Treadmill training is effective for ambulatory adults with stroke: a systematic review

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Question: Does mechanically assisted walking increase walking speed or distance in ambulatory people with stroke compared with no intervention/non-walking intervention, or with overground walking? **Design**: Systematic review with meta-analysis of randomised trials. **Participants**: Ambulatory adults with stroke. **Intervention**: Mechanically assisted walking (treadmill or gait trainer) without body weight support. **Outcome measures**: Walking speed measured in m/s during the 10-m Walk Test and walking distance measured in m during the 6-min Walk Test. **Results**: Nine studies of treadmill training comprising 977 participants were included. Treadmill training resulted in faster walking than no intervention/non-walking intervention immediately after the intervention period (MD 0.14 m/s, 95% CI 0.09 to 0.19) and this was maintained beyond the intervention period (MD –0.12 m/s, 95% CI 0.08 to 0.17). It also resulted in greater walking distance immediately after the intervention period (MD 40 m, 95% CI 27 to 53) and this was also maintained beyond the intervention period (MD 40 m, 95% CI 24 to 55). There was no immediate, statistically significant difference between treadmill training and overground training in terms of walking speed (MD 0.05 m/s, 95% CI 0.12 to 0.21) or distance (MD –6 m, 95% CI –45 to 33). **Conclusion**: This systematic review provides evidence that, for people with stroke who can walk, treadmill training without body weight support results in faster walking speed and greater distance than no intervention/non-walking intervention and the benefit is maintained beyond the training period. **Review registration**: PROSPERO (CRD 42012002622). **[Polese JC, Ada L, Dean CM, Nascimento LR, Teixeira-Salmela LF (2013) Treadmill training is effective for ambulatory adults with stroke: a systematic review. *Journal of Physiotherapy* 59: 73–80]**

Key words: Stroke, Treadmill, Walking, Systematic review, Meta-analysis, Randomised controlled trials

Introduction

Although the majority of individuals achieve an independent gait after stroke, many do not reach a walking level that enables them to perform all their daily activities (Flansbjer et al 2005). Typically, the mean walking speed for the majority of community-dwelling people after stroke ranges from 0.4 m/s to 0.8 m/s (Duncan et al 1998, Eng et al 2002, Green et al 2002, Pohl et al 2002, Ada et al 2003). This slow speed frequently prevents their full participation in community activities. Additionally, people report a lack of ability to cover long distances after stroke, restricting their participation in work and social activities (Combs et al 2012). Moreover, walking ability has been found to be related to community participation (Robinson 2011).

While the goal of inpatient rehabilitation is independent and safe ambulation, once individuals return home, rehabilitation aims to enhance community ambulation skills by increasing walking speed and endurance. Lord et al (2004) found that the ability to confidently negotiate uneven terrain, private venues, malls and other public venues is the most relevant predictor of community ambulation. Therefore, in order to enhance community participation, rehabilitation has focused on identifying the best approach to optimise walking speed and walking distance. One approach to improving gait is the use of mechanically assisted walking devices, such as treadmills or gait trainers. Two Cochrane systematic reviews have examined these devices separately: Moseley et al (2005) reported on treadmill training and Mehrholz (2010) examined electromechanically-assisted training. We wanted to examine all devices that will help improve walking in the one review. In ambulatory stroke, mechanically assisted walking, whether by treadmills or gait trainers, allows an intensive amount of stepping practice by working as a 'forced use'. Mechanically assisted walking also facilitates the practice of a more normal walking pattern because it forces appropriate timing between lower limbs, promotes hip extension during the stance phase of walking and discourages common compensatory behaviours such as circumduction (Harris-Love et al 2001, Ada et al 2003, Moore et al 2010). We have already taken this approach in

What is already known on this topic: Mechanically assisted walking training, which can involve interventions such as treadmill training or electromechanical gait trainers, increases independent walking among people who have been unable to walk after stroke. However, previous systematic reviews have not drawn clear conclusions about the effect of treadmill training or gait trainers among ambulatory stroke survivors specifically.

What this study adds: Compared with no intervention or with an intervention with no walking training component, treadmill training improved walking speed and distance among ambulatory people after stroke. These benefits were maintained beyond the intervention period, but may not be greater than the effects of overground walking training.

relation to non-ambulatory stroke, where our systematic review demonstrated that mechanically assisted walking results in more independent walking (Ada et al 2010).

