minutes) 6 days a week for 8 weeks (45 minutes per day) Control group: conventional physiotherapy (including therapy to improve stance/gait), same time and frequency as experimental group
Outcomes	<p>Outcomes were recorded at baseline and 4, 8, 12, 24, and 48 weeks after baseline</p> <p>Outcome measures: walking ability (FAC), Barthel Index, gait velocity (10-metre walk test), gait endurance (6-minute walk test), health status (Stroke Impact Scale)</p>
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Authors state: "Randomization was performed using a computer-generated sequence of random numbers."
Allocation concealment (selection bias)	Low risk	Authors state: "An independent department generated the random group allocation sequence and transferred the sequence to a series of serially numbered opaque envelopes, which were not opened and revealed until after acceptance into the study and the baseline tests, therefore ensuring allocation concealment."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Authors state: "The data assessors were blinded to group allocation, but it was not possible to blind participants or the health care professionals providing interventions."
Incomplete outcome data (attrition bias) All outcomes	Low risk	All data for all participants provided and analysed. Authors state: "An intention-to-treat approach was used. Data from subjects were analysed according to the group to which they were randomised, regardless of whether they completed the intervention. Participants failing to complete either intervention were asked to return for follow-up."

Dias 2006

Methods	<p>RCT Method of randomisation: permuted block randomisation Blinding of outcome assessors: stated as blinded</p>
---------	---

Electromechanical-assisted training for walking after stroke (Review)

Dias 2006 (Continued)

	<p>Adverse events: none stated</p> <p>Deaths: none</p> <p>Dropouts: none</p> <p>ITT: not stated but probably done because there were no dropouts</p>
Participants	<p>Country: Portugal</p> <p>40 participants (20 in treatment group, 20 in control group)</p> <p>Ambulatory at start of study</p> <p>Mean age: 69 years</p> <p>Inclusion criteria: first-ever stroke patients > 12 months after stroke; age > 18 and < 80 years; cognitive (MMSE > 19) and communication capacities to understand the treatment; absence of cardiac, psychological, and orthopaedic contraindications</p> <p>Exclusion criteria: not stated</p>
Interventions	<p>2 arms:</p> <ul style="list-style-type: none"> Control group used the Bobath method, 5 times a week for 5 weeks Experimental group used the Gait Trainer for the same time and frequency
Outcomes	<p>Outcomes were recorded at baseline and after 4 weeks and 3 months:</p> <ul style="list-style-type: none"> Motricity Index Toulouse Motor Scale Modified Ashworth Scale Berg Balance Scale Rivermead Motor Score Fugl-Meyer Stroke Scale (lower limb and balance) FAC Barthel Index 10-metre walking test and gait cycle parameters Timed Up and Go test 6-minute walking distance test Step test <p>After study end and at follow-up, participants rated satisfaction with and efficiency of treatment in a self questionnaire (Likert scale).</p>
Notes	Published and unpublished data provided by the authors.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Unclear
Allocation concealment (selection bias)	Low risk	Central allocation
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not done
Incomplete outcome data (attrition bias) All outcomes	Low risk	No missing outcome data

Fisher 2008

Methods	<p>RCT</p> <p>Method of randomisation: blocked randomisation</p> <p>Blinding of outcome assessors: stated as 'yes'</p> <p>Adverse events: control group 14, experimental group 11</p> <p>Deaths: none</p> <p>Dropouts: none</p> <p>ITT: stated as 'yes'</p>
Participants	<p>Country: USA</p> <p>20 participants (10 in treatment group, 10 in control group)</p> <p>5 in treatment group and 7 in control group were ambulatory at start of study</p> <p>Mean age: not stated</p> <p>Inclusion criteria: subacute, < 2 months after stroke</p> <p>Exclusion criteria: not stated</p>
Interventions	<p>2 arms:</p> <ul style="list-style-type: none"> Control group received standard physical therapy, 3 to 5 times a week for 24 consecutive sessions Experimental group used the AutoAmbulator for the same time and frequency
Outcomes	<p>Outcomes were recorded at baseline and after 24 sessions:</p> <ul style="list-style-type: none"> Gait test portion of Tinetti's balance and mobility assessment 3-minute walk 25-foot walk
Notes	This trial is described as ongoing; the results of the first 20 participants were reported.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Unclear
Allocation concealment (selection bias)	Unclear risk	Stated as concealed, but method not described.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Yes
Incomplete outcome data (attrition bias) All outcomes	Low risk	ITT stated.

Forrester 2014

Methods	<p>RCT</p> <p>Method of randomisation: not described</p> <p>Blinding of outcome assessors: stated as 'no'</p> <p>Adverse events: no</p> <p>Deaths: not mentioned</p> <p>Dropouts: 5 (3 in treatment group, 2 in control group)</p>
---------	--

Forrester 2014 (Continued)

ITT: no

Participants	Country: USA 39 participants (21 in treatment group, 18 in control group) Not ambulatory at start of study Mean age: 63 years in experimental group and 60 years in control group Inclusion criteria: first stroke; residual lower extremity hemiparesis involving the ankle (1/5 to 4/5 MRC); capable of generating at least trace muscle activation in PF-DF; adequate language and neurocognitive function; sit in the chair for 30 to 60 minutes per session of ankle training Exclusion criteria: total plegia (0/5) at paretic ankle; fixed or painful contractures; dementia; or orthopaedic, arthritic, or inflammatory condition limiting ankle movement; deep venous thrombosis or pulmonary thromboembolism; vision impairment; severe receptive or global aphasia
Interventions	2 arms: <ul style="list-style-type: none"> Experimental group: robot-assisted ankle training, daily for 60 minutes/day, 10 sessions until discharge Control group: passive manual moving and stretching ankle, for the same time
Outcomes	Outcomes were recorded at baseline and at discharge. Outcome measures: walking ability (Functional Independence Measure walking), balance (Berg Balance Scale), walking velocity, active range of motion, muscle strength, spatiotemporal gait parameters (step time, step length, step symmetry), motor control variables (angular velocity, co-ordination)
Notes	Unclear amount of therapy

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not clearly described; authors only state "blocked randomisation"
Allocation concealment (selection bias)	High risk	Not described
Blinding of outcome assessment (detection bias) All outcomes	High risk	Authors state "not blinded".
Incomplete outcome data (attrition bias) All outcomes	High risk	5 participants were excluded from analysis after randomisation.

Geroiin 2011

Methods	RCT Method of randomisation: software-generated randomisation scheme Blinding of outcome assessors: no Adverse events: none Deaths: none Dropouts: none ITT: yes
---------	--

Geroin 2011 (Continued)

Participants	<p>Country: Italy</p> <p>30 participants (10 in treatment group 1, 10 in treatment group 2, and 10 in control group)</p> <p>5 in both treatment groups and 7 in control group were ambulatory at start of study</p> <p>Mean age: not stated</p> <p>Inclusion criteria: at least 12 months from their first unilateral ischaemic stroke; age < 75 years; European Stroke Scale score between 75 and 85; MMSE score $\geq$ 24; ability to maintain standing position without aids for at least 5 minutes; ability to walk independently for at least 15 metres with the use of walking aids (cane and orthoses)</p> <p>Exclusion criteria: preceding epileptic fits; an electroencephalography suspect of elevated cortical excitability; metallic implants within the brain and previous brain surgery; medications altering cortical excitability or with a presumed effect on brain plasticity; posterior circulation stroke; deficits of somatic sensation involving the paretic lower limb; presence of vestibular disorders or paroxysmal vertigo; presence of severe cognitive or communicative disorders; presence of other neurological or orthopaedic conditions involving the lower limbs; presence of cardiovascular comorbidity; performance of any type of rehabilitation treatment in the 3 months before start of study</p>
Interventions	<p>3 arms:</p> <ul style="list-style-type: none"> • Robot-assisted gait training (Gait Trainer GT 1) combined with transcranial direct current stimulation • Robot-assisted gait training (Gait Trainer GT 1) combined with sham transcranial direct current stimulation • Walking overground <p>All participants received 10 x 50-minute treatment sessions, 5 days a week, for 2 consecutive weeks</p>
Outcomes	<p>Outcomes were recorded at baseline and after 2 weeks:</p> <ul style="list-style-type: none"> • Primary outcomes were the 6-minute walk test and the 10-metre walking test • Secondary outcomes were spatiotemporal gait parameters, FAC, Rivermead Mobility Index, Motricity Index leg subscore, and Modified Ashworth Scale
Notes	<p>We combined the results of both robotic-assisted groups (arms 1 and 2) into a single group, which we compared with the results of the control group (arm 3).</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Software-generated list
Allocation concealment (selection bias)	Low risk	Central allocation
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not done
Incomplete outcome data (attrition bias) All outcomes	Low risk	No missing outcome data

Han 2016

Methods	<p>RCT</p> <p>Method of randomisation: not stated</p> <p>Blinding of outcome assessors: stated as 'yes'</p>
---------	---

Electromechanical-assisted training for walking after stroke (Review)

Han 2016 (Continued)

Adverse events: none
Deaths: none
Dropouts: 4 in control group (2 refused and 2 dropped)
ITT: no

Participants	<p>Country: Republic of Korea</p> <p>60 participants (30 in treatment group, 30 in control group) Non-ambulatory at start of study Mean age: 68 years in experimental group and 63 years in control group</p> <p>Inclusion criteria: clinical diagnosis of stroke < 3 months after stroke onset, first-ever stroke, dependent ambulation with severe gait impairment (FAC < 2), and sufficient cognition to understand procedures and provide informed consent</p> <p>Exclusion criteria: contraindications for RAGT therapy; cerebellar or brainstem lesions that could affect autonomic or balance function; musculoskeletal disease involving the lower limbs, such as severe painful arthritis, osteoporosis, amputation, or joint contracture; and other concurrent neurological diseases (e.g. Parkinson's disease, multiple sclerosis, etc.)</p>
Interventions	<p>2 arms:</p> <ul style="list-style-type: none"> Experimental group: 30 minutes of exoskeletal robot-driven gait orthosis training (Lokomat) and 30 minutes conventional rehabilitation therapy 5 times per week for 4 weeks Control group: 60 minutes conventional rehabilitation therapy. Physical therapy conducted by physical therapists certified in neurodevelopmental techniques was provided for balance and mobility 5 times per week for 4 weeks
Outcomes	<p>Outcomes were recorded at baseline and after the 4-week intervention; all outcome parameters were measured within 3 days before and after 20 sessions of training:</p> <ul style="list-style-type: none"> Primary outcomes: brachial-ankle pulse wave velocity (baPWV, which evaluates arterial stiffness) and cardiopulmonary fitness Secondary outcomes: clinical functional outcomes, including basic ADL function, balance, gait functions, and motor functions of the paretic lower limb

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method of randomisation not described.
Allocation concealment (selection bias)	Unclear risk	Allocation concealment not described.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	A physiatrist (rehabilitation doctor) who remained blinded to participant group and treatment throughout the entire study analysed outcome measures.
Incomplete outcome data (attrition bias) All outcomes	High risk	No ITT

Hidler 2009

Methods	<p>RCT</p> <p>Method of randomisation: randomisation table</p> <p>Blinding of outcome assessors: not described</p> <p>Adverse events: control group 14; experimental group 11</p> <p>Deaths: 1, which study arm not reported</p> <p>Dropouts: 9</p> <p>ITT: no, described as analysis per protocol</p>
Participants	<p>Country: USA</p> <p>72 participants (36 in treatment group, 36 in control group); 63 participants completed all training sessions and were analysed as per protocol</p> <p>All participants were ambulatory at start of study</p> <p>Mean age: 60 years</p> <p>Inclusion criteria: hemiparesis resulting from unilateral ischaemic or haemorrhagic stroke, time since stroke less than 6 months, no prior stroke, age > 18 years, ability to ambulate 5 metres without physical assistance and a self selected walking speed between 0.1 and 0.6 m/s, not receiving any other physical therapy targeting the lower limbs</p> <p>Exclusion criteria: severe osteoporosis, contractures limiting range of motion in the lower extremities, not ambulating before stroke, severe cardiac disease (NYHA classification of II-IV), uncontrolled hypertension (systolic > 200 mm Hg, diastolic > 110 mm Hg), stroke of the brainstem or cerebellar lesions, uncontrolled seizures, presence of lower limb non-healing ulcers, lower limb amputation, uncontrolled diabetes, cognitive deficits (< 24 on the MMSE), symptoms of depression (≥ 16 on the Center for Epidemiological Studies Depression Scale)</p>
Interventions	<p>2 arms:</p> <ul style="list-style-type: none"> Control group received conventional gait training, 3 times a week for 8 to 10 weeks for 24 sessions, each session lasted 1½ hours Experimental group used the Lokomat for the same time and frequency
Outcomes	<p>Outcomes were recorded at baseline and after 12 and 24 sessions, and at 3-month follow-up:</p> <ul style="list-style-type: none"> Primary outcome measures: self selected walking speed over 5 metres, walking distance in 6 minutes Secondary outcome measures: Berg Balance Scale, FAC, NIHSS, Motor Assessment Scale, Rivermead Mobility Index, Frenchay Activities Index, SF-36, cadence

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation table
Allocation concealment (selection bias)	Unclear risk	Not described in sufficient detail
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not done
Incomplete outcome data (attrition bias) All outcomes	High risk	No ITT, analysis per protocol

Hornby 2008

Methods	<p>RCT</p> <p>Method of randomisation: opaque, sealed envelopes</p> <p>Blinding of outcome assessors: not done</p> <p>Adverse events: 8 events in control group and 3 events in experimental group</p> <p>Deaths: none</p> <p>Dropouts: 14 (10 in control group and 4 in experimental group)</p> <p>ITT: no ITT; analysis per protocol</p>
Participants	<p>Country: USA</p> <p>62 participants (31 in treatment group, 31 in control group), 48 participants completed all training sessions and were analysed as per protocol</p> <p>All participants were ambulatory at start of study</p> <p>Mean age: 57 years</p> <p>Inclusion criteria: hemiparesis of longer than 6 months' duration after patients with unilateral, supratentorial, ischaemic, or haemorrhage stroke were recruited; no evidence of bilateral or brainstem lesions; able to walk 10 metres overground without physical assistance at speeds of 0.8 m/s at self selected velocity, using assistive devices and bracing below the knee as needed</p> <p>Exclusion criteria: significant cardiorespiratory/metabolic disease or other neurological or orthopaedic injury that may limit exercise participation or impair locomotion, size limitations for the harness/counterweight system or robotic orthosis, botulinum toxin therapy in the lower limbs within 6 months before enrolment, scores lower than 23 on the MMSE, patients could not receive concurrent physical therapy</p>
Interventions	<p>2 arms:</p> <ul style="list-style-type: none"> Control group received therapist-assisted gait training, 12 sessions, each session lasted 30 minutes Experimental group received robotic-assisted gait training using the Lokomat for the same time and frequency
Outcomes	<p>Outcomes were recorded at baseline and after 12 sessions and at 6-month follow-up:</p> <ul style="list-style-type: none"> Primary outcome measures: self selected walking speed Secondary outcome measures: single-limb stance time, step length asymmetry, 6-minute walk test, modified Emory Functional Ambulation Profile, Berg Balance Scale, Frenchay Activities Index, physical component summary score of the Medical Outcomes Questionnaire Short Form 36, strength, Modified Ashworth Scale, Center for Epidemiological Studies Depression Scale
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	(Probably) shuffling envelopes
Allocation concealment (selection bias)	Low risk	Opaque, sealed envelopes
Blinding of outcome assessment (detection bias) All outcomes	High risk	No blinding
Incomplete outcome data (attrition bias) All outcomes	High risk	'As-treated' analysis done

Husemann 2007

Methods	<p>RCT</p> <p>Method of randomisation: opaque envelopes, stratified by side of paresis and aetiology</p> <p>Blinding of outcome assessors: yes</p> <p>Adverse events: 2 (1 in experimental group, 1 in control group)</p> <p>Deaths: none</p> <p>Dropouts: 2 (1 in experimental group, 1 in control group)</p> <p>ITT analysis: not provided for all dropouts</p>
Participants	<p>Country: Germany</p> <p>32 participants (17 in treatment group, 15 in control group)</p> <p>Non-ambulatory at start of study</p> <p>Mean age: not provided</p> <p>Inclusion criteria: not provided</p> <p>Exclusion criteria: not provided</p>
Interventions	<p>2 arms:</p> <ul style="list-style-type: none"> • Robotic gait trainer (Lokomat), 30 minutes per weekday for 4 weeks • Conventional physiotherapy, 30 minutes per weekday for 4 weeks <p>Both groups received additional 30 minutes of physiotherapy daily.</p>
Outcomes	<p>Outcomes were recorded at baseline and after 4 weeks:</p> <ul style="list-style-type: none"> • FAC
Notes	Published and unpublished data provided by the authors.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random numbers generated by a computer program, block randomisation.
Allocation concealment (selection bias)	Low risk	Sealed, opaque envelopes
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Evaluating therapist blinded for group allocation.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient reporting of attrition/exclusions to permit judgement of 'low risk' or 'high risk'

Kim 2015

Methods	<p>RCT</p> <p>Method of randomisation: not described</p> <p>Blinding of outcome assessors: not described</p> <p>Adverse events: not mentioned</p> <p>Deaths: none</p> <p>Dropouts: 4 (2 in experimental group, 2 in control group)</p>
---------	--

Kim 2015 (Continued)

ITT: no

Participants	Country: Korea 30 participants (15 in treatment group, 15 in control group) Not ambulatory at start of study Mean age: 54 years in experimental group and 50 years in control group Inclusion criteria: first stroke < 1 year, plateau in recovery of the locomotor functions after a 30-day conventional neurorehabilitation Exclusion criteria: severe spasticity (Modified Ashworth Scale 2), tremor, severe visual and cognitive impairments, musculoskeletal diseases, cardiopulmonary diseases, body weight of 135 kg; height of 150 cm
Interventions	2 arms: <ul style="list-style-type: none"> Experimental group: robot-assisted training (Walkbot) (2 x 20 minutes/day) and conventional physical therapy (2 x 20 minutes/day) 5 for 4 weeks Control group: conventional physical therapy (2 x 40 minutes/day) for the same time as experimental group
Outcomes	Outcomes were recorded at baseline and after 4 and 8 weeks. Outcome measures: walking ability (FAC), balance (Berg Balance Scale), modified Barthel Index, spasticity (Modified Ashworth Scale), quality of life (EuroQol-5 dimension)
Notes	NCT02053233

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method not described.
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not described
Incomplete outcome data (attrition bias) All outcomes	High risk	No ITT

Kyung 2008

Methods	RCT Method of randomisation: unclear Blinding of outcome assessors: unclear Adverse events: unclear Deaths: unclear Dropouts: 3 (2 in experimental group, 1 in control group) ITT analysis: unclear
Participants	Country: Republic of Korea

Kyung 2008 (Continued)

35 participants (18 in treatment group, 17 in control group)
10 participants in the experimental group and 7 participants in the control group were ambulatory at start of study
Mean age: not stated
Inclusion criteria: not stated
Exclusion criteria: not stated

Interventions	2 arms: <ul style="list-style-type: none"> • Robotic training (Lokomat), 30 minutes, 3 times a week for 4 weeks • Conventional physiotherapy, received equal time and sessions of conventional gait training
Outcomes	Outcomes were recorded at baseline and after training <ul style="list-style-type: none"> • FAC • Modified Motor Assessment Scale • Gait speed • Isometric torque • Fugl-Meyer Assessment • Motricity Index • Ashworth Scale

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Unclear
Allocation concealment (selection bias)	Unclear risk	Method neither described nor stated.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unclear
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear

