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**REVIEW ARTICLE**

# CIRCUIT CLASS THERAPY FOR IMPROVING MOBILITY AFTER STROKE: A SYSTEMATIC REVIEW

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***Objective:*** **To examine the effectiveness of group circuit class therapy for improving the mobility of adults after stroke.**
***Design:*** **Cochrane systematic review.**
***Methods:*** **A comprehensive search strategy was used to find randomized and quasi-randomized controlled trials of adults post-stroke receiving circuit class therapy. Two authors independently selected trials for inclusion, assessed the methodological rigor and extracted data.**
***Results:*** **Six trials were included, involving 292 participants; most were community-dwelling survivors who were able to walk independently. Circuit class therapy was effective in improving walking ability (6-minute walk test mean difference, 76.6 m, 95% confidence interval 38.4–114.7, walking speed mean difference 0.12 m/s, 95% confidence interval 0–0.24) and balance (step test mean difference 3.0 steps, 95% confidence interval 0.08–5.9, activities specific balance confidence mean difference 7.76 points, 95% confidence interval 0.66–14.9). Other balance measures did not show a difference in effect. Results from two studies suggest that circuit class therapy can reduce length of hospital stay (mean difference –19.7 days, 95% confidence interval –35.4 to –4.0). Two studies measured adverse events (falls); all were minor.**
***Conclusion:*** **Circuit class therapy is safe and effective in improving mobility in people after stroke and, when provided as part of hospital-based rehabilitation, may reduce length of stay.**

*Key words:* stroke; rehabilitation; physical therapy; walking; motor activity; circuit class training.

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## INTRODUCTION

Stroke is a leading cause of death and disability in many Western countries (1–3). The systems supporting care and rehabilitation after stroke; for example, whether care is primarily hospital- or community-based, differ between countries. However, the high cost of this care is universal. In Australia, care of stroke survivors costs $AUD 2.14 billion per year (4). It is therefore important that evidence-based therapies are provided to stroke survivors in a way that is both effective and cost-effective.

There is now good evidence that rehabilitation for stroke survivors should be focused on repetitive practice of functional tasks (5, 6), and the amount of therapy time people receive should be maximized within the first 6 months of stroke (7). However, fiscal constraints make increasing supervised practice time difficult. Intensive task practice has also been shown to promote positive neuroplasticity after stroke. A systematic review of intensive task-specific therapy for the upper limb found a significant effect size for positive neuroplastic changes (8), and studies of intensive treadmill training have also shown similar results (9, 10).

Circuit class therapy (CCT) is a method by which people after stroke receive activity-based rehabilitation in a group setting, thereby reducing costs of staffing. The key components of CCT are repetitive task practice and tailoring (including ongoing progression) of exercises to suit individual participants (11, 12). CCT can be directed at improving mobility (walking ability and balance) or upper limb function or both, and can be delivered in both hospital and community settings. For the purpose of this review, CCT was defined as an intervention involving 3 or more participants per staff member, where the exercises included were focused on repetitive practice of functional tasks. Therapy that was focused solely on impairments (such as pure strength or fitness training) was not considered to be CCT.

This systematic review aimed to investigate the evidence for the safety and effectiveness of CCT in improving the mobility of adults after stroke. Outcomes relating to postural control, lower limb function, abilities to perform activities of daily living, lower limb impairment, health-related quality of life and satisfaction were also examined. This paper is based on a Cochrane review first published in the Cochrane Library 2010, Issue 7 (13) (see http://www.thecochranelibrary.com/ for information). The Cochrane Library should be consulted for the most recent version of the review.

## METHODS

This review was conducted according to the Cochrane Collaboration guidelines. A comprehensive search strategy was used, including searches of all relevant databases (including, but not limited to, MEDLINE, Embase, CINAHL and PEDro), conference proceedings and trial registries. The full search strategy is available from the authors. Reference lists of relevant articles were also examined and experts in the field were contacted. There were no language or date restrictions. Trials were included if they were randomized controlled trials (RCTs) or quasi-RCTs; involving adult stroke survivors receiving CCT aimed at improving mobility. Trials comparing CCT with no intervention, sham intervention or other interventions were all included.