Therefore, this systematic review focuses on the efficacy of mechanically assisted walking for improving walking speed and distance in ambulatory people with stroke. Comparisons between mechanically assisted walking and overground walking were also examined in order to assist clinicians to decide the most appropriate intervention for adults with stroke. The specific research questions for this review were, in ambulatory people after stroke:

1. Does mechanically assisted walking result in immediate improvements in walking speed and distance compared with no intervention or a non-walking intervention?
2. Does it result in immediate improvements in walking speed and distance compared with overground walking?
3. Are any benefits maintained beyond the intervention period?

In order to make recommendations based on the highest level of evidence, this review included only randomised or quasi-randomised trials.

Box 1. Inclusion criteria.

Design
- Randomised or quasi-randomised trial

Participants
- Adults (> 18 yr)
- Stroke (> 24 hr)
- Ambulatory (Functional Ambulatory Category ≥ 3, walking speed ≥ 0.2 m/s at baseline or when the inclusion criteria stated 'able to walk without help, with or without walking aids' or, where mixed participants, data for ambulatory participants reported separately.)

Interventions
- Experimental. Mechanically assisted walking training (eg, treadmill training or a gait trainer) without body weight support
- Control. No intervention/non-walking intervention, or overground walking

Outcomes measured
- Walking speed
- Walking distance

Method

Identification and selection of studies

Searches for relevant studies were conducted of the following databases: Medline (1946 to April Week 1 2012, CINAHL (1986 to April Week 1 2012), EMBASE (1980 to April Week 1 2012) and PEDro (to April Week 1 2012), without language or date restrictions. Search terms included words relating to stroke, mechanically assisted walking, and locomotion (see Appendix 1 on the eAddenda for the full search strategy). In addition, we contacted authors about trials that we knew were in progress from trial registration. Titles and abstracts were displayed and screened by one reviewer to identify relevant studies. Only peer-reviewed papers were included. Full paper copies of relevant studies were retrieved and hand searching of reference lists was carried out to identify further relevant studies. The methods and abstracts of the retrieved papers were extracted so that reviewers were blinded to authors, journal, and outcomes. Two independent reviewers examined the papers for inclusion against predetermined criteria (Box 1). Conflict was resolved after discussion with a third reviewer.

Assessment of characteristics of studies

Quality: The quality of included studies was determined using PEDro scale scores extracted from the Physiotherapy Evidence Database (www.pedro.org.au). The PEDro scale rates the methodological quality of randomised trials with a score between 0 and 10 (Maher et al 2003). Where a study was not included on the PEDro database, it was scored by a reviewer following the PEDro guidelines.

Participants: Participants had to be ambulatory adults in the subacute or chronic phase after stroke. *Ambulatory* was defined as a score of at least 3 on the Functional Ambulatory Category (Holden et al 1984) or a walking speed of at least 0.2 m/s at baseline or when the included participants were able to walk without help, with or without walking aids. Studies were included when at least 80% of sample comprised ambulatory participants. Number of participants, age, time since stroke, and baseline walking speed were recorded to assess the similarity of the studies.

Intervention: The experimental intervention was mechanically assisted walking training, such as treadmill or gait trainer *without* body weight support because the participants were able to walk *a priori*. The control intervention was defined as no intervention or an intervention that did not involve walking training, ie, non-walking intervention. The experimental intervention was also compared with overground training. Session duration, session frequency, and program duration were recorded in order to assess the similarity of the studies.

Outcome measures: Two walking outcomes were of interest – speed (typically measured using 10-m Walk Test) and distance (typically measured using 6-min Walk Test). The timing of the measurements of outcomes and the procedure used to measure walking speed and distance were recorded in order to assess the similarity of the studies.

Data analysis

Data were extracted from the included studies by a reviewer and cross checked by another reviewer. Information about the method (ie, design, participants, intervention, outcome measures) and outcome data (ie, mean (SD) walking speed and walking distance) were extracted. Authors were contacted where there was difficulty with data.

The post-intervention scores were used to obtain the pooled estimate of the effect of intervention immediately (ie, post intervention) and beyond the intervention period (ie, after a period of no intervention). A fixed effects model was used. In the case of significant statistical heterogeneity ($I^2 > 50\%$), a random effects model was applied to check the robustness of the results. The analyses were performed using The MIX–Meta-Analysis Made Easy program[a] (Bax et al 2006, Bax et al 2009). The pooled data for each outcome were reported as the weighted mean difference (MD) (95% CI).