Mayr 2008

Methods	RCT Method of randomisation: unclear Blinding of outcome assessors: unclear Adverse events: not stated Deaths: unclear, probably none Dropouts: 13 (4 in experimental group, 9 in control group) ITT analysis: not stated
Participants	Country: Austria 74 participants (37 in treatment group, 37 in control group) Most participants in both groups were non-ambulatory at start of study Mean age: not stated

Mayr 2008 (Continued)

Inclusion criteria: primary ischaemic lesion of the medial cerebral artery, between 10 days and 6 weeks after stroke, stable cardiovascular system, ability to walk with assistance of 1 therapist
Exclusion criteria: brainstem lesions, thrombosis, severe contractures, good walking ability with standing only help by therapist

Interventions	2 arms: <ul style="list-style-type: none"> Add-on robotic training (Lokomat), 45 minutes, 5 times a week for 8 weeks Add-on conventional physiotherapy, received equal time and sessions of conventional gait training
Outcomes	Outcomes were recorded at baseline and after training phase: <ul style="list-style-type: none"> Modified Emory Functional Ambulatory Profile Hochzirl Walking Aids Profile Rivermead Motor Index Mobility milestones Gait analysis
Notes	Published as conference abstract and unpublished data

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Software-generated list
Allocation concealment (selection bias)	Low risk	Described concealed allocation
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Described as blinded evaluator
Incomplete outcome data (attrition bias) All outcomes	High risk	No ITT

Morone 2011

Methods	RCT Method of randomisation: by computer program Blinding of outcome assessors: stated as 'yes' Adverse events: control group 4, experimental group 3 Deaths: none Dropouts: (defined in this study as discontinued intervention) 12 in robotic groups and 9 in control groups ITT: yes
Participants	Country: Italy 48 participants (24 in treatment group , 24 in control group) All participants were non-ambulatory at start of study Mean age: 62 years Inclusion criteria: hemiplegia/hemiparesis in the subacute phase with significant gait deficits (FAC < 3) caused by a first-ever stroke, lesions that were confirmed by computed tomography or magnetic resonance imaging, and age between 18 and 80 years

Morone 2011 (Continued)

Exclusion criteria: presence of subarachnoid haemorrhages, sequelae of prior cerebrovascular accidents or other chronic disabling pathologies, orthopaedic injuries that could impair locomotion, spasticity that limited lower extremity range of motion to less than 80%, sacral skin lesions, MMSE score < 24, and hemispatial neglect, as evaluated by a neuropsychologist

Interventions	<p>2 arms (including strata for motor function):</p> <ul style="list-style-type: none"> After first week post-admission, participants performed 20 robotic sessions (5 times per week for 4 weeks) instead of a second session of standard physiotherapy. These sessions lasted 40 minutes, 20 of which consisted of active gait-training therapy (the remaining 20 minutes were allocated for the participant's preparation, parameter setting, and rest breaks as needed) After first week of admission, participants performed 2 daily physiotherapy sessions. One session was dedicated to walking training, consisting of 20 sessions of 40-minute therapy (5 times per week), instead of a second session of standard physiotherapy. In light of the participant's ability, the walking therapy was focused on trunk stabilisation, weight transfer to the paretic leg, and walking between parallel bars or on the ground. If necessary, the participant was helped by 1 or 2 therapists and walking aids <p>The standard physiotherapy, shared by both groups, was focused on facilitation of movement on the paretic side and upper limb exercises, as well as improving balance, standing, sitting, and transferring.</p>
Outcomes	<p>Outcomes were recorded by a physician who was blinded to the treatment at baseline, after 4 weeks of the intervention, and at hospital discharge:</p> <ul style="list-style-type: none"> Primary outcome: walking ability (as measured by FAC) Secondary outcomes: assessments of mobility function and ability level, evaluated by lower-leg Ashworth (sum of scores for hip, knee, and ankle), Rivermead Mobility Index, Motricity Index, Trunk Control Test, Canadian Neurological Scale, Barthel Index, Rankin Scale, 6-minute walk test on a 20-metre path and 10-metre walk test at a self selected speed

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Generated electronically by www.random.org
Allocation concealment (selection bias)	Low risk	Central allocation
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Yes
Incomplete outcome data (attrition bias) All outcomes	Low risk	ITT done; missing outcome data balanced in numbers across intervention groups, with similar reasons for missing data across groups.

Noser 2012

Methods	<p>RCT</p> <p>Method of randomisation: unclear</p> <p>Blinding of outcome assessors: stated as 'yes'</p> <p>Adverse events: 4 (2 in experimental group and 2 in control group)</p> <p>Deaths: none stated</p>
---------	---

Noser 2012 (Continued)

Dropouts: 1 in the control group (protocol violation)
ITT: stated as 'yes'

Participants	<p>Country: USA</p> <p>21 participants (11 in treatment group, 10 in control group); 20 participants completed all training sessions, and 11 in treatment group and 9 in control group completed the study and were analysed as per protocol</p> <p>All participants were ambulatory at start of study</p> <p>Mean age: unclear</p> <p>Inclusion criteria: people with ischaemic or haemorrhagic stroke confirmed by cerebral CT or MRI scan; age > 18; at least 3 months' poststroke at time of enrolment into study; ability to walk at least 10 feet with maximum 1 person assist, but not to walk in the community independently; residual paresis in the lower extremity as defined by NIHSS lower extremity motor score 2 to 4; ability to perform Lokomat ambulation training with assistance of 1 therapist; ability to follow a 3-step command; physician approval for patient participation; ability to give informed consent, completed rehabilitation services (i.e. not receiving concurrent physical, occupational, or speech therapy)</p> <p>Exclusion criteria: serious cardiac condition, uncontrolled blood pressure defined as > 200 or diastolic > 100 at rest, history of serious chronic obstructive pulmonary disease or oxygen dependence, severe weight-bearing pain, lower extremity amputation, claudication while walking, life expectancy < 1 year, history of deep vein thrombosis or pulmonary embolism within 6 months, severe orthopaedic problem, any medical or psychiatric condition that the investigators believe would prevent participation in study</p>
Interventions	<p>2 arms:</p> <ul style="list-style-type: none"> Control group received therapist-assisted gait training (duration and frequency unclear) Experimental group received robotic-assisted gait training using the Lokomat (duration and frequency unclear)
Outcomes	<p>Outcomes were recorded at baseline and at postintervention, 3 months' postintervention</p> <ul style="list-style-type: none"> Primary outcome measures: 10-metre walk test Secondary outcome measures: 6-minute walk test
Notes	NCT00975156; same study as Kelley 2013

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Unclear
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Authors state: "Blinded assessors tested the participants at baseline, post-intervention, and 3-month follow-up."
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	1 participant in the control group was not analysed.

Ochi 2015

Methods	RCT
---------	-----

Ochi 2015 (Continued)

	Method of randomisation: random number table Blinding of outcome assessors: stated as 'yes' Adverse events: none Deaths: none Dropouts: none
Participants	Country: Japan 26 participants (13 in treatment group, 13 in control group) Not ambulatory at start of study Mean age: 62 years in experimental group and 65 years in control group Inclusion criteria: first-ever stroke < 5 weeks; age between 40 and 85 years; lower extremities Brunnstrom's recovery stage $\leq$ grade III; FAC $\leq$ 2; independence in walking before stroke Exclusion criteria: height between 145 and 180 cm; body weight over 100 kg; limitation in range of motion in the lower extremity; severe cardiovascular, respiratory, renal, or musculoskeletal disease; difficulty in communicating
Interventions	2 arms: <ul style="list-style-type: none"> Experimental group: robot-assisted training (gait-assistance robot) 5 days/week for 4 weeks (20 minutes) Control group: overground conventional gait training for the same time as experimental group
Outcomes	Outcomes were recorded at baseline and after 4 weeks. Outcome measures: Fugl-Meyer Assessment lower extremity, muscle torque, walking ability (FAC), 10-metre walk test, Functional Independence Measure
Notes	Clinical group differences in FAC at baseline

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method of randomisation not described.
Allocation concealment (selection bias)	Unclear risk	No allocation concealment described.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Described as blinded assessors
Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropouts, no participants excluded from analysis.

Peurala 2005

Methods	RCT Method of randomisation: an investigator not involved in the study randomly assigned participants to groups using concealed envelopes Blinding of outcome assessors: no Adverse events: none Deaths: none
---------	---

Peurala 2005 (Continued)

	Dropouts: none ITT analysis: not stated
Participants	Country: Finland 45 participants (15 in treatment group A, 15 in treatment group B, 15 in control group) Ambulatory and non-ambulatory at study onset Mean age: 52 years Inclusion criteria: first supratentorial stroke with duration of illness longer than 6 months, younger than 65 years of age, slow or difficult walking, no unstable cardiovascular disease, no severe malposition of joints, no severe cognitive or communicative disorders, written informed consent Exclusion criteria: not stated
Interventions	3 arms: <ul style="list-style-type: none">• Gait trainer exercise without functional electrical stimulation• Gait trainer exercise with functional electrical stimulation• Walking overground All participants practised gait for 15 sessions over 3 weeks (each session lasting 20 minutes) and received an additional 55 minutes daily physiotherapy.
Outcomes	Outcomes were recorded at baseline and after 2 and 3 weeks and 6 months: <ul style="list-style-type: none">• 10-metre walk test• 6-minute walk test• Lower limb spasticity• Muscle force• Postural sway tests• Modified Motor Assessment Scale• Functional Independence Measure instrument scores
Notes	Published and unpublished data provided by the authors.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	An investigator not involved in the study randomly assigned participants to groups using concealed envelopes.
Allocation concealment (selection bias)	Low risk	Concealed envelopes
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not done
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear if reasons for missing outcome data are unlikely to be related to true outcome

Peurala 2009

Methods	RCT Method of randomisation: sealed envelopes (stratified according to ability to walk) Blinding of outcome assessors: no
---------	---

Peurala 2009 (Continued)

Adverse events: 2 in treatment group A, 3 in control group
Deaths: 1 in control group
Dropouts: 5 in treatment group A, 1 in treatment group B, 3 in control group
ITT analysis: not stated

Participants	Country: Finland 56 participants (22 in treatment group A, 21 in treatment group B, 13 in control group) Non-ambulatory at start of study Mean age: 68 years Inclusion criteria: first supratentorial stroke or no significant disturbance from an earlier stroke (Modified Rankin Scale 0 to 2), acute phase after stroke with a maximum duration of 10 days, FAC 0 to 3, voluntary movement in the leg of the affected side, Barthel Index 25 to 75 points, age 18 to 85 years, no unstable cardiovascular disease, body mass index < 32, no severe malposition of joints, no severe cognitive or communicative disorders Exclusion criteria: not stated
Interventions	Between June 2003 and December 2004, random allocation to 2 arms took place (2 walking exercise groups) <ul style="list-style-type: none"> Gait training with Gait Trainer device (GT-Group) Overground walking training (WALK-Group) All participants received 55 minutes daily gait-oriented physiotherapy and additional gait training for 15 sessions over 3 weeks (each session lasting maximum of 20 minutes of walking). <p>Between January 2005 and February 2007, random allocation to 3 arms took place (3 walking exercise groups)</p> <ul style="list-style-type: none"> Gait training with Gait Trainer device (GT-Group) Overground walking training (WALK-Group) Control group (CT-Group) All participants received 55 minutes daily gait-oriented physiotherapy and additional gait training for 15 sessions over 3 weeks (each session lasting maximum of 20 minutes of walking). However, CT-Group received 1 or 2 physiotherapy sessions daily but not at the same intensity as in the other groups.
Outcomes	Outcomes were recorded at baseline and after 3 weeks and 6 months: <ul style="list-style-type: none"> FAC 10-metre walk test 6-minute walk test Modified Motor Assessment Scale Rivermead Motor Assessment Scale Rivermead Mobility Index
Notes	Because we were interested in the effects of automated electromechanical- and robotic-assisted gait-training devices for improving walking after stroke, we combined the results of the CT-Group and the WALK-Group as one group, which we compared with the results from the GT-Group.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	An investigator not involved in the study randomly assigned participants to groups using concealed envelopes.
Allocation concealment (selection bias)	Low risk	Allocation was performed by an independent person not otherwise involved with the participants.

Peurala 2009 (Continued)

Blinding of outcome assessment (detection bias) All outcomes	High risk	No
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear whether reasons for missing outcome data are unlikely to be related to true outcome

Picelli 2016

Methods	RCT Method of randomisation: software generated Blinding of outcome assessors: yes Adverse events: none Deaths: none Dropouts: none ITT analysis: no dropouts
Participants	Country: Italy 22 participants (11 in treatment group, 11 in control group) Ambulatory at study onset Mean age: 63 years Inclusion criteria: age > 18 years, leg spasticity, FAC > 4, duration of illness > 6 months Exclusion criteria: participation in other trials, deformities such as contractures, spasticity treatment before the study
Interventions	2 arms: <ul style="list-style-type: none">Botulinum toxin injections for spastic triceps surae and additional 30 minutes G-EO gait training for 5 daysBotulinum toxin injections for spastic triceps surae without additional gait training
Outcomes	Outcomes were recorded at baseline, 1 month Primary outcome: <ul style="list-style-type: none">Modified Ashworth Scale Secondary outcomes: <ul style="list-style-type: none">Tardieu Scale6-minute walk test
Notes	1 group received additional gait training (performance bias).

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Software-generated random order
Allocation concealment (selection bias)	Low risk	Sealed, opaque envelopes
Blinding of outcome assessment (detection bias)	Low risk	Blinded evaluator

Electromechanical-assisted training for walking after stroke (Review)

Picelli 2016 (Continued)

All outcomes

Incomplete outcome data (attrition bias)	Low risk	No dropouts
All outcomes		

Pohl 2007

Methods	<p>RCT</p> <p>Method of randomisation: lots indicating A or B were prepared in sealed envelopes</p> <p>Blinding of outcome assessors: primary outcomes were evaluated by blinded assessors</p> <p>Adverse events: 4 (3 in experimental group, 1 in control group)</p> <p>Deaths: 2 (1 in experimental group, 1 in control group)</p> <p>Dropouts: 11 (5 in experimental group, 6 in control group)</p> <p>ITT analysis: yes</p>
Participants	<p>Country: Germany</p> <p>155 participants (77 in treatment group, 78 in control group)</p> <p>Non-ambulatory at study onset</p> <p>Mean age: 63 years</p> <p>Inclusion criteria: first supratentorial stroke (ischaemic or haemorrhagic); age between 18 and 79 years; interval between stroke and study onset less than 60 days; able to sit unsupported (i.e. without holding onto supports such as the edge of the bed), with feet supported, could not walk at all, or required the help of 1 or 2 therapists irrespective of the use of an ankle-foot orthosis or a walking aid (FAC 3 or less); understanding the meaning of the study and following instructions, providing written informed consent to participation in the study approved by the local ethical committee</p> <p>Exclusion criteria: unstable cardiovascular condition after a 12-lead electrocardiogram examined by a cardiologist, restricted passive range of motion in the major lower limb joints (extension deficit > 20° for the affected hip or knee joints, or a dorsiflexion deficit > 20° for the affected ankle, tested while lying supine and on the non-affected side), prevalence of other neurological or orthopaedic diseases impairing walking ability</p>
Interventions	<p>2 arms:</p> <ul style="list-style-type: none"> • 20 minutes locomotor training with Gait Trainer in combination with 25 minutes physiotherapy weekdays for 4 weeks • 45 minutes physiotherapy weekdays for 4 weeks
Outcomes	<p>Outcomes were recorded at baseline and after 4 weeks and 6 months.</p> <p>Primary outcomes:</p> <ul style="list-style-type: none"> • Gait ability (FAC 0 to 5) • Barthel Index (0 to 100) <p>Participants who were ambulatory (FAC 4 or 5) or reaching a Barthel Index > 75 were defined as responders to therapy.</p> <p>Secondary outcomes:</p> <ul style="list-style-type: none"> • Walking velocity • Walking endurance • Mobility (Rivermead Mobility Index) • Leg power (Motricity Index)
Notes	Published and unpublished data provided by the authors.

Pohl 2007 (Continued)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Lots indicating A or B were prepared in sealed envelopes; a person not involved in the study allocated participants to groups using the concealed envelopes.
Allocation concealment (selection bias)	Low risk	Concealed envelopes
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Blinded primary outcomes (a person not involved in the study rated video-tapes of participants)
Incomplete outcome data (attrition bias) All outcomes	Low risk	ITT analysis done; missing outcome data balanced in numbers across intervention groups, with similar reasons for missing data across groups.

Saltuari 2004

Methods	Cross-over RCT Method of randomisation: by random numbers Blinding of outcome assessors: unclear Adverse events: none Deaths: none Dropouts: none ITT: yes
Participants	Country: Austria 16 participants (8 in treatment group, 8 in control group) Ambulatory and non-ambulatory at study onset Mean age: 61 years Inclusion criteria: not provided Exclusion criteria: not provided
Interventions	2 arms (A: Lokomat, B: physiotherapy): <ul style="list-style-type: none"> 3 weeks A, 3 weeks B, 3 weeks A 3 weeks B, 3 weeks A, 3 weeks B
Outcomes	Outcomes were recorded at baseline and after 3 weeks (they were additionally recorded after 6 and 9 weeks, but only outcomes of the first phase were included in this review).
Notes	Unpublished data provided by the authors.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	By random numbers
Allocation concealment (selection bias)	Unclear risk	Unclear

Saltuari 2004 (Continued)

Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unclear
Incomplete outcome data (attrition bias) All outcomes	Low risk	No missing outcome data

Schwartz 2006

Methods	RCT Method of randomisation: block sampling method (each block contained 6 participants: 4 experimental group and 2 control group) Blinding of outcome assessors: no Adverse events: 5 (3 in experimental group, 2 in control group) Deaths: none Dropouts: 11 (8 in experimental group, 3 in control group) ITT: no (stated, but 2 participants from the control group were excluded from analysis)	
Participants	Country: Israel 67 participants (at October 2006) (37 in treatment group, 30 in control group) Non-ambulatory at study onset Mean age: 60 years Inclusion criteria: first stroke, until 3 months after stroke Exclusion criteria: not provided	
Interventions	2 arms: <ul style="list-style-type: none"> • Physiotherapy with additional gait training using the Lokomat 3 times a week for 6 weeks • Physiotherapy with additional gait training 3 times a week for 6 weeks 	
Outcomes	Outcomes were recorded at baseline and after 3, 6, and 9 weeks: <ul style="list-style-type: none"> • FAC • NIHSS • Stroke Activity Scale • Functional Independence Measure • Gait velocity • 2-minute walk test • Timed Up and Go Test • Stair-climbing test 	
Notes	Published and unpublished data provided by the authors.	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Block sampling
Allocation concealment (selection bias)	Unclear risk	Unclear

Schwartz 2006 (Continued)

Blinding of outcome assessment (detection bias) All outcomes	High risk	Not done
Incomplete outcome data (attrition bias) All outcomes	High risk	For dichotomous outcome data, the proportion of missing outcomes compared with observed event risk was enough to induce clinically relevant bias into intervention effect estimate.