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Two reviewers independently examined all database hits on the basis of title and abstract. Full text articles for those papers in which all criteria were met or unsure were retrieved and reviewed by the same two reviewers. The final lists of included articles were compared and any disagreements resolved by consensus. Each included study was then reviewed for risk of bias, according to the guidelines set out in the Cochrane Handbook for systematic reviews (14). This was assessed according to 6 domains; sequence generation, allocation concealment, blinding of participants, personnel and outcome assessors, incomplete outcome data, selective reporting and sample size. The two reviewers then extracted the relevant data and entered into the review software package *Revman5*. If any disagreement occurred with respect to risk of bias assessment or data extraction, it was resolved by consensus, with referral to a third party if necessary.

We were primarily interested in the effect of CCT on improving walking capacity as measured by the 6-min walk test (6MWT). Other common measures of walking ability, postural control in standing, lower limb impairment measures (strength, range of motion), activity limitations such as the ability to perform activities of daily living (ADLs) or instrumental activities of daily living (iADLs) and health-related quality of life and patient satisfaction were also considered. In addition, measures of adverse events, length of hospital stay and economic indicators were collected.

Data were extracted and pooled to calculate the mean difference (and 95% confidence intervals (CI)) between groups based on post-intervention scores. Clinical heterogeneity between trials was examined, as was the statistical heterogeneity of the meta-analyses by consideration of the $I^2$ statistic. Finally, a sensitivity analysis was performed to assess whether the design of a trial (RCT or quasi-RCT) skewed results.

## RESULTS

A total of 6 trials was included in the final review. Fig. 1 shows the flow of trial identification and inclusion. Characteristics of the included studies are summarized in Table I. All 6 trials were published between 2000 and 2009 and were conducted in Australia (11, 15), New Zealand (16) or Canada (17–19). Five trials were RCTs and one was a quasi-RCT with allocation by date of admission to rehabilitation (11). A total of 292 participants was included, with sample sizes ranging from 12 (17) to 68 (11). Two trials included participants within the first 3 (11, 15) months of stroke and were conducted in hospital settings. The other 4 trials (16–19) involved participants between 1 and 5 years post-stroke, and were conducted in community-based settings. The frequency and duration of the intervention varied from more than 2 h per day, 5 days a week for 4 or more weeks (11) to an 1 h-long session 3 times a week for 4 or more weeks. The comparator group received some form of therapy in all studies. This ranged from usual care physiotherapy in the hospital setting (11), CCT focused on improving arm function (15, 17, 19), a stretching programme (18) or group education sessions (16). Table I summarizes the included trials and the outcome measures used.

The overall risk of bias in the studies was low. Individually, 3 studies achieved all criteria (15, 16, 19) although in 2 of these (15, 19) one criteria lacked clarity. In the trial by Blennerhassett & Dite (15), the exact method of sequence generation was unclear, and the trial by Pang et al. (19) was reported in several different papers, leading to uncertainty as to whether there was complete reporting of all outcome measures. Dean et al. (17) had the highest risk of bias, with a small sample size, un-blinding of the assessor, no intention-to-treat analysis and high drop-outs. English et al. (11) did not have adequate sequence generation or concealment and Marigold et al. (18) failed to use appropriate reporting for drop-outs. Fig. 2 summarizes the risk of bias across included studies. A sensitivity analysis was conducted for those analyses involving the one study that was not randomized (11). This did not materially change the outcome of any analyses.

Data were able to be pooled for measures of walking ability (6MWT, gait speed), postural control in standing (Step Test,

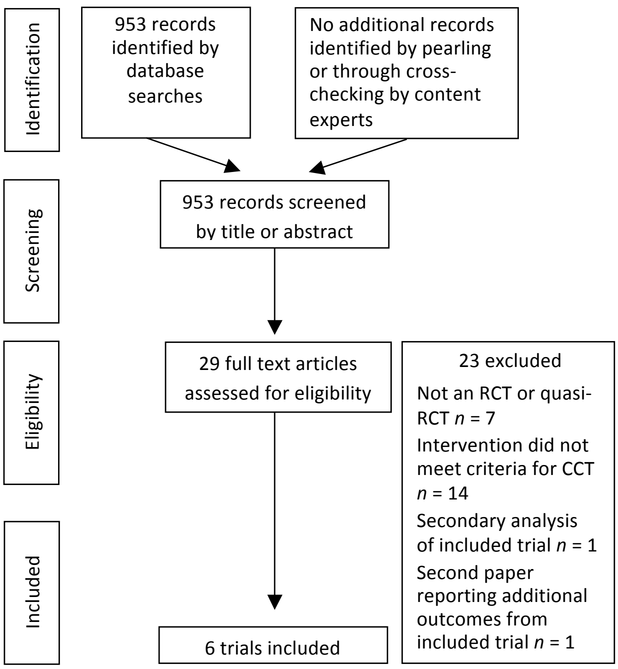


*Fig. 1.* Trial identification and inclusion. RCT: randomized controlled trial; CCT: circuit class therapy.