Stein 2014

Methods	<p>RCT</p> <p>Method of randomisation: not stated</p> <p>Blinding of outcome assessors: stated as 'yes'</p> <p>Adverse events: none</p> <p>Deaths: none</p> <p>Dropouts: none immediately after study end (at 3-month follow-up: 2 in experimental group and 2 in control group)</p> <p>ITT: no</p>
Participants	<p>Country: USA</p> <p>24 participants (12 in treatment group, 12 in control group)</p> <p>Ambulatory at start of study</p> <p>Mean age: 58 years in experimental group and 57 years in control group</p> <p>Inclusion criteria: single stroke, significant leg weakness and gait alterations < 6 months before study entry, independent in household ambulation</p> <p>Exclusion criteria: ongoing physical therapy for the leg and/or gait and mobility, botulinum toxin injections < 3 months before study entry, no further planned injections, other neurologic disorders, excessive spasticity of lower limb (Ashworth Scale > 3), uncontrolled hypertension, unstable coronary artery disease, contractures of lower limb, impaired cognition (MMSE score < 24)</p>
Interventions	<p>2 arms:</p> <ul style="list-style-type: none"> Experimental group: robotic gait treatment (robotic leg brace), 3 days/week for 6 weeks (60 minutes/day) Control group: group exercises for relaxation/meditation, self stretching, and gentle upper and lower limb active range-of-motion exercises for the same time
Outcomes	<p>Outcomes were recorded at baseline, after 6, 10, and 19 weeks</p> <p>Outcome measures: Timed Up and Go Test, 10-metre walk test, 6-minute walk test, Five-Times-Sit-to-Stand Test, Berg Balance Scale, California Functional Evaluation, Emory Functional Ambulation Profile</p>
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method unclear
Allocation concealment (selection bias)	Unclear risk	Unclear, not described

Stein 2014 (Continued)

Blinding of outcome assessment (detection bias) All outcomes	Low risk	Performed by 1 physical therapist blinded to group assignment
Incomplete outcome data (attrition bias) All outcomes	High risk	No ITT

Tanaka 2012

Methods	Cross-over RCT Method of randomisation: computer-generated randomisation Blinding of outcome assessors: no Adverse events: none described Deaths: none Dropouts: none ITT: no
Participants	Country: Japan 12 participants (7 in treatment group, 5 in control group) All were ambulatory at study onset Mean age: 62 years Inclusion criteria: first stroke; more than 6 months since stroke onset; slight-to-moderate motor deficit (Brunnstrom recovery stages III–VI); could walk with or without walking aids Exclusion criteria: higher brain function disorder or cognitive deficit affecting ability to understand and describe symptoms (< 24 on the MMSE); severe heart disorder affecting gait movement intensity; severe bone and joint disease affecting gait movement
Interventions	2 arms (only the first 12 weeks before cross-over are described here; A: no training, B: gait training with Gait Master 4, 1 session: 20 minutes): <ul style="list-style-type: none">• 4 weeks A; 2 or 3 times a week, 12 gait training sessions B; 4 weeks A• 4 weeks A; 4 weeks A; 4 weeks follow-up
Outcomes	Outcomes were recorded weekly over a 24-week period: <ul style="list-style-type: none">• Gait speed• Timed Up and Go Test times
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	High risk	No

Tanaka 2012 (Continued)

Incomplete outcome data (attrition bias)	Unclear risk	Unclear
All outcomes		

Tong 2006

Methods	<p>RCT</p> <p>Randomisation was done by computer-generated random numbers</p> <p>Blinding of outcome assessors: no (except for Barthel Index and Functional Independence Measure scores, which were performed by nurses who were blinded)</p> <p>Adverse events: 2 (none in experimental group, 2 in control group)</p> <p>Deaths: none</p> <p>Dropouts: 4 (none in experimental group, 4 in control group)</p> <p>ITT: yes</p>
Participants	<p>Country: Hong Kong, China</p> <p>50 participants (15 in treatment group A, 15 in treatment group B, 20 in control group)</p> <p>Non-ambulatory at study onset</p> <p>Mean age: 68 years</p> <p>Inclusion criteria: diagnosis of first ischaemic brain injury or intracerebral haemorrhage shown by magnetic resonance imaging or computed tomography less than 6 weeks after onset of stroke; sufficient cognition to follow simple instructions and understand the content and purpose of the study (MMSE score > 21); ability to stand upright, supported or unsupported, for 1 minute; significant gait deficit (FAC score < 3); no skin allergy to electrical stimulation</p> <p>Exclusion criteria: recurrent stroke; other neurological, medical, or psychological deficit or condition that would affect ambulation ability or compliance with study protocol (such as Parkinson's disease, major depression, pain, cardiac arrhythmias); aphasia with an inability to follow 2 consecutive step commands or a cognitive deficit; severe hip, knee, or ankle contracture that would preclude passive range of motion of the leg</p>
Interventions	<p>3 arms:</p> <ul style="list-style-type: none"> • Gait trainer • Gait trainer + functional electrical stimulation • Conventional physiotherapy alone <p>The study consisted of 1 training session per weekday for 4 weeks.</p> <p>Experimental groups 1 and 2 underwent gait training for 20 minutes, with body weight support by an electromechanical gait trainer; group 2 also received functional electrical stimulation to the paretic lower limb during gait training.</p> <p>Participants in group 3 received physiotherapy overground gait training based on the principles of proprioceptive neuromuscular facilitation and Bobath concepts.</p>
Outcomes	<ul style="list-style-type: none"> • 5-metre walking speed test • Elderly Mobility Scale • Berg Balance Scale • FAC • Motricity Index leg subscale • Functional Independence Measure instrument score • Barthel Index score
Notes	Published and unpublished data provided by the authors.

Risk of bias

Tong 2006 (Continued)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated random numbers
Allocation concealment (selection bias)	Low risk	Concealed
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Yes for primary outcome
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	ITT unclear

Ucar 2014

Methods	<p>RCT Method of randomisation: random number list</p> <p>Blinding of outcome assessors: yes Adverse events: not described Deaths: not described Dropouts: not described ITT: unknown</p>
Participants	<p>Country: Turkey 22 participants (11 in treatment group, 11 in control group) Ambulatory at start of study Mean age: 56 years in experimental group and 62 years in control group</p> <p>Inclusion criteria: adult male (> 18 years), ability to ambulate 10 metres without personal assistance, and not receiving any other physical therapy</p> <p>Exclusion criteria: body weight more than 300 pounds (135 kg), FAC score < 3 and not able to walk consistently or independently within the community, cognitive deficits, cardiac disease, spasticity of the lower limbs preventing robotic walking, traumatic stroke, intracranial space occupying lesion-induced strokes, and seizures</p>
Interventions	<p>2 arms:</p> <ul style="list-style-type: none"> Experimental group: robotic gait treatment (Lokomat), 30-minute sessions, 5 sessions per week for 2 weeks Control group: the conventional exercise group received the equivalent additional time of conventional physiotherapy at home as determined by rehabilitation unit physiotherapists. Home exercise procedure focused on gait in order to raise awareness about trunk stability-symmetry and body weight support on the paretic leg. Sessions taken 5 days per week for 2 weeks included active and passive range of motion, active-assistive exercises, strengthening of the paretic leg, and balance training
Outcomes	<p>Outcomes were assessed at baseline and after 2 and 8 weeks:</p> <ul style="list-style-type: none"> Walking speed Timed Up and Go Test
Notes	

Ucar 2014 (Continued)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random number list
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Stated as blinded
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear

Van Nunen 2012

Methods	<p>RCT</p> <p>Method of randomisation: stated as block randomisation</p> <p>Blinding of outcome assessors: no</p> <p>Adverse events: none described</p> <p>Deaths: none</p> <p>Dropouts: none</p> <p>ITT: unknown</p>
Participants	<p>Country: Hong Kong, China</p> <p>50 participants (30 in treatment group , 20 in control group)</p> <p>Non-ambulatory at study onset (intervention group: 3 , control group: 2)</p> <p>Mean age: 53 years</p> <p>Inclusion criteria: unknown</p> <p>Exclusion criteria: unknown</p>
Interventions	<p>2 arms</p> <ul style="list-style-type: none"> 60-minute sessions of gait training 2 times a week with the Lokomat, 60-minute sessions of over-ground gait training 3 times a week for 8 weeks 60-minute sessions of overground gait training without device 5 times a week for 8 weeks
Outcomes	<p>Outcomes were assessed at baseline and after 8 weeks:</p> <ul style="list-style-type: none"> Walking speed FAC Berg Balance Scale Rivermead Mobility Index Fugl-Meyer Leg Score
Notes	Published and unpublished data provided by the authors.

Risk of bias

Bias	Authors' judgement	Support for judgement
------	--------------------	-----------------------

Electromechanical-assisted training for walking after stroke (Review)

Van Nunen 2012 (Continued)

Random sequence generation (selection bias)	Unclear risk	Unclear
Allocation concealment (selection bias)	Low risk	A person not involved in the study was asked to draw 1 of the opaque envelopes inside which group assignment was established each time a new participant entered the study.
Blinding of outcome assessment (detection bias) All outcomes	High risk	No
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear

Waldman 2013

Methods	RCT Method of randomisation: unclear Blinding of outcome assessors: no Adverse events: none described Deaths: none Dropouts: none ITT: unknown	
Participants	Country: USA 24 participants (12 in treatment group, 12 in control group) Ambulatory at study onset Mean age: 51 years Inclusion criteria: people with stroke duration longer than 3 months, with reduced ankle range of motion and strength, and able to walk with or without assistant devices Exclusion criteria: unknown	
Interventions	2 arms <ul style="list-style-type: none"> • 18 sessions (1 hour, 3 times a week over 6 weeks) gait training with portable rehabilitation robot • 18 sessions (1 hour, 3 times a week over 6 weeks) exercise training without device (instructed exercise for the control group involved stretching the plantar flexors and active movement exercises for ankle mobility and strength) 	
Outcomes	Outcomes were assessed at baseline and after 6 and 12 weeks : <ul style="list-style-type: none"> • modified Ashworth scale • Stroke Rehabilitation Assessment of Movement (STREAM) • Berg Balance Scale • 6-minute walk test • Passive range of motion • Plantar flexor strength 	
Notes	Published and unpublished data provided by the authors.	

Risk of bias

Bias	Authors' judgement	Support for judgement
------	--------------------	-----------------------

Waldman 2013 (Continued)

Random sequence generation (selection bias)	Unclear risk	Method not described.
Allocation concealment (selection bias)	High risk	Not described
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	No ITT

Watanabe 2014

Methods	<p>RCT</p> <p>Method of randomisation: computer generated</p> <p>Blinding of outcome assessors: stated as 'no'</p> <p>Adverse events: none</p> <p>Deaths: none</p> <p>Dropouts: 10 (6 in experimental group and 4 in control group)</p> <p>ITT: no</p>
Participants	<p>Country: Japan</p> <p>32 participants (17 in treatment group, 15 in control group)</p> <p>Not ambulatory at start of study</p> <p>Mean age: 67 years in experimental group and 76 years in control group</p> <p>Inclusion criteria: stroke < 6 months</p> <p>Exclusion criteria: not ambulating prior to stroke, FAC 4 or 5, severe cardiac disease, NYHA III or IV, severe disturbance of consciousness (Japan Coma Scale II or III), size limitations for the robotic orthosis, skin disease, pacemaker</p>
Interventions	<p>2 arms:</p> <ul style="list-style-type: none"> Experimental group: robotic gait treatment (robot suit Hybrid Assistive Limb, single-leg version of the Hybrid Assistive Limb on the paretic side), 20 minutes daily for 12 sessions over 4 weeks Control group: conventional gait rehabilitation for the same amount of time
Outcomes	<p>Outcomes were recorded at baseline, after 12 training sessions</p> <p>Primary outcome:</p> <ul style="list-style-type: none"> FAC <p>Secondary outcomes:</p> <ul style="list-style-type: none"> Maximum walking speed Timed Up and Go Test 6-minute walk test Short Physical Performance Battery Fugl-Meyer Assessment of Lower Extremity Isometric muscle strength (hip flexion and extension, knee flexion and extension)

Electromechanical-assisted training for walking after stroke (Review)

Watanabe 2014 (Continued)

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated sequence
Allocation concealment (selection bias)	Unclear risk	Odd-numbered participants underwent gait training using the Hybrid Assistive Limb, and even-numbered participants underwent conventional gait training (maybe even high risk of bias).
Blinding of outcome assessment (detection bias) All outcomes	High risk	Not done
Incomplete outcome data (attrition bias) All outcomes	High risk	No ITT

Werner 2002

Methods	<p>Cross-over RCT</p> <p>Method of randomisation: participants randomly assigned to groups (group allocation in envelopes that were drawn by an independent person)</p> <p>Blinding of outcome assessors: yes</p> <p>Adverse events: none</p> <p>Deaths: none</p> <p>Dropouts: none</p> <p>ITT: yes</p>
Participants	<p>Country: Germany</p> <p>30 participants (15 in treatment group, 15 in control group)</p> <p>Non-ambulatory at study onset</p> <p>Mean age: 60 years</p> <p>Inclusion criteria: first stroke, supratentorial lesion 4 to 12 weeks' poststroke, younger than 75 years of age, not able to walk (FAC of 2 or less), able to sit unsupported on the edge of a bed, able to stand for at least 10 seconds with help, able to provide and did provide written informed consent</p> <p>Exclusion criteria: hip and knee extension deficit > 20 degrees; passive dorsiflexion of the affected ankle to less than a neutral position; severe impairment of cognition or communication; evidence of cardiac ischaemia, arrhythmia, decompression, or heart failure; feeling of 'overexertion' or heart rate exceeding the age-predicted maximum (i.e. 190 beats/minute minus age) during training; resting systolic blood pressure exceeding 200 mm Hg at rest or dropping by more than 10 mm Hg with increasing workload</p>
Interventions	<p>2 arms:</p> <ul style="list-style-type: none"> 2 weeks A, 2 weeks B, 2 weeks A 2 weeks B, 2 weeks A, 2 weeks B <p>Treated as inpatients for five 15- to 20-minute sessions per week for 2 weeks</p> <p>A: treadmill training with body weight support: participants walked on a treadmill with partial body weight support provided by a harness</p> <p>B: gait trainer with body weight support: participants walked on Gait Trainer with partial body weight support provided by a harness</p>

Werner 2002 (Continued)

Outcomes	<p>Outcomes were recorded at baseline and after 2 weeks (additionally after 4 and 6 weeks, but only the first phase was included in this review):</p> <ul style="list-style-type: none"> • FAC • Fast walking speed over 10 metres with personal assistance and gait aids if required • Rivermead Motor Assessment Scale • Ankle spasticity (Modified Ashworth Scale)
Notes	<p>We used the first treatment phase only. Published and unpublished data provided by the authors. 0% dropouts at the end of first treatment phase (data were analysed as ITT)</p>

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	By envelopes
Allocation concealment (selection bias)	Low risk	Concealed envelopes that were drawn by an independent person
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Yes
Incomplete outcome data (attrition bias) All outcomes	Low risk	No missing data

Westlake 2009

Methods	<p>RCT Method of randomisation: computer-generated random order (stratified by fast or slow walking) Blinding of outcome assessors: not described Adverse events: 1 in control group Deaths: none Dropouts: none ITT: yes</p>
Participants	<p>Country: USA 16 participants (8 in treatment group, 8 in control group) All were ambulatory at study onset Mean age: 57 years Inclusion criteria: hemiparesis resulting from a single cortical or subcortical stroke > 6 months before the study, categorised as at least unlimited household ambulatory, written informed consent Exclusion criteria: unstable cardiovascular, orthopaedic, or neurological conditions; uncontrolled diabetes that would preclude exercise of moderate intensity; significant cognitive impairment affecting ability to follow directions</p>
Interventions	<p>2 arms:</p> <ul style="list-style-type: none"> • 12 physiotherapy sessions including gait training using the Lokomat (3 times a week over 4 weeks) • 12 physiotherapy sessions including manual guided gait training (3 times a week over 4 weeks)
Outcomes	<p>Outcomes were recorded at baseline and after 4 weeks</p>

Electromechanical-assisted training for walking after stroke (Review)

Westlake 2009 (Continued)

- Self selected and fast walking speed
- 6-minute walk test
- Absolute step length ratio
- Lower extremity Fugl-Meyer
- Short Physical Performance Battery
- Berg Balance Scale
- Late-Life Function & Disability Instrument

Notes

—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Unclear
Allocation concealment (selection bias)	Low risk	Randomisation list was overseen by 1 of the investigators who had no contact with participants until group assignment was revealed. Group assignment was not revealed to study personnel until the participant consented and baseline testing was complete.
Blinding of outcome assessment (detection bias) All outcomes	High risk	No
Incomplete outcome data (attrition bias) All outcomes	Low risk	No missing data

ABC: Activities-specific Balance Confidence

ADL: activities of daily living

CT: computed tomography

FAC: Functional Ambulation Category

ITT: intention-to-treat

MMSE: Mini-Mental State Examination

MRC: Medical Research Council

MRI: magnetic resonance imaging

NIHSS: National Institutes of Health Stroke Scale

NYHA: New York Heart Association

PF-DF: plantar flexion and dorsiflexion

RAGT: robot-assisted gait training

RCT: randomised controlled trial

SF-36: 36-Item Short Form Health Survey

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Bae 2014	Intervention: both groups received robot-assisted gait training (the experimental group also received functional electrical stimulation on the ankle dorsiflexor of the affected side).
Byun 2011	Uses a sliding rehabilitation machine, not robotic training as experimental condition

Study	Reason for exclusion
Caldwell 2000	Did not investigate electromechanical- and robotic-assisted gait-training devices as stated in the protocol of this review: bicycle training versus treadmill walking versus variable surface training were investigated
Danzl 2013	Investigates brain stimulation, and both groups participated in identical locomotor training with a robotic gait orthosis
David 2006	Did not meet inclusion criteria of this review: not an RCT
Forrester 2016	Compared different robotic applications
Gong 2003	Did not investigate electromechanical- and robotic-assisted gait-training devices as stated in the protocol of this review: no electromechanical-assisted devices were compared
Goodman 2014	Did not meet inclusion criteria of this review: not an RCT
Hesse 2001	Did not meet inclusion criteria of this review: not an RCT
Hsieh 2014	Investigated upper limbs
Mirelman 2009	Did not meet inclusion criteria of this review: experimental and control groups received a kind of assisted stepping therapy in a seated position. This study investigated the effects of virtual reality as an adjunct to stepping training. After discussion, we reached consensus to exclude this study from our review.
Morone 2016	Investigated the i-Walker, a rollator vehicle
NCT01337960	Compared different robotic approaches
Page 2008	Did not meet inclusion criteria of this review: the experimental group received a kind of assisted stepping therapy in a seated position. This study investigated the effect of the NuStep apparatus. After discussion, we reached consensus to exclude this study from our review.
Park 2015	Uses a treadmill training approach as experimental condition (Gait Trainer 2 analysis system, Biodex Medical Systems, Inc., Shirley, NY, USA)
Patten 2006	According to the information on ClinicalTrials.gov (NCT00125619), this is a 1-arm, non-randomised trial.
Pennati 2015	Investigated upper limbs
Picelli 2015	Both groups received the same robotic treatment.
Pitkanen 2002	Did not meet inclusion criteria of this review: the study describes preliminary findings of an initial sample of 9 participants; the experimental group received treadmill training or gait training
Richards 1993	Did not meet inclusion criteria of this review: the experimental group received a specialised locomotor training including early intensive physiotherapy with tilt table, limb load monitor, resistance exercises, and treadmills to promote functional recovery. After discussion, we reached consensus to exclude this study.
Richards 2004	Did not meet inclusion criteria of this review: the experimental group received specialised locomotor training including early intensive physiotherapy with tilt table, limb load monitor, resistance exercises and treadmills to promote functional recovery. After discussion, we reached consensus to exclude this study.

Study	Reason for exclusion
Shirakawa 2001	Not an RCT
Skvortsova 2008	Not an RCT, control groups were age and sex matched
Stoller 2015	Compared 2 treadmill exercise options
Wu 2014	Compared different modes (resistance versus assistance training) of the same robotic device

RCT: randomised controlled trial

Characteristics of studies awaiting assessment *[ordered by study ID]*

[Chernikova 2014](#)

Methods	Probably an RCT
Participants	Unclear
Interventions	Unclear
Outcomes	Unclear
Notes	—

[Globokar 2005](#)

Methods	Probably an RCT
Participants	People after stroke, number unclear
Interventions	2 arms: <ul style="list-style-type: none"> • 25 minutes neurophysiotherapy plus 20 minutes of Gait Trainer • Not described
Outcomes	Unclear
Notes	This study was presented at the 5th World Congress of Physical Medicine and Rehabilitation.

[Golyk 2006](#)

Methods	Probably an RCT
Participants	Unclear
Interventions	Unclear
Outcomes	Unclear
Notes	—

Jang 2005

Methods	Probably an RCT
Participants	34 non-ambulatory stroke survivors
Interventions	2 arms: <ul style="list-style-type: none"> • 14 participants: 20 minutes of physiotherapy 2 days per week and 20 minutes of Gait Trainer 3 days per week • 20 participants: 20 minutes of physiotherapy 5 days per week
Outcomes	Unclear
Notes	This study was presented at the 5th World Congress of Physical Medicine and Rehabilitation.

Kim 2001

Methods	Probably an RCT
Participants	Unclear
Interventions	Unclear
Outcomes	Unclear
Notes	Study was found in the Proceedings of the 1st International Congress of International Society of Physical and Rehabilitation Medicine (ISPRM), 2001 July 7-13.

Kim 2014

Methods	Probably an RCT
Participants	Unclear
Interventions	Unclear
Outcomes	Unclear
Notes	—

Koeneman 2004

Methods	Probably an RCT
Participants	Unclear
Interventions	Unclear
Outcomes	Unclear

Electromechanical-assisted training for walking after stroke (Review)

Koeneman 2004 (Continued)

Notes

—

Mehrberg 2001

Methods	Probably an RCT
Participants	Unclear
Interventions	Unclear
Outcomes	Unclear
Notes	—

Ohata 2015

Methods	Probably a randomised cross-over trial
Participants	23 participants with stroke (stroke onset < 6 months) Group 1 (N = 13; mean: 60.9 ± 9.6 years) Group 2 (N = 10; mean: 61.1 ± 14.6 years)
Interventions	Gait training with the Stride Management Assist device (Honda R&D Co., Ltd. Japan) (20 minutes/time, 5 times per week for 4 weeks) Conventional rehabilitation (40 minutes/time) 4 weeks
Outcomes	<ul style="list-style-type: none"> • Brunnstrom Recovery Stage • Sensory subscale of Fugl-Meyer Assessment • Modified Ashworth Scale • Barthel Index • Short-Form Berg Balance Scale • Functional Reach • Activities-specific Balance Confidence Scale • Functional Ambulation Category • 10-metre walk test • Timed Up and Go Test • Muscle strength measured by hand-held dynamometry
Notes	Published as abstract

Sale 2012

Methods	Probably an RCT
Participants	Unclear
Interventions	Unclear

Electromechanical-assisted training for walking after stroke (Review)

Copyright © 2017 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.

Sale 2012 (Continued)

Outcomes	Unclear
Notes	No longer at ClinicalTrials.gov

Wu 2012

Methods	Probably an RCT
Participants	Unclear
Interventions	Unclear
Outcomes	Unclear
Notes	-

Yoon 2015

Methods	Probably an RCT
Participants	Unclear
Interventions	N = 10 in gait training with active-assistive gait device group N = 10 in control group
Outcomes	<ul style="list-style-type: none"> • 10-metre walk test (m/s) • Step cycle (cycle/s) • Step length (m) • Angle of ankle dorsiflexion in swing phase • Korean Modified Barthel Index • Manual Muscle Test • Modified Ashworth Scale of hemiplegic ankle
Notes	Conference abstract

Zhu 2016

Methods	Probably an RCT
Participants	Unclear
Interventions	Unclear
Outcomes	Unclear
Notes	-

RCT: randomised controlled trial

Characteristics of ongoing studies [ordered by study ID]

Louie 2015

Trial name or title	Use of a powered robotic exoskeleton to promote walking recovery after stroke: study protocol for a randomised controlled trial
Methods	Single-blind randomised controlled trial to evaluate the efficacy of a powered mobile exoskeleton (Ekso) on improving walking ability in people early after stroke
Participants	50 individuals admitted for stroke rehabilitation in Canada, within 4 weeks' poststroke and needing second person assist to walk, will be randomly assigned to either a usual care group or exoskeleton group for 5 days/week for 4 weeks.
Interventions	2 arms: <ul style="list-style-type: none"> • Usual care will consist of daily 1-hour physical therapy with approximately 45 minutes of walking-related activities including muscle strengthening and standing • Exoskeleton group will receive the same care, except that the 45 minutes of walking-related activities will initially take place with the participant wearing an exoskeleton to ensure early over-ground walking; participants will transition to walking without the device when able
Outcomes	Outcomes will be measured at baseline, 4 weeks later at discharge, and at 6 months after program ends. Primary outcome: <ul style="list-style-type: none"> • Walking ability (FAC) Secondary outcomes: <ul style="list-style-type: none"> • Walking speed (10-metre walk test) • Endurance (6-minute walk test) • Quality of life
Starting date	Unknown
Contact information	Louie DR ^{1,2} ¹ University of British Columbia, Vancouver, Canada ² Rehabilitation Research Program, Vancouver Coastal Health Research Institute, Vancouver, Canada
Notes	Presented at the Canadian Stroke Conference, Toronto, 2015 September 17

NCT00284115

Trial name or title	Efficacy of a mechanical gait repetitive training technique compared with a usual rehabilitation program on gait recovery in hemiparetic stroke patients
Methods	RCT with 2 arms
Participants	Country: France Inclusion criteria: men or women aged 18 years or older; hemiplegia secondary to stroke; interval between stroke and study inclusion of 2 months or less; first-time supratentorial stroke; non-ambu-

NCT00284115 (Continued)

	latory (FAC stage 0); able to sit unsupported at the edge of the bed; no severe impairment of cognition or communication; written informed consent provided Exclusion criteria: orthopaedic or rheumatological disease impairing mobility, or both; other neurologically associated disease; history of myocardial infarction or deep venous embolism or pulmonary embolism within 3 months before study inclusion; chronic pulmonary disease; intolerance to standing up
Interventions	4-week rehabilitation programme comparing physiotherapy and gait trainer therapy with physiotherapy alone
Outcomes	Primary outcomes: walking speed (time needed to walk 10 metres) after the 4-week rehabilitation programme Secondary outcomes: FAC; walking endurance (6-minute walk test); time to self sufficient gait recovery; spasticity (Modified Ashworth Scale); Motricity Index; need for mobility and self assistance (Barthel Index, PMSI-SSR scores, need for physical assistance); economic evaluation (healthcare requirements, rehabilitation unit length of stay)
Starting date	March 2006
Contact information	Principal Investigator: Régine Brissot, MD, Service de Médecine Physique et Réadaptation, Hôpital Pontchaillou, Rennes, 35033, France Tel: +33 2 9928 4219 email: regine.brissot@chu-rennes.fr
Notes	Expected total enrolment: 122 participants Sponsored by: Rennes University Hospital Information derived from: ClinicalTrials.gov identifier: NCT00284115

NCT00530543

Trial name or title	Effects of gait training with assistance of a robot-driven gait orthosis in hemiparetic patients after stroke
Methods	Randomised 2 arms
Participants	Inclusion criteria <ul style="list-style-type: none"> • first-ever stroke • hemiplegic patient after stroke • can stand independently, but cannot walk more than 10 meters independently • muscle powers of hip and knee are more than poor on manual muscle test Exclusion criteria <ul style="list-style-type: none"> • previous gait difficulty before stroke onset • arthralgia on lower extremity • uncontrolled hypertension or hypotension • severe medical illness
Interventions	Robot-assisted gait training
Outcomes	Not provided

NCT00530543 (Continued)

Starting date	Unknown status
Contact information	Not provided
Notes	The recruitment status of this study is unknown. The completion date has passed, and the status has not been verified in more than 2 years.

NCT01146587

Trial name or title	Comparative study of GangTrainer GT1, Lokomat and conventional physiotherapy (GALOP)
Methods	RCT with 3 arms
Participants	<p>Inclusion criteria: first supratentorial stroke (ischaemic, haemorrhagic, or intracerebral haemorrhage) resulting in hemiparesis; interval from stroke 3 to 12 weeks; non-ambulatory (FAC < 3); free sitting on bedside for 1 minute, with both feet on the floor and holding onto bedside by hands; Barthel Index 25 to 65</p> <p>Exclusion criteria: unstable cardiovascular system (in case of doubt, only after approval by an internist); manifested heart diseases like labile compensated cardiac insufficiency (NYHA III), angina pectoris, myocardial infarction 120 days before study onset, cardiomyopathy, severe cardiac arrhythmia, severe joint misalignment (severe constriction of movement for hip, knee, or ankle, or any combination of the 3: more than 20° fixed hip and knee extension deficit, or more than 20° fixed plantar flexion of the ankle); severe cognitive dysfunction that prevents comprehension of the aims of study; severe neurological or orthopaedic diseases (e.g. polio, Parkinson's disease) that massively affect mobility; deep vein thrombosis; severe osteoporosis; or malignant tumour disease</p>
Interventions	<p>Group A: 30 minutes of treatment on the GangTrainer GT1 and 30 minutes of conventional physiotherapy every workday for 8 weeks</p> <p>Group B: 30 minutes of treatment on the Lokomat and 30 minutes of conventional physiotherapy every workday for 8 weeks</p> <p>Group C: 60 minutes of conventional physiotherapy every workday for 8 weeks</p>
Outcomes	<p>Primary outcomes: FAC, modified Emory Functional Ambulation</p> <p>Secondary outcomes: Barthel Index, 10-metre walk test, 6-minute walk test on the floor, Medical Research Council, Rivermead Visual Gait Assessment, EuroQol-5 Dimensions (EQ-5D)</p>
Starting date	August 2010
Contact information	<p>Contact: Andreas Waldner, MD; +39 0471 471 471; waldner.andreas@villamelitta.it</p> <p>Contact: Christopher Tomelleri, MSc; +39 0471 471 471; christopher.tomelleri@villamelitta.it</p>
Notes	<p>Estimated enrolment: 120</p> <p>Estimated study completion date: August 2013</p> <p>Estimated primary completion date: August 2013 (final data collection date for primary outcome measure)</p>

NCT01187277

Trial name or title	A randomised controlled trial on hemiplegic gait rehabilitation: robotic locomotor training versus conventional training in subacute stroke
Methods	RCT with 2 arms

NCT01187277 (Continued)

Participants	<p>Country: Thailand</p> <p>Inclusion criteria: subacute first-time stroke patients (haemorrhage and ischaemic), age 18 to 80 years, impaired FAC at initial score 0 to 2, cardiovascular stable, provided signed informed consent</p> <p>Exclusion criteria: unstable general medical condition, severe malposition or fixed contracture of joint with an extension deficit > 30°, any functional impairment before stroke, cannot adequately co-operate in training, severe communication problems, severe cognitive-perceptual deficits</p>
Interventions	<p>Group A: conventional therapy: 50 minutes individual physiotherapy and 60 minutes individual occupational therapy per workday (5 times per week) for 4 consecutive weeks</p> <p>Group B: conventional therapy plus robot-assisted gait training: 30 minutes individual physiotherapy plus 20 minutes robotic-assisted gait training (with Gait Trainer GT1) and 60 minutes individual occupational therapy per workday (5 times per week) for 4 consecutive weeks</p>
Outcomes	<p>Primary outcomes: FAC 0 to 5 and Barthel Index 0 to 100</p> <p>Secondary outcome: Berg Balance Scale 0 to 56, Resistance to Passive Movement Scale (REPAS)-Muscle tone 0 to 52</p>
Starting date	January 2011
Contact information	<p>Principal Investigator:</p> <p>Ratanapat Chanubol, MD, Rehabilitation Department, Prasat Neurological Institute, Mahidol University</p>
Notes	<p>Study Completion Date: July 2012</p> <p>Enrolment: 60</p>

NCT01678547

Trial name or title	Robot walking rehabilitation in stroke patients
Methods	RCT with 3 arms
Participants	<p>Inclusion criteria: between the ages of 18 and 95 years, able to walk 25 feet unassisted or with assistance, first acute event of cerebrovascular stroke, unilateral paresis, ability to understand and follow simple instructions, ability to walk without assistance before stroke, endurance sufficient to stand at least 20 minutes unassisted per participant report</p> <p>Exclusion criteria: unable to understand instructions required by the study (Informed Consent Test of Comprehension), medical or neurological comorbidities that could contribute to significant gait dysfunction, uncontrolled hypertension > 190/110 mm Hg, significant symptoms of orthostasis when standing up, circulatory problems, history of vascular claudication or significant (+ 3) pitting oedema, lower extremity injuries or joint problems (hip or leg) that limit range of motion or function or cause pain with movement, bilateral impairment, severe sensory deficits in the paretic upper limb, cognitive impairment or behavioural dysfunction that would influence the ability to comprehend or participate in the study, women who are pregnant or lactating, or both</p>
Interventions	<p>Experimental group: Robot G-EO: each participant will be asked to perform 15 sessions (3 to 5 days a week for 4 up to 5 weeks) consisting of a treatment cycle using the G-EO system device, according to individually tailored exercise scheduling</p> <p>Control group: Treadmill training: each participant will be asked to perform 15 sessions (3 to 5 days a week for 4 up to 5 weeks) consisting of a treatment cycle using the treadmill system device, according to individually tailored exercise scheduling</p> <p>Control group: Ground treatment: each participant will be asked to perform 15 sessions (3 to 5 days a week for 4 up to 5 weeks) of traditional lower limb physiotherapy</p>

NCT01678547 (Continued)

Outcomes

Starting date	September 2012
Contact information	Contact: Patrizio Sale, MD; patrizio.sale@gmail.com Contact: Marco Franceschini, MD; marco.franceschini@sanraffaele.it
Notes	Estimated enrolment: 90 Estimated study completion date: September 2015 Estimated primary completion date: August 2014 (final data collection date for primary outcome measure)

NCT01726998

Trial name or title	Effects of locomotion training with assistance of a robot-driven gait orthosis in hemiparetic patients after subacute stroke
Methods	Randomised trial 2 arms
Participants	<p>Inclusion criteria</p> <ul style="list-style-type: none"> • Hemiparesis as result of first stroke • No other neurologic or orthopaedic disorder • Independent ambulation before the stroke • No severe medical illnesses • Hemiparesis: lower extremity strength graded ≤ 3 in more than 2 muscle groups • FAC ≤ 1: indicating a need for personal assistance in ambulation • Time since stroke onset < 6 months • Age 20 to 80 years old <p>Exclusion criteria</p> <ul style="list-style-type: none"> • Unstable fractures • Severe osteoporosis • Severe skin problems • Severe joint problems • Major difference in leg length • Body weight over 130 kg • Orthostatic circulatory problem • Severe cognitive impairment <p>72 first-ever stroke patients who could not walk independently (FAC < 2), and suffered stroke within 6 months were enrolled and randomly assigned into 2 groups. People with congestive heart failure, malignancies, cardiopulmonary dysfunctions, and who could not walk independently before their stroke were excluded.</p>
Interventions	<p>2 groups received 30 minutes of conventional gait training including neurodevelopmental treatment:</p> <ul style="list-style-type: none"> • the robotic-assisted locomotor training group received additional robotic-assisted gait therapy for 30 minutes with Lokomat (Hocoma, Zurich, Switzerland) daily for 4 weeks; • the conventional gait-training group received additional daily conventional gait training with neurodevelopmental treatment for the same period.

Electromechanical-assisted training for walking after stroke (Review)

NCT01726998 (Continued)

Outcomes	Independent walking ability (FAC ≥ 3), FAC, Motricity index, Fugl-Meyer Assessment, Modified Barthel Index, Medical Research Council were assessed for lower extremity muscles before, during (2 weeks), and after training. Independent walking ability was followed until 3 months.
Starting date	March 2012
Contact information	Yonsei University
Notes	

NCT02114450

Trial name or title	Human-machine system for the H2 lower limb exoskeleton (H2-NeuroExo)
Methods	RCT with 2 arms
Participants	<p>Inclusion criteria</p> <ul style="list-style-type: none"> • Subacute or chronic stroke, i.e. interval of at least 3 months or at least 6 months from stroke to time of enrolment, respectively • Cognitive ability to assimilate and participate actively in the treatment protocol (Mini Mental State Examination score > 24 points, out of a total 30 indicating normal cognitive ability) • Modified Rankin Scale scores 2 to 4 (mild-moderate functional disability poststroke) • Modified Ashworth Scale of Spasticity score ≤ 2 (range 0 to 4, with 4 reflecting maximum spasticity) • Have no skin integrity issues • Sufficient passive range of motion at the hip (at least 90° flexion, 15° to 20° extension), knee (90° flexion, complete extension), and ankle (15° dorsiflexion, 15° plantar flexion) • Have no contraindications to standing or walking; able to stand with assistive device for at least 5 minutes; and able to walk with assistive device for 10 metres <p>Exclusion criteria</p> <ul style="list-style-type: none"> • Severe cognitive or visual deficit, or both • Hemineglect (determined based on medical record or initial clinical assessment) • Severe sensory deficit • Joint contractures of any extremity that limit normal range of motion during ambulation with assistive devices • Skin lesions that may hinder or prevent the application of exoskeleton • Uncontrolled angina • Severe chronic obstructive pulmonary disease • Other medical contraindications; any medical comorbidities that would prevent standard rehabilitation
Interventions	<p>Experimental: robot-assisted rehabilitation participants will receive robot-assisted training with the H2 lower limb powered exoskeleton. They will perform walking and other lower limb exercises (as applicable) while wearing the H2 lower limb powered exoskeleton. Training will involve 3 sessions per week for 4 weeks, each lasting about 1.5 hours.</p> <p>Control: supervised motor practice participants will perform walking and other lower limb exercises (as applicable) under the supervision of a research physical therapist. Training will involve 3 sessions per week for 4 weeks, each lasting about 1.5 hours.</p>
Outcomes	<p>Primary outcome measures</p> <ul style="list-style-type: none"> • Change from baseline in Fugl-Meyer Assessment Lower Extremity

NCT02114450 (Continued)

- Functional Gait Assessment
- Lower limb joint kinematics during walking
- Cortical dynamics measured by electroencephalography

Secondary outcome measures

- Robotic measure of performance measured by the H2
- Berg Balance Scale score
- Distance walked during the 6-minute walk test
- Timed Up and Go Test score

Starting date	March 2014
Contact information	clinicaltrials.gov/ct2/show/study/NCT02114450#contacts
Notes	

NCT02471248

Trial name or title	Interactive exoskeleton robot for walking - ankle joint
Methods	Randomised 2 arms
Participants	Inclusion criteria <ul style="list-style-type: none"> • Ischaemic or haemorrhagic stroke with drop-foot problem • Sufficient cognition to follow simple instructions and to understand the content and purpose of the study (Mini Mental State Examination > 21) • Capable of standing and walking independently for an extended period of time (FAC > 3, Berg Balance Scale > 40) Exclusion criteria <ul style="list-style-type: none"> • Any medical or psychological dysfunctions that would affect ability to comply with test study protocol, such as lower back pain, neuralgia, rotational vertigo, musculoskeletal disorders, injuries, and pregnancy • Any severe contractures in hip, knee, or ankle joint that would preclude passive range of motion in the lower extremity • Participation in any therapeutic treatment ("outside therapy") performed with the lower extremity during the planned study, including the baseline and the follow-up
Interventions	<ul style="list-style-type: none"> • Experimental: ankle robot with power assistance. The ankle robot assists the ankle dorsiflexion when the stroke patient voluntarily performs the swing phase gait movement. • Placebo comparator: sham group. The ankle robot provides very low assistance to generate tactile feedback to the stroke patient indicating the patient is performing the swing phase gait movement, but no assistance will be given to support ankle dorsiflexion.
Outcomes	<ul style="list-style-type: none"> • Fugl-Meyer Assessment Lower Extremity • Timed 10-metre walk test • 6-minute walk test • Berg Balance Scale • Modified Ashworth Scale • Kinematic and Kinetic Gait Motion Capture