| | Adequate sequence generation? | Allocation concealment? | Blinding? | Incomplete outcome data addressed? | Free of selective reporting? | Free of other bias? |
|---|---|---|---|---|---|---|
| Blennerhassett & Dite (15) 2004 | ? | + | + | + | + | + |
| Dean et al. (17) 2000 | + | + | – | – | + | – |
| English et al. (11) 2007 | – | – | + | + | + | + |
| Marigold et al. (18) 2005 | + | + | + | – | + | + |
| Mudge et al. (21) 2009 | + | + | + | + | + | + |
| Pang et al. (19) 2005 | + | + | + | + | ? | + |

*Fig. 2.* Authors' assessment of risk of bias for included trials.

Table I. *Summary of included trials*

| Author and year | Design | Sample size (E/C) | Setting | Description of CCT intervention | Description of comparator intervention | Participant characteristics: Age, years Mean (SD) | Months since stroke onset Mean (SD) | Level of ability at baseline | Outcome measures |
|---|---|---|---|---|---|---|---|---|---|
| Blennerhassett & Dite 2004 (15) | RCT | 30 (15/15) | Inpatient rehabilitation hospital | 1 h per day, 5 days/week mobility-related CCT in addition to usual care for 4 weeks | 1 h per day, 5 days/week upper limb-related CCT in addition to usual care for 4 weeks | 55.1 (15.6) | 1.4 (1.3) | Able to walk 10 metres with supervision | 6MWT<br>Step Test<br>TUG<br>MAS (upper limb)<br>JTHFT<br>Length of stay |
| Dean et al. 2000 (17) | RCT | 9 (5/4) | Community | Mobility related CCT. 1 h per session, 3 times a week for 4 weeks | Seated upper limb activities, 1 h per day 3 times a week for 4 weeks. | 62.3 (6.6) | 15.6 (10.8) | Able to walk 10 m independently | 6MWT<br>Step Test<br>TUG<br>Gait speed<br>GRF paretic LL<br>Gait kinematics |
| English et al. 2007 (11) | Quasi-RCT[a] | 68 (31/37) | Inpatient rehabilitation hospital | Mobility and upper limb CCT delivered in 2, 90-min sessions per day, 5 days/week during hospital stay | Usual care therapy during hospital stay | 61.6 (11.8) | 0.8 (0.5) | Able to stand with the assistance of 1 person | Gait speed<br>BBS<br>MAS (upper limb)<br>ILAS<br>Patient satisfaction<br>Length of stay |
| Marigold et al. 2005 (18) | RCT | 59 (28/31) | Community | Mobility related CCT. 1 h per session, 3 times a week for 10 weeks | Stretching and tai-chi like exercises 1 h per session, 3 times a week for 10 weeks. | 67.8 (8.0) | 44.4 (25.4) | Able to walk 10 m independently | TUG<br>BBS<br>ABC<br>NHP<br>Force platform measures<br>Falls diary |
| Mudge et al. 2009 (16) | RCT | 58 (31/27) | Community | Mobility related CCT. 1 h per session, 3 times a week for 4 weeks | Social and education sessions 90-min per session, 2 times a week for 4 weeks. | 73.7 (34.2) | 53.8 (137.4) | Able to walk independently | 6MWT<br>Gait speed<br>RMI<br>ABC<br>PADS<br>Free living step counts |
| Pang et al. 2005 (19) | RCT | 63 (32/21) | Community | Mobility related CCT. 1 h per session, 3 times a week for 19 weeks | Upper limb-related CCT. 1 h per session, 3 times a week for 19 weeks | 65.3 (8.7) | 61.8 (52.0) | Able to walk independently | 6MWT<br>BBS<br>$VO_2$max<br>Knee extension strength<br>PASIPD<br>Femur BMD |

[a]Allocated to group based on date of admission to rehabilitation.