NCT02471248 (Continued)

- Subjective feedback questionnaire

Starting date	June 2015
Contact information	Raymond KY Tong, Professor, Chinese University of Hong Kong
Notes	

NCT02483676

Trial name or title	Adaptive ankle robot control system to reduce foot-drop in chronic stroke
Methods	Randomised 2 arms
Participants	Inclusion criteria <ul style="list-style-type: none"> • Ischaemic or haemorrhagic stroke > 2 months prior in men or women • Residual hemiparesis of the lower extremity that includes symptoms of foot-drop • Capable of ambulating on a treadmill with handrail support • Have completed all conventional physical therapy • Adequate language and cognitive function to provide informed consent and participate in testing and training Exclusion criteria <ul style="list-style-type: none"> • Cardiac history of: unstable angina, recent (< 3 months) myocardial infarction, congestive heart failure (NYHA category II or higher), haemodynamic valvular dysfunction, hypertension that is a contraindication for a bout of treadmill training (> 160/100 on 2 assessments)
Interventions	<ul style="list-style-type: none"> • Device: treadmill plus Anklebot: this intervention employs the use of the adaptive Anklebot control system to complement treadmill exercise training over a 6-week intervention period • Behavioural: treadmill only: this intervention employs the use of a treadmill for gait exercise training over a 6-week intervention period
Outcomes	<ul style="list-style-type: none"> • Independent gait function indexed by gait velocity, swing-phase dorsiflexion, terminal stance push-off • Balance function indexed by measures of postural sway (centre of pressure), asymmetric loading in quiet standing, peak paretic anteroposterior forces in non-paretic gait initiation, and standardised scales for balance and fall risk • Long-term mobility outcomes, assessed by repeated measures of all key gait and balance outcomes at 6 weeks and 3 months after cessation of formal training
Starting date	September 2015
Contact information	clinicaltrials.gov/ct2/show/study/NCT02483676?term=NCT02483676&rank=1#contacts
Notes	

NCT02545088

Trial name or title	New technology for individualised, intensive training of gait after stroke - phase III trials, study II
---------------------	---

Electromechanical-assisted training for walking after stroke (Review)

NCT02545088 (Continued)

Methods	Randomised 3 arms
Participants	<p>Inclusion criteria</p> <ul style="list-style-type: none"> • 1 to 10 years since stroke onset • Able to walk but not independently, i.e. need for manual support or close supervision due to lower extremity paresis; FAC score 2 to 3 or FAC 4 combined with gait speed < 0.8 m/s according to 10-metre walk test, which corresponds to limitations in community ambulation • Ability to understand training instructions as well as written and oral study information and to express informed consent or by proxy • Body size compatible with the Hybrid Assistive Limb (HAL) suit <p>Exclusion criteria</p> <ul style="list-style-type: none"> • Contracture restricting gait movements at any lower limb joint • Cardiovascular or other somatic condition incompatible with intensive gait training • Severe, contagious infections (e.g. methicillin-resistant <i>Staphylococcus aureus</i> or extended-spectrum beta-lactamase bacteria)
Interventions	<ul style="list-style-type: none"> • Device: Hybrid Assistive Limb (HAL) intensive gait training is performed 1 session/day, 3 days/week for 6 weeks; each session will not exceed 60 minutes of effective walking time with HAL. In addition, each session will include conventional gait training that will not exceed 30 minutes effective training time. • 1st control group: conventional gait training performed 1 session/day, 3 days/week for 6 weeks that will not exceed 90 minutes effective training time • 2nd control group: no intervention
Outcomes	<ul style="list-style-type: none"> • FAC • Fugl-Meyer Assessment Lower Extremity • Modified Ashworth Scale • Spasticity measured with NeuroFlexor foot module Spasticity • Berg Balance Scale • 10-metre walk test • 2-minute walk test • 6-minute walk test • Borg Rating of Perceived Exertion Scale • Montreal Cognitive Assessment • Hospital Anxiety and Depression Scale • Barthel Index • Stroke Impact Scale • Physical activity in everyday life using SenseWear • Gait Deviation Index (Laboratory gait analysis)
Starting date	October 2015
Contact information	clinicaltrials.gov/ct2/show/study/NCT02545088?term=NCT02545088&rank=1#contacts
Notes	

NCT02680691

Trial name or title	Robot assisted gait training in patients with infratentorial stroke
Methods	Randomised 2 arms
Participants	Inclusion criteria <ul style="list-style-type: none"> • Patients with infratentorial stroke • Cognitively intact enough to understand and follow the instructions from the investigator Exclusion criteria <ul style="list-style-type: none"> • Chronic neurological pathology • Orthopaedic injuries • Femur lengths of less than 34 cm • Severely limited range of lower extremity joint motion • Medical instability
Interventions	<ul style="list-style-type: none"> • Experimental: robot, then conventional training: robot-assisted gait training 4 weeks after conventional gait training • Active comparator: conventional, then robot training: conventional gait training 4 weeks after robot-assisted gait training
Outcomes	Primary outcome measures <ul style="list-style-type: none"> • Berg Balance Scale Secondary outcome measures <ul style="list-style-type: none"> • Trunk Impairment Scale • FAC • 10-metre walk test • Fugl-Meyer Assessment • Korean version of Falls Efficacy Scale (assesses fear of falling in the elderly population) (time frame: baseline, 4 weeks from baseline, 8 weeks from baseline, 12 weeks from baseline); designated as safety issue: no perception of balance and stability during activities of daily living • Scale for the assessment and rating of ataxia • Balance test using force plate
Starting date	April 2015
Contact information	clinicaltrials.gov/ct2/show/study/NCT02680691?term=NCT02680691&rank=1#contacts
Notes	

NCT02694302

Trial name or title	Clinical trial of robot-assisted-gait-training (RAGT) in stroke patients (Walkbot)
Methods	Randomised 2 arms
Participants	Inclusion criteria

NCT02694302 (Continued)

- Age older than 19 years and younger than 80 years
- Weight under 100 kg
- Height less than 200 cm
- Able to walk independently before onset of stroke
- Ischaemic or haemorrhagic stroke patients
- Motor paralysis and gait disturbance after stroke and seeking rehabilitation treatment
- FAC under 3 (0 ~ 2)
- Subacute stroke patients, i.e. after 3 days and before 3 months of stroke onset
- Be informed of the nature of the study and agreed on written consent voluntarily
- Taking medications or scheduled medications due to stroke

Exclusion criteria

- Contraindications to weight bearing such as fractures, etc.
- Uncontrolled stage 2 hypertension (systolic over 160 mm Hg or diastolic over 100 mm Hg) or with uncontrolled orthostatic hypotension
- Cardiopulmonary disease or other underlying diseases that cannot tolerate gait training
- Severe skin damage and bed sore on wearing part of the trial device
- Pregnant or breastfeeding
- Participation in other clinical trials within 30 days
- People whom the investigator considers inappropriate to participate in the study

Interventions	<ul style="list-style-type: none"> • Walkbot (robot-assisted gait training) 30 minutes and conventional physical therapy 30 minutes per day to be administered 5 times a week for 3 weeks • Conventional physical therapy 30 minutes to be administered twice a day, 5 times a week for 3 weeks
Outcomes	<p>Primary outcome measure</p> <ul style="list-style-type: none"> • FAC <p>Secondary outcome measures</p> <ul style="list-style-type: none"> • Motricity Index • 10-metre walk test • 6-minute walk test • Medical Research Council • Modified Ashworth Scale • Fugl-Meyer Assessment • Modified Barthel Index • National Institutes of Health Stroke Scale • Beck Depression Inventory • Treatment Satisfaction Survey
Starting date	March 2014
Contact information	P&S Mechanics Co., Ltd.
Notes	

NCT02755415

Trial name or title	Clinical applicability of robot-assisted gait training system in acute stroke patients
---------------------	--

Electromechanical-assisted training for walking after stroke (Review)

Copyright © 2017 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.

NCT02755415 (Continued)

Methods	Randomised 2 arms
Participants	Inclusion criteria <ul style="list-style-type: none"> Between the ages of 20 and 80 years Diagnosis of first single unilateral cortical-subcortical acute stroke verified by brain imaging Paresis of a lower limb Ability to walk only a few metres either with or without aid Exclusion criteria <ul style="list-style-type: none"> Deemed by a physician to be medically unstable Other prior musculoskeletal conditions that affected gait capacity Coexistence of other neurological diseases Cognitive impairments that would impact on the safe participation in the study (Mini Mental State Examination < 23)
Interventions	Device: HIWIN Robotic Gait Training System~: the HIWIN Robotic Gait Training System is an automatic training system that combines weight-bearing standing, repetitive stepping, and gait training
Outcomes	<ul style="list-style-type: none"> Berg Balance Scale Pittsburgh Sleep Quality Index EuroQol-5 Dimensions (EQ-5D) 6-minute walk test Beck Depression Inventory
Starting date	May 2016
Contact information	China Medical University Hospital
Notes	Other study ID: CMUH105-REC1-037

NCT02781831

Trial name or title	Robot-assisted gait training for patients with stroke
Methods	Randomised 2 arms
Participants	Inclusion criteria <ol style="list-style-type: none"> Between the ages of 20 and 65 years Diagnosis of first single unilateral cortical-subcortical stroke verified by brain imaging Paresis of a lower limb Inability to walk without aid or device Exclusion criteria <ol style="list-style-type: none"> Deemed by a physician to be medically unstable Other prior musculoskeletal conditions that affected gait capacity Coexistence of other neurological diseases

NCT02781831 (Continued)

4. Cognitive impairments that would impact on the safe participation in the study (Mini Mental State Examination < 23)

Interventions	Standard hospital-based rehabilitation for people with stroke
Outcomes	<ul style="list-style-type: none"> Fugl-Meyer Assessment Lower Extremity 10-metre walk test Berg Balance Scale
Starting date	May 2016
Contact information	Principal Investigator: Nai-Hsin Meng, MD, China Medical University Hospital
Notes	HIWIN-CMU-C-105-1

NCT02843828

Trial name or title	Gait pattern analysis and feasibility of gait training with a walking assist robot in stroke patients and elderly adults
Methods	Randomised 2 treatment groups
Participants	Number of participants: 54 (n = 27 per group) Inclusion criteria <ul style="list-style-type: none"> Elderly adults: age between 65 and 84 years; no neurological or musculoskeletal abnormalities affecting gait; ability to walk at least 10 metres regardless of assist devices; high levels of physical performance (Short Physical Performance Battery > 7); participant is willing to be randomised to either the control group or the treatment group Stroke: age between 50 and 84 years; ≥ 3 months' poststroke; ability to walk at least 10 metres regardless of assist devices; adequate gait function (FAC > 3); physician approval for patient participation; participant is willing to be randomised to either the control group or the treatment group Exclusion criteria <ul style="list-style-type: none"> Elderly adults: history of any diseases (e.g. lower extremity orthopaedic diseases, neurologic disorders, cardiovascular disease, heart failure, uncontrolled hypertension) that affect walking capacity, efficiency, and endurance; severe visual impairment or dizziness that increases the risk of falls Stroke: serious cardiac conditions (hospitalisation for myocardial infarction or heart surgery within 3 months, history of congestive heart failure, documented serious and unstable cardiac arrhythmias, hypertrophic cardiomyopathy, severe aortic stenosis, angina or dyspnoea at rest or during activities of daily living); advanced liver, kidney, cardiac, or pulmonary disease; history of concussion in last 6 months; history of unexplained, recurring headaches, epilepsy/seizures/skull fractures, or skull deficits
Interventions	Group 1 : gait rehabilitation with hip assist robot (Samsung Hip Assist v1): 10 sessions (5 sessions: treadmill gait training/5 sessions: overground gait training), 30 minutes per session Group 2 : gait rehabilitation without hip assist robot: 10 sessions (5 sessions: treadmill gait training/5 sessions: overground gait training), 30 minutes per session
Outcomes	<ul style="list-style-type: none"> Berg Balance Scale Tinetti Performance-Oriented Mobility Assessment

Electromechanical-assisted training for walking after stroke (Review)

NCT02843828 (Continued)

- Modified Barthel Index
- FAC

Starting date	September 2015
Contact information	Yun-Hee Kim, MD, PhD; 82-2-3410-2824 yunkim@skku.edu
Notes	

FAC: Functional Ambulation Category
 NYHA: New York Heart Association
 RCT: randomised controlled trial

DATA AND ANALYSES

Comparison 1. Electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Independent walking at the end of intervention phase, all electromechanical devices used	36	1472	Odds Ratio (M-H, Random, 95% CI)	1.94 [1.39, 2.71]
2 Recovery of independent walking at follow-up after study end	6	496	Odds Ratio (M-H, Random, 95% CI)	1.93 [0.72, 5.13]
3 Walking velocity (metres per second) at the end of intervention phase	24	985	Mean Difference (IV, Random, 95% CI)	0.04 [-0.00, 0.09]
4 Walking velocity (metres per second) at follow-up	9	578	Mean Difference (IV, Random, 95% CI)	0.07 [-0.05, 0.19]
5 Walking capacity (metres walked in 6 minutes) at the end of intervention phase	12	594	Mean Difference (IV, Random, 95% CI)	5.84 [-16.73, 28.40]
6 Walking capacity (metres walked in 6 minutes) at follow-up	7	463	Mean Difference (IV, Random, 95% CI)	-0.82 [-32.17, 30.53]
7 Acceptability of electromechanical-assisted gait training devices during intervention phase: dropouts	36	1472	Odds Ratio (M-H, Random, 95% CI)	0.67 [0.43, 1.05]
8 Death from all causes until the end of intervention phase	36	1472	Risk Difference (M-H, Random, 95% CI)	0.00 [-0.01, 0.02]

Analysis 1.1. Comparison 1 Electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care), Outcome 1 Independent walking at the end of intervention phase, all electromechanical devices used.

Analysis 1.2. Comparison 1 Electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care), Outcome 2 Recovery of independent walking at follow-up after study end.

Analysis 1.3. Comparison 1 Electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care), Outcome 3 Walking velocity (metres per second) at the end of intervention phase.

Analysis 1.4. Comparison 1 Electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care), Outcome 4 Walking velocity (metres per second) at follow-up.

Analysis 1.5. Comparison 1 Electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care), Outcome 5 Walking capacity (metres walked in 6 minutes) at the end of intervention phase.

Analysis 1.6. Comparison 1 Electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care), Outcome 6 Walking capacity (metres walked in 6 minutes) at follow-up.

Analysis 1.7. Comparison 1 Electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care), Outcome 7 Acceptability of electromechanical-assisted gait training devices during intervention phase: dropouts.

Analysis 1.8. Comparison 1 Electromechanical- and robotic-assisted gait training plus physiotherapy versus physiotherapy (or usual care), Outcome 8 Death from all causes until the end of intervention phase.

Comparison 2. Planned sensitivity analysis by trial methodology

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Regaining independent walking ability	36		Odds Ratio (M-H, Random, 95% CI)	Subtotals only
1.1 All studies with adequate sequence generation process	20	949	Odds Ratio (M-H, Random, 95% CI)	1.80 [1.06, 3.08]
1.2 All studies with adequate concealed allocation	17	831	Odds Ratio (M-H, Random, 95% CI)	1.87 [1.12, 3.12]
1.3 All studies with blinded assessors for primary outcome	16	762	Odds Ratio (M-H, Random, 95% CI)	1.81 [1.10, 2.98]
1.4 All studies without incomplete outcome data	14	590	Odds Ratio (M-H, Random, 95% CI)	2.23 [1.16, 4.29]
1.5 All studies excluding the largest study Pohl 2007	35	1317	Odds Ratio (M-H, Random, 95% CI)	1.65 [1.17, 2.34]

Analysis 2.1. Comparison 2 Planned sensitivity analysis by trial methodology, Outcome 1 Regaining independent walking ability.

Study or subgroup	Treatment n/N	Control n/N	Odds Ratio M-H, Random, 95% CI	Weight	Odds Ratio M-H, Random, 95% CI
2.1.1 All studies with adequate sequence generation process					
Bang 2016	9/9	9/9			Not estimable
Brincks 2011	7/7	6/6			Not estimable
Buesing 2015	25/25	25/25			Not estimable

Favours control 0.02 0.1 1 10 50 Favours treatment

Comparison 3. Subgroup analysis comparing participants in acute and chronic phases of stroke

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Independent walking at the end of intervention phase, all electromechanical devices used	36		Odds Ratio (IV, Random, 95% CI)	Subtotals only
1.1 Acute phase: less than or equal to 3 months after stroke	20	1143	Odds Ratio (IV, Random, 95% CI)	1.90 [1.38, 2.63]
1.2 Chronic phase: more than 3 months after stroke	16	461	Odds Ratio (IV, Random, 95% CI)	1.20 [0.40, 3.65]

Analysis 3.1. Comparison 3 Subgroup analysis comparing participants in acute and chronic phases of stroke, Outcome 1 Independent walking at the end of intervention phase, all electromechanical devices used.

Study or subgroup	Treatment n/N	Control n/N	Odds Ratio IV, Random, 95% CI	Weight	Odds Ratio IV, Random, 95% CI
3.1.1 Acute phase: less than or equal to 3 months after stroke					
Aschbacher 2006	0/11	0/12			Not estimable

Favours control 0.01 0.1 1 10 100 Favours treatment

Comparison 4. Post hoc sensitivity analysis: ambulatory status at study onset

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Recovery of independent walking: ambulatory status at study onset	36		Odds Ratio (M-H, Random, 95% CI)	Subtotals only
1.1 Studies that included independent walkers	15	500	Odds Ratio (M-H, Random, 95% CI)	1.38 [0.45, 4.20]
1.2 Studies that included dependent and independent walkers	9	340	Odds Ratio (M-H, Random, 95% CI)	1.90 [1.11, 3.25]
1.3 Studies that included dependent walkers	12	632	Odds Ratio (M-H, Random, 95% CI)	1.90 [1.04, 3.48]
2 Walking velocity: ambulatory status at study onset	24		Mean Difference (IV, Random, 95% CI)	Subtotals only
2.1 Studies that included independent walkers	10	317	Mean Difference (IV, Random, 95% CI)	-0.02 [-0.10, 0.06]
2.2 Studies that included dependent and independent walkers	5	146	Mean Difference (IV, Random, 95% CI)	0.03 [-0.05, 0.11]
2.3 Studies that included dependent walkers	9	522	Mean Difference (IV, Random, 95% CI)	0.10 [0.03, 0.17]

Analysis 4.1. Comparison 4 Post hoc sensitivity analysis: ambulatory status at study onset, Outcome 1 Recovery of independent walking: ambulatory status at study onset.

Analysis 4.2. Comparison 4 Post hoc sensitivity analysis: ambulatory status at study onset, Outcome 2 Walking velocity: ambulatory status at study onset.

Comparison 5. Post hoc sensitivity analysis: type of device

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Different devices for regaining walking ability	32		Odds Ratio (M-H, Random, 95% CI)	Subtotals only
1.1 All studies using end-effector devices	11	598	Odds Ratio (M-H, Random, 95% CI)	1.90 [0.99, 3.63]
1.2 All studies using exoskeleton devices	16	585	Odds Ratio (M-H, Random, 95% CI)	2.05 [1.21, 3.50]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.3 All studies using mobile devices	3	106	Odds Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
1.4 All studies using ankle devices	2	63	Odds Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
2 Different devices for regaining walking speed	24		Mean Difference (IV, Random, 95% CI)	Subtotals only
2.1 All studies using end-effector devices	9	519	Mean Difference (IV, Random, 95% CI)	0.11 [0.04, 0.18]
2.2 All studies using exoskeleton devices	12	360	Mean Difference (IV, Random, 95% CI)	-0.02 [-0.08, 0.04]
2.3 All studies using mobile devices	3	106	Mean Difference (IV, Random, 95% CI)	0.02 [-0.11, 0.15]
2.4 All studies using ankle devices	1	39	Mean Difference (IV, Random, 95% CI)	0.04 [0.01, 0.07]
3 Different devices for regaining walking capacity	12	594	Mean Difference (IV, Random, 95% CI)	5.84 [-16.73, 28.40]
3.1 All studies using end-effector devices	4	328	Mean Difference (IV, Random, 95% CI)	27.50 [3.64, 51.36]
3.2 All studies using exoskeleton devices	5	186	Mean Difference (IV, Random, 95% CI)	-15.64 [-46.34, 15.05]
3.3 All studies using mobile devices	2	56	Mean Difference (IV, Random, 95% CI)	20.06 [-39.52, 79.63]
3.4 All studies using ankle devices	1	24	Mean Difference (IV, Random, 95% CI)	8.0 [-83.03, 99.03]

Analysis 5.1. Comparison 5 Post hoc sensitivity analysis: type of device, Outcome 1 Different devices for regaining walking ability.

Analysis 5.2. Comparison 5 Post hoc sensitivity analysis: type of device, Outcome 2 Different devices for regaining walking speed.

Analysis 5.3. Comparison 5 Post hoc sensitivity analysis: type of device, Outcome 3 Different devices for regaining walking capacity.

ADDITIONAL TABLES

Table 1. Participant characteristics in studies

Study ID	Experimental: age, mean (SD)	Control: age, mean (SD)	Experimental: time post- stroke	Control: time post- stroke	Experimental: sex	Control: sex	Experimental: side paresis	Control: side paresis
Aschbacher 2006	57 years	65 years	≤ 3 months	≤ 3 months	2 female	4 female	Not stated	Not stated
Bang 2016	54 years	54 years	12 months	13 months	5 male, 4 female	4 male, 5 female	4 right, 5 left	4 right, 5 left
Brincks 2011	61 (median) years	59 (median) years	56 (median) days	21 (median) days	5 male, 2 female	4 male, 2 female	5 right, 2 left	1 right, 5 left
Buesing 2015	60 years	62 years	7 years	5 years	17 male, 8 female	16 male, 9 female	13 right, 12 left	12 right, 13 left
Chang 2012	56 (12) years	60 (12) years	16 (5) days	18 (5) days	13 male, 7 female	10 male, 7 female	6 right, 14 left	6 right, 11 left
Cho 2015	55 (12) years	55 (15) years	15 months	13 months	Not stated	Not stated	6 right, 4 left (4 both)	3 right, 1 left (3 both)
Chua 2016	62 (10) years	61 (11) years	27 (11) days	30 (14) days	35 male, 18 fe- male	40 male, 13 fe- male	24 right, 29 left	21 right, 32 left
Dias 2006	70 (7) years	68 (11) years	47 (64) months	48 (30) months	16 male, 4 female	14 male, 6 female	Not stated	Not stated
Fisher 2008	Not stated	Not stated	Less than 12 months	Less than 12 months	Not stated	Not stated	Not stated	Not stated
Forrester 2014	63 years	60 years	12 days	11 days	Not stated	Not stated	9 right, 9 left	7 right, 9 left
Geroiin 2011	63 (7) years	61 (6) years	26 (6) months	27 (6) months	14 male, 6 female	9 male, 1 female	Not stated	Not stated
Han 2016	68 (15) years	63 (11) years	22 (8) days	18 (10) days	Not stated	Not stated	20 right, 10 left	14 right, 12 left
Hidler 2009	60 (11) years	55 (9) years	111 (63) days	139 (61) days	21 male, 12 fe- male	18 male, 12 fe- male	22 right, 11 left	13 right, 17 left
Hornby 2008	57 (10) years	57 (11) years	50 (51) months	73 (87) months	15 male, 9 female	15 male, 9 female	16 right, 8 left	16 right, 8 left

Table 1. Participant characteristics in studies (Continued)

Husemann 2007	60 (13) years	57 (11) years	79 (56) days	89 (61) days	11 male, 5 female	10 male, 4 female	12 right, 4 left	11 right, 3 left
Kim 2015	54 (13) years	50 (16) years	80 (60) days	120 (84) days	9 male, 4 female	10 male, 3 female	8 right, 5 left	10 right, 3 left
Kyung 2008	48 (8) years	55 (16) years	22 (23) months	29 (12) months	9 male, 8 female	4 male, 4 female	9 right, 8 left	4 right, 4 left
Mayr 2008	Not stated	Not stated	Between 10 days and 6 months	Between 10 days and 6 months	Not stated	Not stated	Not stated	Not stated
Morone 2011	62 (11) years	62 (14) years	19 (11) days	20 (14) days	15 male, 9 female	13 male, 11 female	13 right, 11 left	15 right, 9 left
Noser 2012	67 (9) years	64 (11) years	1354 days	525 days	7 male, 4 female	6 male, 4 female	Not stated	Not stated
Ochi 2015	62 (8) years	66 (12) years	23 (7) days	26 (8) days	11 male, 2 female	9 male, 4 female	6 right, 7 left	5 right, 8 left
Peurala 2005	52 (8) years	52 (7) years	2.5 (2.5) years	4.0 (5.8) years	26 male, 4 female	11 male, 4 female	13 right, 17 left	10 right, 5 left
Peurala 2009	67 (9) years	68 (10) years	8 (3) days	8 (3) days	11 male, 11 female	18 male, 16 female	11 right, 11 left	14 right, 20 left
Picelli 2016	62 (10) years	65 (3) years	6 (4) years	6 (4) years	7 male, 4 female	9 male, 2 female	Not stated	Not stated
Pohl 2007	62 (12) years	64 (11) years	4.2 (1.8) weeks	4.5 (1.9) weeks	50 male, 27 female	54 male, 24 female	36 right, 41 left	33 right, 45 left
Saltuari 2004	62 (13) years	60 (19) years	3.6 (4.6) months	1.9 (0.8) months	4 male, 4 female	2 male, 6 female	Not stated	Not stated
Schwartz 2006	62 (9) years	65 (8) years	22 (9) days	24 (10) days	21 male, 16 female	20 male, 10 female	17 right, 20 left	8 right, 22 left
Stein 2014	58 (11) years	57 (15) years	49 (39) months	89 (153) months	Not stated	Not stated	Not stated	Not stated
Tanaka 2012	63 (10) years	60 (9) years	55 (37) months	65 (67) months	10 male, 2 female		9 right, 3 left	
Tong 2006	71 (14) years	64 (10) years	2.5 (1.2) weeks	2.7 (1.2) weeks	19 male, 11 female	12 male, 8 female	13 right, 17 left	7 right, 13 left

Table 1. Participant characteristics in studies (Continued)

Ucar 2014	56 years	62 years	Not stated	Not stated	Not stated	Not stated	Not stated	Not stated
Van Nunen 2012	53 (10) years		2.1 (1.3) months		16 male, 14 female		Not stated	Not stated
Waldman 2013	51 (8) years	53 (7) years	41 (20) months	30 (22) months	Not stated	Not stated	Not stated	Not stated
Watanabe 2014	67 (17) years	76 (14) years	59 (47) days	51 (34) days	7 male, 4 female	4 male, 7 female	6 right, 5 left	5 right, 6 left
Werner 2002	60 (9) years	60 (9) years	7.4 (2.0) weeks	6.9 (2.1) weeks	8 male, 7 female	5 male, 10 female	8 right, 7 left	8 right, 7 left
Westlake 2009	59 (17) years	55 (14) years	44 (27) months	37 (20) months	6 male, 2 female	7 male, 1 female	4 right, 4 left	3 right, 5 left

SD: standard deviation

Table 2. Demographics of studies including dropouts and adverse events

Cri- te- ria	Stroke sever- ity	Electro- mechan- ical device used	Du- ra- tion of study in- ter- ven- tion	Ac- ti- ol- o- gy (is- chaemic/haem- or- rhage)	Intensity of treatment per day	Description of the control inter- vention	Dropouts and adverse events in the ex- perimental group	Reasons for dropout and adverse events in the control group	Source of informa- tion
As- chbach er 2006	Not stated	Loko- mat	3 weeks	Not stat- ed	30 minutes, 5 times a week	Described as task-oriented physio- therapy, 5 times a week for 3 weeks (2.5 hours a week)	4 Not stated of 23	Not stated	Unpublished infor- mation in the form of a conference presentation
Bang 2016	Un- clear	Loko- mat	4 weeks	13/5	60 minutes, 5 times a week (20 sessions)	Described as treadmill training with- out body weight support	0 - of 18	-	Published informa- tion
Brincks 2011	Mean FIM, 92	Loko- mat	3 weeks	Not stat- ed	Not stated	Physiotherapy	0 - of 13	-	Unpublished and published informa-

Table 2. Demographics of studies including dropouts and adverse events (Continued)

	of 126 points									tion provided by the authors.
Buesing 2015	Unclear	Wearable exoskeleton Stride Management Assist system (SMA)	6 to 8 weeks	Unclear	3 times per week for a maximum of 18 sessions	Functional task-specific training (intensive overground training and mobility training)	0 of 50	-	-	Published information
Chang 2012	Not stated	Lokomat	10 days	Not stated	30 minutes daily for 10 days	Conventional gait training by physical therapists (with equal therapy time and same amount of sessions as experimental group)	3 of 40	Not described by group (3 participants dropped out: 1 due to aspiration pneumonia, and 2 were unable to co-operate fully with the experimental procedure)		Unpublished and published information provided by the authors.
Cho 2015	Mean Modified Barthel Index, 36 points	Lokomat	8 weeks (2 phases, cross-over after 4 weeks)	4/14	30 minutes, 3 times a week both for 4 weeks	Bobath (neuropsychological exercises, inhibition of spasticity and synergy pattern)	0 of 20	-	-	Published information
Chua 2016	Mean Barthel Index, 49 points	Gait Trainer	8 weeks	Not stated	Not stated	Physiotherapy including 25 minutes of stance/gait, 10 minutes cycling, 10 minutes tilt table standing	20 of 106	2 death, 3 refusal, 1 medical problem, 1 transport problem (1 pain as adverse event)	1 death, 6 refusal, 3 medical problem, 1 administrative problem (no adverse events)	Published information
Dias 2006	Mean Barthel Index	Gait Trainer	4 weeks	Not stated	40 minutes, 5 times a week	Bobath method, 5 times a week for 5 weeks	0 of 40	-	-	Unpublished and published information

Table 2. Demographics of studies including dropouts and adverse events (Continued)

	Not stated	Au- toAm- bulator	24 ses- sions	Not stat- ed	Minimum of 3 sessions a week up to 5 sessions; num- ber of minutes in each session unclear	"Standard" physical therapy, 3 to 5 times a week for 24 consecutive ses- sions	0 of 20	14 adverse events, no details provided	11 adverse events, no details provided	tion provided by the authors.
Fisher 2008	Not stated	Au- toAm- bulator	24 ses- sions	Not stat- ed	Minimum of 3 sessions a week up to 5 sessions; num- ber of minutes in each session unclear	"Standard" physical therapy, 3 to 5 times a week for 24 consecutive ses- sions	0 of 20	14 adverse events, no details provided	11 adverse events, no details provided	Unpublished and published informa- tion provided by the authors.
Forrester 2014	Mean FIM walk 1 point	Ankle- bot	8 to 10 ses- sions (with ca. 200 rep- eti- tions)	Not stat- ed	60 minutes, 8 to 10 sessions	Stretching of the paretic ankle	5 of 34	Total of 5 dropouts in both groups (1 medical of complication, 1 discharge prior study end, 2 34 time poststroke > 49 days, 1 non-compliance)		Published informa- tion provided by the authors.
Geroian 2011	Mean Euro- pean Stroke Scale, 80 points	Gait Trainer	2 weeks	Not stat- ed	50 minutes, 5 times a week	Walking exercises according to the Bobath approach	0 of 30	-	-	Unpublished and published informa- tion provided by the authors.
Han 2016	Not stated	Loko- mat	4 weeks	33/23	30 minutes, 5 times a week	Neurodevelopmental techniques for balance and mobility	4 of 60	-	4 unclear reasons	Published informa- tion provided by the authors.
Hilder 2009	Not stated	Loko- mat	8 to 10 weeks (24 ses- sions)	47/16	45 minutes, 3 days a week	Conventional gait training, 3 times a week for 8 to 10 weeks (24 sessions), each session lasted 1.5 hours	9 of 72	Not described by group (9 withdrew or were removed because of poor attendance or a decline in health, in- cluding 1 death, which according to the au- thors was unrelated to study)		Unpublished and published informa- tion provided by the authors.
Hornby 2008	Not stated	Loko- mat	12 ses- sions	22/26	30 minutes, 12 sessions	Therapist-assisted gait training, 12 sessions, each session lasted 30 min- utes	14 of 62	4 participants dropped out (2 discontinued sec- ondary	10 participants dropped out	Published informa- tion provided by the authors.

Table 2. Demographics of studies including dropouts and adverse events (Continued)

							to leg pain during training, 1 experienced pitting oedema, and 1 had travel limitations)	(4 discontinued secondary to leg pain, 1 experienced an injury outside therapy, 1 reported fear of falling during training, 1 presented with significant hypertension, 1 had travel limitations, and 2 experienced subjective exercise intolerance)	
Husemann 2007	Median Barthel Index, 35 points	Lokomat	4 weeks	22/8	30 minutes, 5 times a week	Conventional physiotherapy, 30 minutes per day for 4 weeks	2 1 participant enteritis 32	1 participant pulmonary embolism	Information as provided by the authors
Kim 2015	Mean Barthel Index, 20 points	Walkbot	4 weeks	13/130	minutes, 5 times a week	Conventional physiotherapy (bed mobility, stretching, balance training, strengthening, symmetry training, treadmill training)	4 1 rib fracture, 3 decline in health condition 30		Information as provided by the authors
Kyung 2008	Not stated	Lokomat	4 weeks	18/7	45 minutes, 3 days a week	Conventional physiotherapy, received equal time and sessions of conventional gait training	10 1 participant dropped out for private reasons (travelling); 35 adverse events not described	9 participants refused after randomisation (reasons not provided); adverse events not described	Unpublished and published information provided by the authors.
Mayr 2008	Not stated	Lokomat	8 weeks	Not stated	Not stated	Add-on conventional physiotherapy, received equal time and sessions of conventional gait training	13 4 participants dropped out (reasons not provided); adverse events not described 74	9 participants dropped out (reasons not provided)	Unpublished and published information provided by the authors.

Table 2. Demographics of studies including dropouts and adverse events (Continued)

Mo- rone 2011	Can- dian Neuro- logical Scale, 6 points	Gait Trainer	4 weeks	41/7 times a week	40 minutes, 5 times a week	Focused on trunk stabilisation, weight transfer to the paretic leg, and walking between parallel bars or on the ground. The partici- pant was helped by 1 or 2 therapists and walking aids if necessary.	21 of 48	12 (hypotension, referred weakness, knee pain, urinary infection, uncon- trolled blood pres- sure, fever, ab- sence of physio- therapist)	9 (hypotension, re- ferred weakness, knee pain, ankle pain, un- controlled blood pres- sure, fever, absence of physiotherapist)	Information as pro- vided by the au- thors
Noser 2012	Not stated	Loko- mat	Un- clear	Not stat- ed	Not stated		1 of 21	No dropouts; 2 serious adverse events (1 skin breakdown as a result of thera- py, 1 second stroke during the post- treatment phase)	1 dropout due to pro- tocol violation; 2 serious adverse events (1 sudden drop in blood pressure at par- ticipant's home lead- ing to brief hospitalisa- tion, 1 sudden chest pain before therapy lead- ing to brief hospitalisa- tion)	Information as pro- vided by the au- thors
Ochi 2015	Not stated	Gait- ass- istance robot (con- sisting of 4 ro- botic arms for the thighs and legs, thigh cuffs, leg ap- para- tuses, and a	4 weeks	10/1620 minutes, 5 times a week for 4 weeks, in addition to rehabilitation treatment		Range-of-motion exercises, muscle strengthening, rolling over and sit- to-stand and activity and gait exer- cises	0 of 26	-	-	Published informa- tion

Table 2. Demographics of studies including dropouts and adverse events (Continued)

		tread- mill)								
Peu- rala 2005	Scan- dina- vian Stroke Scale, 42 points	Gait Trainer	3 weeks	25/2020 minutes, 5 times a week for 3 weeks, in addition to rehabilitation treatment	Walking overground; all participants practised gait for 15 sessions over 3 weeks (each session lasting 20 minutes)	0 - of 45	-	-		Published informa- tion
Peu- rala 2009	Not stated	Gait Trainer	3 weeks	42/1420 minutes, 5 times a week for 3 weeks, in addition to rehabilitation treatment	Overground walking training; in the other control group, 1 or 2 physio- therapy sessions daily but not at the same intensity as in the other groups	9 5 dropouts of 56 (2 situation wors- ened after 1 to 2 treatment days; 1 had 2 unsucces- ful attempts in de- vice; 1 had scheduling problems; 1 felt protocol too demanding)		4 dropouts (1 felt protocol too de- manding; 2 situation worsened after 1 to 2 treatment days; 1 death)		Published informa- tion
Pi- cel- li 2016	Not stated	G-EO System Evolu- tion	Ex- per- i- men- tal group (G- EO) 30 min- utes a day for 5 con- sec- u-	Not 5 days in addi- stat- tion to botu- ed linum toxin in- jection of calf muscles	None	0 - of 22		-		Published informa- tion

Table 2. Demographics of studies including dropouts and adverse events (Continued)

Pohl 2007	Mean Barthel Index, 37 points	Gait Trainer	4 weeks	124/320 minutes, 5 times a week	Physiotherapy every weekday for 4 weeks	11 2 participants re- of fused therapy, 155 1 increased cranial pressure, 1 relapsing pan- creas tumour, 1 cardiovascular unstable	4 participants refused therapy, 1 participant died, 1 myocardial in- farction	Published informa- tion		
Sal- tu- ari 2004	Not stated	Loko- mat	2 weeks	13/3 A-B study: in phase A, 30 minutes, 5 days a week	Physiotherapy every weekday for 3 weeks (phase B)	0 None of 16	None	Unpublished and published informa- tion provided by the authors.		
Schwaninger 2006	Mean NIHSS, 11 points	Loko- mat	6 weeks	49/6730 minutes, 3 times a week	Physiotherapy with additional gait training 3 times a week for 6 weeks	6 2 participants with of leg wounds, 46 1 participant with recurrent stroke, 1 refused therapy	1 participant with re- current stroke, 1 with pulmonary em- bolism	Unpublished and published informa- tion provided by the authors.		
Stein 2014	Not stated	Bion- ic leg device (Al- terG)	6 weeks	Not stat- ed 1 hour, 3 times a week for 6 weeks	Group exercises	0 - of 24	-	Published informa- tion		
Tana- ka 2012	Mean FIM, 79 points	Gait Mas- ter4	4 weeks	Not stat- ed 20 minutes, 2 or 3 times a week (12 sessions)	Non-intervention (non-training)	0 - of 12	-	Published informa- tion		
Tong 2006	Mean Barthel In- dex, 51 points	Gait Trainer	4 weeks	39/1120 minutes, 5 times a week	Conventional physiotherapy alone, based on Bobath concept	4 None of 50	2 participants dis- charged before study end, 1 participant readmit- ted to an acute ward,	Published informa- tion		