E: experimental group; C: control group; RCT: randomized controlled trial; CCT: circuit class therapy; 6MWT: 6-minute walk test; TUG: timed up and go test; MAS: motor assessment scale for stroke; JTHFT: Jebsen Taylor Hand Function Test; GRF paretic LL: peak vertical ground reaction force of the paretic lower limb during sit to stand; BBS: Berg Balance Scale; ILAS: Iowa Level of Assistance Scale; ABC: activities-specific balance confidence scale; NHP: Nottingham Health Profile; RMI: Rivermead Mobility Index; PADS: Physical Activity and Disability Scale; $VO_2$max: maximal oxygen uptake; PASIPD: Physical Activity Scale for Individuals with Physical Disability; BMD: bone mineral density.

Timed Up and Go (TUG), Berg Balance Scale (BBS) and activities-specific balance confidence scale (ABC)) and length of hospital stay. Four studies (157 participants) measured walking capacity using the 6MWT (15–17, 19). Overall, there was a significant effect in favour of CCT (mean difference (MD) fixed 76.57 m, 95% CI 38.44–114.70, $p<0.0001$, (Fig. 3A)). A significant, but smaller, effect was found in favour of CCT for improving walking speed (MD, fixed 0.12 m/s, 95% CI 0.00–0.24, $p=0.04$, (Fig. 3B)) in 3 studies (11, 16–17) (130 participants). Results of the meta-analysis with regards to postural control in standing were mixed. Two studies (15, 17) used the Step Test (39 participants) and the meta-analysis showed a superior effect in favour of CCT (MD, fixed 3.00 steps, 95% CI 0.08–5.91, $p=0.04$, (Fig. 3C)). Two studies (16, 18) measured confidence with balance (ABC scale) and found a superior effect in favour of CCT (MD, fixed 7.76 points, 95% CI 0.66–14.87, A

| Study or Subgroup | experimental Mean | SD | Total | control Mean | SD | Total | Weight | Mean Difference IV, Fixed, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Blennerhassett 2004 | 404 | 101 | 15 | 288 | 124 | 15 | 22.2% | 116.00 [35.07, 196.93] |
| Dean 2000 | 250 | 135 | 5 | 264.3 | 159.1 | 4 | 3.8% | -14.30 [-210.03, 181.43] |
| Mudge 2009 | 282 | 117 | 30 | 200 | 99 | 25 | 44.6% | 82.00 [24.91, 139.09] |
| Pang 2005 | 392.7 | 151.1 | 32 | 342.4 | 133.4 | 31 | 29.4% | 50.30 [-20.03, 120.63] |
| **Total (95% CI)** | | | **82** | | | **75** | **100.0%** | **76.57 [38.44, 114.70]** |

Heterogeneity: Chi² = 2.31, df = 3 (P = 0.51); I² = 0%
Test for overall effect: Z = 3.94 (P < 0.0001)

B

| Study or Subgroup | experimental Mean | SD | Total | control Mean | SD | Total | Weight | Mean Difference IV, Fixed, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Dean 2000 | 0.707 | 0.483 | 5 | 0.854 | 0.542 | 4 | 2.9% | -0.15 [-0.83, 0.53] |
| English 2007 | 0.58 | 0.46 | 30 | 0.53 | 0.43 | 36 | 28.7% | 0.05 [-0.17, 0.27] |
| Mudge 2009 | 0.79 | 0.28 | 30 | 0.63 | 0.25 | 25 | 68.4% | 0.16 [0.02, 0.30] |
| **Total (95% CI)** | | | **65** | | | **65** | **100.0%** | **0.12 [0.00, 0.24]** |

Heterogeneity: Chi² = 1.31, df = 2 (P = 0.52); I² = 0%
Test for overall effect: Z = 2.02 (P = 0.04)

C

| Study or Subgroup | experimental Mean | SD | Total | control Mean | SD | Total | Weight | Mean Difference IV, Fixed, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Blennerhassett 2004 | 11.1 | 5 | 15 | 8.5 | 4.6 | 15 | 71.8% | 2.60 [-0.84, 6.04] |
| Dean 2000 | 9.8 | 4 | 5 | 5.8 | 4.3 | 4 | 28.2% | 4.00 [-1.48, 9.48] |
| **Total (95% CI)** | | | **20** | | | **19** | **100.0%** | **3.00 [0.08, 5.91]** |

Heterogeneity: Chi² = 0.18, df = 1 (P = 0.67); I² = 0%
Test for overall effect: Z = 2.02 (P = 0.04)

D

| Study or Subgroup | experimental Mean | SD | Total | control Mean | SD | Total | Weight | Mean Difference IV, Fixed, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Marigold 2005 | 74 | 18.3 | 22 | 68.3 | 19.4 | 26 | 44.3% | 5.70 [-4.98, 16.38] |
| Mudge 2009 | 73.6 | 19 | 30 | 64.2 | 17 | 25 | 55.7% | 9.40 [-0.12, 18.92] |
| **Total (95% CI)** | | | **52** | | | **51** | **100.0%** | **7.76 [0.66, 14.87]** |

Heterogeneity: Chi² = 0.26, df = 1 (P = 0.61); I² = 0%
Test for overall effect: Z = 2.14 (P = 0.03)

E

| Study or Subgroup | experimental Mean | SD | Total | control Mean | SD | Total | Weight | Mean Difference IV, Fixed, 95% CI |
|---|---|---|---|---|---|---|---|---|
| Blennerhassett 2004 | 58.3 | 30.1 | 15 | 91.3 | 53.6 | 15 | 25.5% | -33.00 [-64.11, -1.89] |
| English 2007 | 56.1 | 31.1 | 30 | 71.3 | 44 | 36 | 74.5% | -15.20 [-33.38, 2.98] |
| **Total (95% CI)** | | | **45** | | | **51** | **100.0%** | **-19.73 [-35.43, -4.04]** |

Heterogeneity: Chi² = 0.94, df = 1 (P = 0.33); I² = 0%
Test for overall effect: Z = 2.46 (P = 0.01)

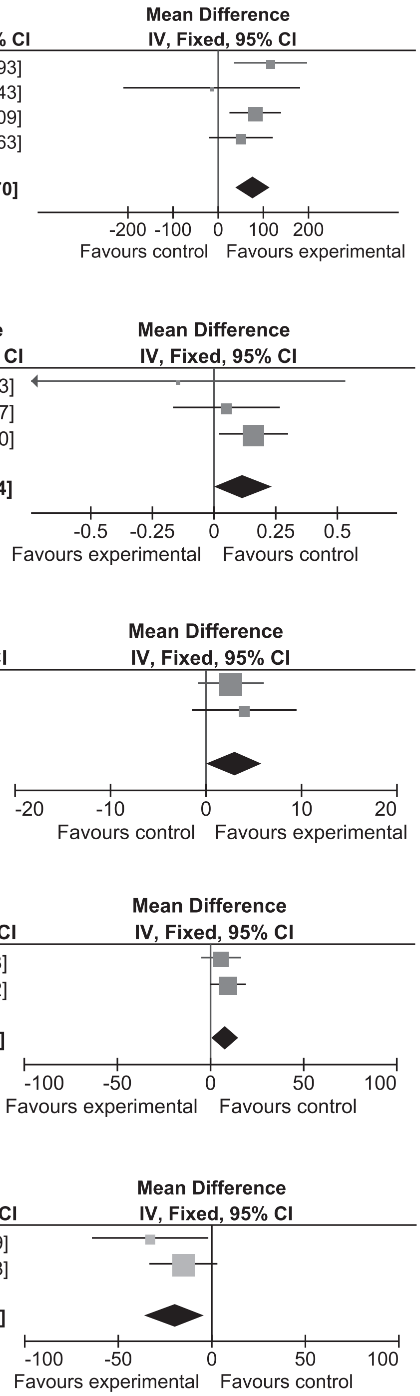


*Fig. 3.* Meta-analysis of (A) 6-minute walk test data, (B) gait speed data, (C) Step Test data, (D) Activities Specific Balance Confidence Scale data and (E) length of hospital stay data. CI: confidence interval; SD: standard deviation; df: degrees of freedom; IV: inverse variance.

$p=0.03$ (Fig. 3D)). However, results of the meta-analysis for the TUG, measured in 3 studies (12, 15, 16) (89 participants) did not show a significant effect (MD, fixed –3.08 s, 95% CI –7.59 to 1.43, $p=0.018$), nor did the meta-analysis for the BBS measured in 3 studies (11, 18, 19) (177 participants), (MD, fixed 0.86, 95% CI –1.02–2.74, $p=0.37$).

Length of hospital stay was measured in the two studies conducted within a hospital setting (11, 15). Pooling data from these two studies revealed a significant effect in favour of CCT for reducing length of stay (MD, fixed –19.73 days, 95% CI –35.43 to –4.04, $p=0.01$ (Fig. 3E)). Only two studies (11, 19) collected data on adverse events. In both studies the number of falls was higher in the CCT group (2 falls in the control vs 4 in the CCT group (11), 1 fall in the control group and 5 falls in the CCT group (19)). Neither study reported any falls resulting in injury or any other adverse event.