Table 2. Demographics of studies including dropouts and adverse events (Continued)

								1 participant deteriorating condition	
Ucar 2014	Not stated	Lokomat	2 weeks	Not stat- ed	30 minutes, 5 times a week	Conventional physiotherapy at home (focused on gait)	0 of 22	-	Published information
Van Nunen 2012	Not stated	Lokomat	8 weeks	Not stat- ed	30 minutes, twice a week	Overground therapy	0 of 30	-	Unpublished and published information provided by the author.
Waldman 2013	Not stated	Portable rehab robot (ankle device)	6 weeks	Not stat- ed	3 times a week, 18 sessions	Stretching the plantar flexors and active exercises for ankle mobility and strength	0 of 24	-	Published information
Watanabe 2014	Not stated	Single-leg version of the Hybrid Assistive Limb (HAL)	4 weeks	11/120	minutes, 12 sessions	Aimed to improve walking speed, endurance, balance, postural stability, and symmetry	10 of 32	4 withdrew, 1 epilepsy, 1 technical reasons	2 pneumonia, 2 discharged
Werner 2002	Mean Barthel Index, 38 points	Gait Trainer	2 weeks	13/120	minutes, 5 times a week	Gait therapy including treadmill training with body weight support	0 of 30	None	None
Westlake 2009	Not stated	Lokomat	4 weeks (12 sessions)	8/8	30 minutes, 3 times a week	12 physiotherapy sessions including manually guided gait training (3 times a week over 4 weeks)	0 of 16	None	None

FIM: Functional Independence Measure

NIHSS: National Institutes of Health Stroke Scale

APPENDICES

Appendix 1. CENTRAL search strategy

#1MeSH descriptor: [Cerebrovascular Disorders] explode all trees
#2MeSH descriptor: [Brain Injuries] this term only
#3MeSH descriptor: [Brain Injury, Chronic] this term only
#4stroke* or cva or poststroke or post-stroke
#5cerebrovasc* or cerebral vascular
#6cerebral or cerebellar or brain* or vertebrobasilar
#7infarct* or isch?emi* or thrombo* or emboli* or apoplexy
#8#6 and #7
#9cerebral or brain or subarachnoid
#10haemorrhage or hemorrhage or haematoma or hematoma or bleed*
#11#9 and #10
#12MeSH descriptor: [Hemiplegia] this term only
#13MeSH descriptor: [Paresis] explode all trees
#14hemp* or hemipleg* or brain injur*
#15MeSH descriptor: [Gait Disorders, Neurologic] this term only
#16#1 or #2 or #3 or #4 or #5 or #8 or #11 or #12 or #13 or #14 or #15
#17MeSH descriptor: [Physical Therapy Modalities] this term only
#18MeSH descriptor: [Exercise Therapy] this term only
#19MeSH descriptor: [Motion Therapy, Continuous Passive] this term only
#20MeSH descriptor: [Musculoskeletal Manipulations] this term only
#21MeSH descriptor: [Exercise] this term only
#22MeSH descriptor: [Exercise Test] this term only
#23MeSH descriptor: [Robotics] this term only
#24MeSH descriptor: [Automation] this term only
#25MeSH descriptor: [Orthotic Devices] this term only
#26MeSH descriptor: [Man-Machine Systems] this term only
#27MeSH descriptor: [Self-Help Devices] this term only
#28MeSH descriptor: [Therapy, Computer-Assisted] this term only
#29MeSH descriptor: [Body Weight] this term only
#30MeSH descriptor: [Weight-Bearing] this term only
#31((gait or locomot*) near/5 (train* or therapy or rehabilitat* or re-educat* or machine* or powered or device*))
#32(electromechanical or electro-mechanical or mechanical or mechanised or mechanized or driven or assistive device*)
#33((body-weight or body weight) near/3 (support* or relief))
#34(robot* or orthos* or orthotic or automat* or computer aided or computer assisted or power-assist*)
#35(bws or harness or treadmill or exercise* or fitness train* or Lokomat or Locomat or GaiTrainer or GT1 or Kinetron or Haptic Walker or Anklebot or LOPES or AutoAmbulator)
#36(continuous passive or cpm) near/3 therap*
#37#17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30 or #31 or #32 or #33 or #34 or #35 or #36
#38MeSH descriptor: [Gait] this term only
#39MeSH descriptor: [Walking] explode all trees
#40MeSH descriptor: [Locomotion] this term only
#41MeSH descriptor: [Range of Motion, Articular] this term only
#42MeSH descriptor: [Recovery of Function] this term only
#43walk* or gait* or ambulat* or mobil* or locomot* or balanc* or stride
#44#38 or #39 or #40 or #41 or #42 or #43
#45#16 and #37 and #44
#46MeSH descriptor: [Animals] explode all trees
#47#45 not #46
#48#47 in Trials
#49#48 Publication Year from 2012 to 2016

Number of records retrieved until 2012: 1140

Number of records retrieved until 2016: 861

Appendix 2. MEDLINE search strategy (OvidSP)

1. exp cerebrovascular disorders/ or brain injury, chronic/

2. (stroke\$ or cva or poststroke or post-stroke).tw.
3. (cerebrovasc\$ or cerebral vascular).tw.
4. (cerebral or cerebellar or brain\$ or vertebrobasilar).tw.
5. (infarct\$ or isch?emi\$ or thrombo\$ or emboli\$ or apoplexy).tw.
6. 4 and 5
7. (cerebral or brain or subarachnoid).tw.
8. (haemorrhage or hemorrhage or haematoma or hematoma or bleed\$).tw.
9. 7 and 8
10. hemiplegia/ or exp paresis/
11. (hemipar\$ or hemipleg\$ or brain injur\$).tw.
12. Gait Disorders, Neurologic/
13. 1 or 2 or 3 or 6 or 9 or 10 or 11 or 12
14. physical therapy modalities/ or exercise therapy/ or motion therapy, continuous passive/ or musculoskeletal manipulations/
15. *exercise/ or *exercise test/
16. robotics/ or automation/ or orthotic devices/ or man-machine systems/ or self-help devices/ or therapy, computer-assisted/
17. body weight/ or weight-bearing/
18. ((gait or locomot\$) adj5 (train\$ or therapy or rehabilitat\$ or re-educat\$ or machine\$ or powered or device\$)).tw.
19. (electromechanical or electro-mechanical or mechanical or mechanised or mechanized or driven or assistive device\$).tw.
20. ((body-weight or body weight) adj3 (support\$ or relief)).tw.
21. (robot\$ or orthos\$ or orthotic or automat\$ or computer aided or computer assisted or power-assist\$).tw.
22. (bws or harness or treadmill or exercise\$ or fitness train\$ or Lokomat or Locomat or GaiTrainer or GT1 or Kinetron or Haptic Walker or Anklebot or LOPES or AutoAmbulator).tw.
23. ((continuous passive or cpm) adj3 therap\$).tw.
24. or/14-23
25. gait/ or exp walking/ or locomotion/
26. "Range of Motion, Articular"/
27. recovery of function/
28. (walk\$ or gait\$ or ambulat\$ or mobil\$ or locomot\$ or balanc\$ or stride).tw.
29. or/25-28
30. 13 and 24 and 29
31. Randomized Controlled Trials as Topic/
32. random allocation/
33. Controlled Clinical Trials as Topic/
34. control groups/
35. clinical trials as topic/ or clinical trials, phase i as topic/ or clinical trials, phase ii as topic/ or clinical trials, phase iii as topic/ or clinical trials, phase iv as topic/

36. double-blind method/
 37. single-blind method/
 38. Placebos/
 39. placebo effect/
 40. cross-over studies/
 41. Therapies, Investigational/
 42. Research Design/
 43. evaluation studies as topic/
 44. randomized controlled trial.pt.
 45. controlled clinical trial.pt.
 46. (clinical trial or clinical trial phase i or clinical trial phase ii or clinical trial phase iii or clinical trial phase iv).pt.
 47. (evaluation studies or comparative study).pt.
 48. random\$.tw.
 49. (controlled adj5 (trial\$ or stud\$)).tw.
 50. (clinical\$ adj5 trial\$).tw.
 51. ((control or treatment or experiment\$ or intervention) adj5 (group\$ or subject\$ or patient\$)).tw.
 52. (quasi-random\$ or quasi random\$ or pseudo-random\$ or pseudo random\$).tw.
 53. ((multicenter or multicentre or therapeutic) adj5 (trial\$ or stud\$)).tw.
 54. ((control or experiment\$ or conservative) adj5 (treatment or therapy or procedure or manage\$)).tw.
 55. ((singl\$ or doubl\$ or tripl\$ or trebl\$) adj5 (blind\$ or mask\$)).tw.
 56. (coin adj5 (flip or flipped or toss\$)).tw.
 57. versus.tw.
 58. (cross-over or cross over or crossover).tw.
 59. placebo\$.tw.
 60. sham.tw.
 61. (assign\$ or alternate or allocat\$ or counterbalance\$ or multiple baseline).tw.
 62. or/31-61
 63. 30 and 62
 64. exp animals/ not humans.sh.
 65. 63 not 64
 66. limit 65 to ed=20120719-20160815
- Number of records retrieved until 2012: 1928
- Number of records retrieved until 2016: 1094

Appendix 3. Embase search strategy (OvidSP)

1. cerebrovascular disease/ or exp basal ganglion hemorrhage/ or exp brain hematoma/ or exp brain hemorrhage/ or exp brain infarction/ or exp brain ischemia/ or exp carotid artery disease/ or cerebral artery disease/ or exp cerebrovascular accident/ or exp intracranial aneurysm/ or exp occlusive cerebrovascular disease/ or stroke patient/
2. (stroke or poststroke or post-stroke or cerebrovasc\$ or brain vasc\$ or cerebral vasc\$ or cva\$ or apoplex\$ or SAH).tw.
3. ((brain\$ or cerebr\$ or cerebell\$ or intracran\$ or intracerebral) adj5 (isch?emi\$ or infarct\$ or thrombo\$ or emboli\$ or occlus\$)).tw.
4. ((brain\$ or cerebr\$ or cerebell\$ or intracerebral or intracranial or subarachnoid) adj5 (haemorrhage\$ or hemorrhage\$ or haematoma\$ or hematoma\$ or bleed\$)).tw.
5. hemiparesis/ or hemiplegia/ or paresis/
6. (hemipleg\$ or hemipar\$ or paresis or paretic or hemineglect or hemi-neglect or ((unilateral or spatial or hemi?spatial or visual) adj5 neglect)).tw.
7. Gait Disorders, Neurologic/
8. or/1-7
9. physical therapy modalities/ or exercise therapy/ or motion therapy, continuous passive/ or musculoskeletal manipulations/
10. *exercise/ or *exercise test/
11. robotics/ or automation/ or orthotic devices/ or man-machine systems/ or self-help devices/ or therapy, computer-assisted/
12. body weight/ or weight-bearing/
13. ((gait or locomot\$) adj5 (train\$ or therapy or rehabilitat\$ or re-educat\$ or machine\$ or powered or device\$)).tw.
14. (electromechanical or electro-mechanical or mechanical or mechanised or mechanized or driven or assistive device\$).tw.
15. ((body-weight or body weight) adj3 (support\$ or relief)).tw.
16. (robot\$ or orthos\$ or orthotic or automat\$ or computer aided or computer assisted or power-assist\$).tw.
17. (bws or harness or treadmill or exercise\$ or fitness train\$ or Lokomat or Locomat or GaiTrainer or GT1 or Kinetron or Haptic Walker or Anklebot or LOPES or AutoAmbulator).tw.
18. ((continuous passive or cpm) adj3 therap\$).tw.
19. or/9-18
20. gait/ or exp walking/ or locomotion/
21. "Range of Motion, Articular"/
22. recovery of function/
23. (walk\$ or gait\$ or ambulat\$ or mobil\$ or locomot\$ or balanc\$ or stride).tw.
24. or/20-23
25. 19 and 24
26. Randomized Controlled Trial/ or "randomized controlled trial (topic)"/
27. Randomization/
28. Controlled clinical trial/ or "controlled clinical trial (topic)"/
29. control group/ or controlled study/
30. clinical trial/ or "clinical trial (topic)"/ or phase 1 clinical trial/ or phase 2 clinical trial/ or phase 3 clinical trial/ or phase 4 clinical trial/
31. Crossover Procedure/

32. Double Blind Procedure/
33. Single Blind Procedure/ or triple blind procedure/
34. placebo/ or placebo effect/
35. (random\$ or RCT or RCTs).tw.
36. (controlled adj5 (trial\$ or stud\$)).tw.
37. (clinical\$ adj5 trial\$).tw.
38. ((control or treatment or experiment\$ or intervention) adj5 (group\$ or subject\$ or patient\$)).tw.
39. (quasi-random\$ or quasi random\$ or pseudo-random\$ or pseudo random\$).tw.
40. ((control or experiment\$ or conservative) adj5 (treatment or therapy or procedure or manage\$)).tw.
41. ((singl\$ or doubl\$ or tripl\$ or trebl\$) adj5 (blind\$ or mask\$)).tw.
42. (cross-over or cross over or crossover).tw.
43. (placebo\$ or sham).tw.
44. trial.ti.
45. (assign\$ or allocat\$).tw.
46. controls.tw.
47. or/26-46
48. 8 and 25 and 47
49. (exp animals/ or exp invertebrate/ or animal experiment/ or animal model/ or animal tissue/ or animal cell/ or nonhuman/) not (human/ or normal human/ or human cell/)
50. 48 not 49
51. limit 50 to dd=20120719-20160815

Number of records retrieved until 2012: 2315

Number of records retrieved until 2016: 1601

Appendix 4. CINAHL search strategy (via EBSCOHost)

S1 .(MH "Cerebrovascular Disorders") OR (MH "Basal Ganglia Cerebrovascular Disease+") OR (MH "Carotid Artery Diseases+") OR (MH "Cerebral Ischemia+") OR (MH "Cerebral Vasospasm") OR (MH "Intracranial Arterial Diseases+") OR (MH "Intracranial Embolism and Thrombosis") OR (MH "Intracranial Hemorrhage+") OR (MH "Stroke") OR (MH "Vertebral Artery Dissections")

S2 .(MH "Stroke Patients") OR (MH "Stroke Units")

S3 .TI (stroke or poststroke or post-stroke or cerebrovasc* or brain vasc* or cerebral vasc or cva or apoplex or SAH) or AB (stroke or poststroke or post-stroke or cerebrovasc* or brain vasc* or cerebral vasc or cva or apoplex or SAH)

S4 .TI (brain* or cerebr* or cerebell* or intracran* or intracerebral) or AB (brain* or cerebr* or cerebell* or intracran* or intracerebral)

S5 .TI (ischemi* or ischaemi* or infarct* or thrombo* or emboli* or occlus*) or AB (ischemi* or ischaemi* or infarct* or thrombo* or emboli* or occlus*)

S6 .S4 and S5

S7 .TI (brain* or cerebr* or cerebell* or intracerebral or intracranial or subarachnoid) or AB (brain* or cerebr* or cerebell* or intracerebral or intracranial or subarachnoid)

S8 .TI (haemorrhage* or hemorrhage* or haematoma* or hematoma* or bleed*) or AB (haemorrhage* or hemorrhage* or haematoma* or hematoma* or bleed*)

S9 .S7 and S8

S10 .(MH "Hemiplegia")

S11 .TI (hemipleg* or hemipar* or paresis or paretic) or AB (hemipleg* or hemipar* or paresis or paretic)

S12 .S1 OR S2 OR S3 OR S6 OR S9 OR S10 OR S11

S13 .(MM "PhysicalTherapy") OR (MM "TherapeuticExercise") OR (MM "Motion Therapy, Continuous Passive") OR (MM "Robotics") OR (MM "Automation") OR (MM "Orthoses") OR (MM "Assistive Technology Devices") OR (MM "Therapy, Computer Assisted") OR (MM "Body Weight") OR (MM "Weight-Bearing")

S14 *exercise or (*exercise test)

S15 "man-machine systems"

S16 ((gait or locomot*) N5 (train* or therapy or rehabilitat* or re-educat* or machine* or powered or device*))

S17 electromechanical or electro-mechanical or mechanical or mechanised or mechanized or driven or assistive device*

S18 ((body-weight or body weight) N3 (support* or relief))

S19 robot* or orthos* or orthotic or automat* or computer aided or computer assisted or power-assist*

S20 bws or harness or treadmill or exercise* or fitness train* or Lokomat or Locomat or GaiTrainer or GT1 or Kinetron or Haptic Walker or Anklebot or LOPES or AutoAmbulator

S21 (continuous passive or cpm) N3 therap*

S22 S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21

S23 (MM "Gait")

S24 (MH "Walking+")

S25 (MM "Locomotion")

S26 (MM "Range of Motion")

S27 (MM "Recovery")

S28 walk* or gait* or ambulat* or mobil* or locomot* or balanc* or stride

S29 S23 OR S24 OR S25 OR S26 OR S27 OR S28

S30 S22 AND S29

S31 .(MH "Randomized Controlled Trials") or (MH "Random Assignment") or (MH "Random Sample+")

S32 .(MH "Clinical Trials") or (MH "Intervention Trials") or (MH "Therapeutic Trials")

S33 .(MH "Double-Blind Studies") or (MH "Single-Blind Studies") or (MH "Triple-Blind Studies")

S34 .(MH "Control (Research)") or (MH "Control Group") or (MH "Placebos") or (MH "Placebo Effect")

S35 .(MH "Crossover Design") OR (MH "Quasi-Experimental Studies")

S36 .PT (clinical trial or randomized controlled trial)

S37 .TI (random* or RCT or RCTs) or AB (random* or RCT or RCTs)

S38 .TI (controlled N5 (trial* or stud*)) or AB (controlled N5 (trial* or stud*))

S39 .TI (clinical* N5 trial*) or AB (clinical* N5 trial*)

S40 .TI ((control or treatment or experiment* or intervention) N5 (group* or subject* or patient*)) or AB ((control or treatment or experiment* or intervention) N5 (group* or subject* or patient*))

S41 .TI ((control or experiment* or conservative) N5 (treatment or therapy or procedure or manage*)) or AB ((control or experiment* or conservative) N5 (treatment or therapy or procedure or manage*))

S42 .TI ((singl* or doubl* or tripl* or trebl*) N5 (blind* or mask*)) or AB ((singl* or doubl* or tripl* or trebl*) N5 (blind* or mask*))

S43 .TI (cross-over or cross over or crossover) or AB (cross-over or cross over or crossover)

S44 .TI (placebo* or sham) or AB (placebo* or sham)

S45 .TI trial

S46 .TI (assign* or allocat*) or AB (assign* or allocat*)

S47 .TI controls or AB controls

S48 .TI (quasi-random* or quasi random* or pseudo-random* or pseudo random*) or AB (quasi-random* or quasi random* or pseudo-random* or pseudo random*)

S49 .S31 OR S32 OR S33 OR S34 OR S35 OR S36 OR S37 OR S38 OR S39 OR S40 OR S41 OR S42 OR S43 OR S44 OR S45 OR S46 OR S47 OR S48

S50 .S12 AND S30 AND S49

S51 .EM 201207-

S52 .S50 AND S51

Number of records retrieved until 2012: 787

Number of records retrieved until 2016: 382

Appendix 5. AMED search strategy (OvidSP)

1. cerebrovascular disorders/ or cerebral hemorrhage/ or cerebral infarction/ or cerebral ischemia/ or cerebrovascular accident/ or stroke/
2. (stroke or poststroke or post-stroke or cerebrovasc\$ or brain vasc\$ or cerebral vasc\$ or cva\$ or apoplex\$ or SAH).af.
3. ((brain\$ or cerebr\$ or cerebell\$ or intracran\$ or intracerebral) adj5 (isch?emi\$ or infarct\$ or thrombo\$ or emboli\$ or occlus\$)).af.
4. ((brain\$ or cerebr\$ or cerebell\$ or intracerebral or intracranial or subarachnoid) adj5 (haemorrhage\$ or hemorrhage\$ or haematoma\$ or hematoma\$ or bleed\$)).af.
5. hemiplegia/
6. (hemipleg\$ or hemipar\$ or paresis or paretic or hemineglect or hemi-neglect or ((unilateral or spatial or hemi?spatial or visual) adj5 neglect)).af.
7. or/1-6
8. physical therapy modalities/ or exercise therapy/ or motion therapy, continuous passive.mp or musculoskeletal manipulations/
9. exercise/ or exercise test/
10. robotics/ or orthotic devices/ or myoelectric prosthesis/ or therapy, computer-assisted/
11. body weight/ or weight-bearing/
12. ((gait or locomot\$) adj5 (train\$ or therapy or rehabilitat\$ or re-educat\$ or machine\$ or powered or device\$)).af.
13. (electromechanical or electro-mechanical or mechanical or mechanised or mechanized or driven or assistive device\$).af.
14. ((body-weight or body weight) adj3 (support\$ or relief)).af.
15. (robot\$ or orthos\$ or orthotic or automat\$ or computer aided or computer assisted or power-assist\$).af.
16. (bws or harness or treadmill or exercise\$ or fitness train\$ or Lokomat or Locomat or GaiTrainer or GT1 or Kinetron or Haptic Walker or Anklebot or LOPES or AutoAmbulator).af.
17. ((continuous passive or cpm) adj3 therap\$).af.

18. or/8-17
19. gait/ or exp walking/ or locomotion/
20. "Range of Motion"/
21. recovery of function/
22. (walk\$ or gait\$ or ambulat\$ or mobil\$ or locomot\$ or balanc\$ or stride).af.
23. or/19-22
24. 7 and 18 and 23
25. exp animals/ not humans.sh.
26. 24 not 25
27. limit 26 to up=201207-201609

Number of records retrieved until 2012: 383

Number of records retrieved until 2016: 392

Appendix 6. Web of Science search strategy

- #1.TS=(stroke or poststroke or post-stroke or cerebrovasc* or brain vasc* or cerebral vasc* or cva* or apoplex* or SAH)
- #2.TS=((brain* or cerebr* or cerebell* or intracran* or intracerebral) NEAR/5 (isch\$emi* or infarct* or thrombo* or emboli* or occlus*))
- #3.TS=((brain* or cerebr* or cerebell* or intracran* or intracerebral) NEAR/5 (h\$emorrhage* or h\$ematoma* or bleed*))
- #4.TS=(hemipleg* or hemipar* or paresis or paretic)
- #5.#4 OR #3 OR #2 OR #1
- #6.TS=(Neurologic NEAR/5 Gait NEAR/5 Disorders)
- #7.TS= (robotics or automation or orthotic devices or man-machine system* or self-help devices or (computer-assisted NEAR/5 therapy))
- #8.TS=((gait or locomot*) NEAR/5 (train* or therapy or rehabilitat* or re-educat* or machine* or powered or device\$))
- #9.TS=(electromechanical or electro-mechanical or mechanical or mechanised or mechanized or driven or assistive device\$)
- #10.TS=((body-weight or (body NEAR/3 weight)) NEAR/3 (support\$ or relief))
- #11.TS=(robot* or orthos* or orthotic or automat* or computer aided or computer assisted or power-assist*)
- #12.TS=(bws or harness or treadmill or exercise\$ or fitness train* or Lokomat or Locomat or GaiTrainer or GT1 or Kinetron or Haptic Walker or Anklebot or LOPES or AutoAmbulator)
- #13.TS=((continuous NEAR/3 passive) or cpm) NEAR/3 therap*)
- #14. #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13
- #15.TS=((gait or walk* or locomot* or ambulat* or mobil* or balance* or stride) or (range of motion) or recovery of function)
- #16.#14 and #15
- #17.TS=(random* or RCT or RCTs)
- #18.TS=(controlled NEAR/5 (trial\$ or stud*))
- #19.TS=(clinical* NEAR/5 trial*)
- #20.TS=((control or treatment or experiment* or intervention) NEAR/5 (group\$ or subject\$ or patient\$))
- #21.TS=(quasi-random* or quasi random* or pseudo-random* or pseudo random*)

#22.TS=((control\$ or experiment* or conservative) NEAR/5 (treatment or therapy or manage* or procedure))

#23.TS=((singl\$ or doubl* or tripl* or trebl*) NEAR/5 (blind* or mask*))

#24.TS=(cross-over or cross over or crossover)

#25.TS=(placebo* or sham)

#26.TI=trial

#27.TS=(assign* or allocat*)

#28.TS=controls

#29.#17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28

#30.#5 and #16 and #29

Number of records retrieved until 2016: 3806

Appendix 7. PEDro search strategy

Abstract&Title: Stroke AND gait

Method: Clinical Trial

Published since: 2012

All other fields not mentioned here have been left blank.

Number of records retrieved until 2012: 165

Number of records retrieved until 2016: 166

Appendix 8. COMPENDEX search strategy (via DIALOG)

1. CEREBROVASCULAR (W) DISORDER? ?/TI,AB,DE
2. BRAIN (W) INJUR???/TI,AB,DE
3. CHRONIC (W) BRAIN (W) INJUR???/TI,AB,DE
4. (STROKE? OR CVA OR POSTSTROKE? OR CEREBROVASC?)/TI,AB,DE
5. CEREBRAL (W) VASCULAR/TI,AB,DE
6. (CEREBRAL OR CEREBELLAR OR BRAIN? OR
7. (INFARCT? OR ISCHAEMI? OR ISCHEMI? OR THROMBO? OR
8. S6 AND S7
9. (CEREBRAL OR BRAIN OR SUBARACHNOID)/TI,AB,DE
10. (HAEMORRHAGE OR HEMORRHAGE OR HAEMATOMA OR HEMATOMA OR
11. S9 AND S10
12. (HEMIPLEG? OR HEMIPAR? OR PARESIS)/TI,AB,DE
13. BRAIN (W) INJUR???/TI,AB,DE
14. GAIT (W) DISORDER? ?/TI,AB,DE
15. NEUROLOGIC??/TI,AB,DE
16. S14 AND S15
17. S1 OR S2 OR S3 OR S4 OR S5 OR S8 OR S16 OR S11-S13
18. PHYSICAL (W) THERAPY (W) MODALIT???/TI,AB,DE
19. EXERCISE (W) THERAP?/TI,AB,DE
20. MOTION (W) THERAP? /TI,AB,DE
21. CONTINUOUS (3W) PASSIVE (3W) MOTION (3W) THERAP?
22. EXERCISE?/TI,AB,DE
23. (ROBOTICS OR AUTOMATION) /TI,AB,DE
24. ORTHOTIC (W) DEVICE? ?/TI,AB,DE
25. BODY (W) WEIGHT/TI,AB,DE
26. WEIGHT (W) BEARING/TI,AB,DE
27. GAIT (5N) TRAIN???/TI,AB,DE
28. GAIT (5N) THERAP?/TI,AB,DE
29. GAIT (5N) REHABILITAT?/TI,AB,DE
30. GAIT (5N) EDUCAT?/TI,AB,DE
31. LOCOMOT? (5N) TRAIN?/TI,AB,DE

32. LOCOMOT? (5N) THERAP?/TI,AB,DE
33. LOCOMOT? (5N) REHABILITAT?/TI,AB,DE
34. LOCOMOT? (5N) EDUCAT?/TI,AB,DE
35. (ELECTROMECHANICAL OR MECHANICAL OR MECHAN?ED OR
36. ((BODY (W) WEIGHT (3N) SUPPORT?)/TI,AB,DE
37. ((BODY (W) WEIGHT (3N) RELIEF)/TI,AB,DE
38. (ROBOT? OR ORTHOS? OR ORTHOTIC OR AUTOMAT?)/TI,AB,DE
39. COMPUTER (W) AIDED/TI,AB,DE
40. (COMPUTER (W) ASSISTED)/TI,AB,DE
41. (BWS OR HARNESS OR TREADMILL OR LO?OMAT OR GAITRAINER
42. FITNESS (W) TRAIN?/TI,AB,DE
43. CONTINUOUS (W) PASSIVE/TI,AB,DE
44. THERAP?/TI,AB,DE
45. S43 AND S44
46. CPM (3N) THERAP?/TI,AB,DE
47. S18-S42
48. S48 OR S45 OR S46
49. (GAIT OR WALKING OR LOCOMOTION)/TI,AB,DE
50. RANGE (1W) MOTION/TI,AB,DE
51. ARTICULAR/TI,AB,DE
52. S51 AND S52
53. RECOVERY (3N) FUNCTION/TI,AB,DE
54. (WALK? OR GAIT? ? OR AMBULAT? OR MOBIL? OR LOCOMOT? OR
55. S50 OR S53 OR S54 OR S55
56. S17 AND S49 AND S56
57. S57 AND HUMAN

Number of records retrieved until 2012: 701

Appendix 9. SPORTDiscus search strategy (via EBSCOHost)

- S1 .DE "CEREBROVASCULAR disease" OR DE "BRAIN -- Hemorrhage" OR DE "CEREBRAL embolism & thrombosis"
- S2 .DE "CEREBROVASCULAR disease -- Patients"
- S3 .DE "HEMIPLEGIA" OR DE "HEMIPLEGICS"
- S4 .TI (stroke* or poststroke* cva* or cerebrovascular* or cerebral vascular) OR AB (stroke* or poststroke* cva* or cerebrovascular* or cerebral vascular)
- S5 .TI (cerebral or cerebellar or brain* or vertebrobasilar) OR AB (cerebral or cerebellar or brain* or vertebrobasilar)
- S6 .TI (infarct* or ischemi* or ischaemi* or thrombo* or emboli* or apoplexy) OR AB (infarct* or ischemi* or ischaemi* or thrombo* or emboli* or apoplexy)
- S7 .S5 and S6
- S8 .TI (cerebral or brain or subarachnoid) OR AB (cerebral or brain or subarachnoid)
- S9 .TI (haemorrhage or hemorrhage or haematoma or hematoma or bleed*) OR AB (haemorrhage or hemorrhage or haematoma or hematoma or bleed*)
- S10 .S8 and S9
- S11 .TI (hemipar\$ or hemipleg* or brain injur*) OR AB (hemipar\$ or hemipleg* or brain injur*)
- S12 .DE "GAIT disorders"
- S13 .S1 or S2 or S3 or S4 or S7 or S10 or S11 or S12
- S14 .DE "PHYSICAL therapy"
- S15 .DE "EXERCISE" OR DE "LEG exercises" OR DE "STRENGTH training" OR DE "TREADMILL exercise"
- S16 .DE "EXERCISE therapy"
- S17 .DE "MANIPULATION (Therapeutics)"
- S18 .TI (gait or locomot*) OR AB (gait or locomot*)
- S19 .TI (train* or therapy or rehabilitat* or re-educat* or machine* or powered or device*) OR AB (train* or therapy or rehabilitat* or re-educat* or machine* or powered or device*)
- S20 .S18 and S19
- S21 .TI (electromechanical or electro-mechanical or mechanical or mechanised or mechanized or driven or assistive device*) OR AB (electromechanical or electro-mechanical or mechanical or mechanised or mechanized or driven or assistive device*)
- S22 .TI (body-weight or body weight) OR AB (body-weight or body weight)
- S23 .TI (support* or relief) OR AB (support* or relief)
- S24 .S22 and S23
- S25 .TI (robot* or orthos* or orthotic or automat* or computer aided or computer assisted or power-assist*) OR AB (robot* or orthos* or orthotic or automat* or computer aided or computer assisted or power-assist*)

S26.TI (bws or harness or treadmill or exercise* or fitness train* or Lokomat or Locomat or GaiTrainer or GT1 or Kinetron or Haptic Walker or Anklebot or LOPES or AutoAmbulator) OR AB (bws or harness or treadmill or exercise* or fitness train* or Lokomat or Locomat or GaiTrainer or GT1 or Kinetron or Haptic Walker or Anklebot or LOPES or AutoAmbulator)
S27.TI (continuous passive or cpm) OR AB (continuous passive or cpm)
S28.TI Therapy OR AB therapy
S29 .S27 and S28
S30 .S14 or S15 or S16 or S17 or S20 or S21 or S24 or S25 or S26 or S29
S31 .DE "WALKING" OR DE "FITNESS walking" OR DE "GAIT in humans"
S32 .DE "LOCOMOTION" OR DE "HUMAN locomotion"
S33 .DE "JOINTS -- Range of motion"
S34 .TI (walk* or gait* or ambulat* or mobil* or locomot* or balanc* or stride) OR AB (walk* or gait* or ambulat* or mobil* or locomot* or balanc* or stride)
S35 .S31 or S32 or S33 or S34
S36 .S13 and S30 and S35
S37.TI (random* or RCT or trial* or placebo* or sham or double-blind* or single-blind or control or controls or assign* or allocat*) OR AB (random* or RCT or trial* or placebo* or sham or double-blind* or single-blind or control or controls or assign* or allocat*)
S38 .S36 and S37

Number of records retrieved until 2012: 461

Appendix 10. Inspec search strategy (TecFinder)

Robot AND gait AND stroke

publication year: 2012 - 2016

Number of records retrieved until 2012: 81

Number of records retrieved until 2016: 20

Appendix 11. World Health Organization International Clinical Trials Registry Platform (WHO ICTRP)

Robot AND gait AND stroke

Robot AND Walking AND stroke

publication year: 2012 - 2016

Number of records retrieved until 2016: 10

FEEDBACK

Feedback, 30 June 2010

Summary

It appears that the P value for the walking capacity outcome is incorrect in your abstract. The P value is reported as P = 0.073 in the abstract but is reported as P = 0.73 in the results section and in the forest plot.

Reply

The feedback from Meghan Malone-Moses, above, is accurate. I am sorry for this error which occurred in the abstract. The printed P value in the abstract (P = 0.073) was not correct and has now been changed to P = 0.73 as reported correctly in the Results section and in the forest plot. There is no change to the conclusions because the P value for the walking capacity outcome remains non-significant.

Contributors

Commenter: Meghan Malone-Moses, MPH, Medical Writer, DynaMed

Responder: Jan Mehrholz

WHAT'S NEW

Date	Event	Description
6 December 2016	New search has been performed	We have updated the searches to September 2016 and revised the text as appropriate. We have included 36 studies with 1472 participants in this update, compared with 23 trials with 999 participants in the previous version of this review from 2013.
6 December 2016	New citation required and conclusions have changed	The conclusions of the review have changed. The previous version of this review concluded that, for the primary outcome (walking), the number needed to treat was five patients to prevent one dependency; this updated version of our review concludes that seven patients need to be treated to prevent one dependency in walking.

HISTORY

Protocol first published: Issue 4, 2006

Review first published: Issue 3, 2007

Date	Event	Description
23 January 2013	New citation required and conclusions have changed	The conclusions of the review have changed. The previous version of this review concluded that, for the primary outcome (walking), the number needed to treat was six patients to prevent one dependency; this updated version of our review concludes that five patients need to be treated to prevent one dependency in walking.
14 January 2013	New search has been performed	We have updated the searches to December 2012 and revised the text as appropriate. We have included 23 trials with 999 participants in this update, compared with 17 trials with 837 participants in the previous version of this review from 2009.
28 July 2010	Feedback has been incorporated	Feedback and author response included in the Feedback section, and error corrected in the Abstract.
16 October 2009	New search has been performed	We have updated the searches to April 2009 and revised the text as appropriate. The conclusions of the review have not changed. We have included 17 trials with 837 participants in this update, as compared with eight trials with 414 participants in the previous version of this review from 2007. The previous version of this review concluded that, for the primary outcome (walking), the number needed to treat was four patients to prevent one dependency; this updated version of our review concludes that six patients need to be treated to prevent one dependency in walking.
6 August 2008	Amended	Converted to new review format.

CONTRIBUTIONS OF AUTHORS

Jan Mehrholz (JM) contributed to the conception and the design of the protocol and drafted the protocol. He searched electronic databases and conference proceedings, screened titles and abstracts of references identified by the search, selected and assessed trials, extracted trial and outcome data, guided the analysis and interpretation of data, and contributed to and approved the final manuscript of the review.

Simone Thomas (ST) evaluated and extracted trial data, assessed the methodological quality of selected trials, contributed to the interpretation of data, and contributed to and approved the final manuscript of the review.

Cordula Werner (CW) screened the titles and abstracts of references identified by the search; located, selected, and assessed trials; extracted trial and outcome data; assessed the methodological quality of selected trials; contributed to the interpretation of data; and contributed to and approved the final manuscript of the review.

Joachim Kugler (JK) evaluated and extracted trial and outcome data, assessed the methodological quality of selected trials, contributed to the interpretation of data, and contributed to and approved the final manuscript of the review.

Marcus Pohl (MP) contributed to the conception and design of the review, drafted the protocol, and assessed the methodological quality of selected trials. Together with JM, he contacted trialists about unpublished data and entered the data, carried out statistical analysis, helped with the interpretation of the data, drafted the review, and approved the final manuscript of the review.

Bernhard Elsner (BE) searched electronic databases and conference proceedings, screened titles and abstracts of references identified by the search, selected and assessed trials, guided analysis and the interpretation of the data, and contributed to and approved the final manuscript of the review.

DECLARATIONS OF INTEREST

Bernhard Elsner: none known.

Simone Thomas: none known.

Joachim Kugler: none known.

Marcus Pohl was author of one included trial ([Pohl 2007](#)).

Jan Mehrholz was co-author of one included trial ([Pohl 2007](#)).

Cordula Werner was an author of two included trials ([Pohl 2007](#); [Werner 2002](#)), and of one excluded trial ([Hesse 2001](#)).

These review authors (MP, JM, CW) did not participate in quality assessment and data extraction of these studies.

SOURCES OF SUPPORT

Internal sources

- Klinik Bavaria Kreisch, Wissenschaftliches Institut, Germany.
- Technical University Dresden, Lehrstuhl Public Health, Germany.
- SRH Fachhochschule Gera, Lehrstuhl Therapiewissenschaften, Germany.

External sources

- No sources of support supplied

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

In our protocol we stated that we would use the PEDro Scale to assess the methodological quality of the included trials. However, Chapter 8 of the latest edition of the *Cochrane Handbook for Systematic Reviews of Interventions* suggests that scales that yield a summary score should be avoided ([Higgins 2011a](#)). In accordance with this suggestion, we no longer used the PEDro Scale to assess the methodological quality of the included trials, instead using the Cochrane 'Risk of bias' tool to analyse trial methodology.

In our protocol we planned to quantify heterogeneity with the I^2 statistic and to use a cutoff of $I^2 = 50\%$ for all comparisons. Additionally, we planned to calculate the overall effects using a random-effects model instead of a fixed-effect model when we found substantial heterogeneity. However, in this update we calculated the overall effects using a random-effects model, irrespective of the level of heterogeneity.

In this review update we expanded our post-hoc sensitivity analysis: type of device ([Analysis 5.1](#); [Analysis 5.2](#); [Analysis 5.3](#)) by introducing a new subgroup of studies using mobile and ankle devices and adding a new comparison in Analysis 5 ([Analysis 5.3](#) Different devices for regaining walking capacity).

INDEX TERMS

Medical Subject Headings (MeSH)

*Orthotic Devices; *Stroke Rehabilitation; *Walking; Combined Modality Therapy [instrumentation] [methods]; Electric Stimulation Therapy; Equipment Design; Exercise Therapy [methods]; Gait; Randomized Controlled Trials as Topic; Robotics [*instrumentation]; Walking Speed

MeSH check words

Aged; Humans; Middle Aged