Only one study formally assessed patient satisfaction (11). In this trial, participants in the CCT arm were significantly more satisfied with the amount of physiotherapy they received while in hospital. Other studies (16, 17) anecdotally reported that participants enjoy the group setting and peer support offered by the CCT intervention. No trials included any form of cost or economic analyses.

## DISCUSSION

This systematic review and meta-analysis found CCT to be effective in improving walking ability and postural control in standing in people after stroke. Results also indicated that CCT may reduce length of hospital stay when implemented in the hospital setting. However, to accurately interpret the findings of meta-analyses, attention must be paid to the clinical relevance of the findings. The significant effect in favour of CCT for walking capacity, as measured by the 6MWT, is of clinical relevance. Other studies have suggested that improvement on the 6MWT must exceed 13% to be meaningful (20). This equates to between 32.5 and 52.5 m, based on data extracted for this review, therefore the mean difference of over 76 m represents clinically meaningful improvement. In addition, walking capacity as measured by the 6MWT is a strong predictor of community walking ability (21, 22) and is associated with higher quality of life (23).

While this review also found a statistically positive effect in favour of CCT improving walking speed, the mean difference between groups was only 0.12 m/s. However, this difference may not be as clinically important as the changes seen in walking capacity. The minimal clinically important difference in walking speed for people recovering from stroke has been estimated to be 0.16 m/s (24).

The mixed results in terms of the measures of postural control in standing may be explained by the relative sensitivity of the measures used. The positive effect for balance self-efficacy (ABC scale) can be interpreted as being clinically meaningful, as the magnitude of the difference (7.76 points) exceeds the known inherent measurement error (5.05 points) (25). Furthermore, balance self-efficacy, particularly in conjunction with improved walking ability is related to an improvement in perceived health status (26). The BBS has a ceiling effect when used with ambulant, community-dwelling stroke survivors (27), which may explain why no trials found improvement in this measure. Therefore, there is only moderate evidence in favour of CCT improving postural control in standing.

The significant result of reduced length of stay in favour of the CCT groups is of interest as it suggests some economic benefits for the use of CCT. It should be noted it is only based on two studies (one of which was not randomized). Furthermore, the causal link between the type of intervention and length of hospital stay is difficult to make, due to the myriad of factors that can impact on length of stay (28). However, further studies prospectively investigating this link are warranted.

Both studies that prospectively measured adverse events (the number of falls during therapy) found a higher, though not significant, incidence of falls during CCT (11, 19). However, this finding must be considered in light of the relative exposure to risk. In both these trials participants in the control group had considerably less exposure to the risk of falls as they either participated in a seated upper limb programme (19) or spent less than 25% of the time engaged in physical therapy sessions compared with the intervention group (11).

The content of the CCT sessions offered across the included studies was remarkably similar. Many of the same exercises and activities were included, and there was a strong emphasis on walking practice in all of them. Similarly, the characteristics of the participants were similar. With one exception (11), all included studies involved only those participants who were able to walk at least 10 m independently at baseline. In addition, 4 of the 6 included trials involved participants at least 3 months (on average 1–5 years) after their stroke. Therefore, the results of this systematic review can be extrapolated only to community-dwelling stroke survivors who have regained the ability to walk at least short distances. The results may also be limited to those people with sufficient motivation to attend a regular group programme.

Considering people earlier after stroke, only two trials included people less than 3 months post-stroke, and both were conducted in an inpatient rehabilitation facility. They differed in the level of ability of participants (able to walk at least 10 m vs able to stand with one person assisting) as well as the type of intervention (CCT offered as an adjunct to usual care therapy vs CCT offered as an alternative to usual care). Both trials reported reductions in length of hospital stay that were clinically meaningful, but not statistically significant. In addition, English et al. (11) found that more than 4 times the amount of therapy time could be provided to CCT participants compared with usual care therapy, and this took an individual therapist less time to deliver. This finding, coupled with the reduction in length of hospital stay, suggests that CCT has the potential to lead to substantial savings to the healthcare system.

There has been one other published systematic review of CCT for improving mobility in people after stroke (12), which included some trials not included in this review because the interventions were either not delivered in a group setting (29, 30) or were primarily impairment-based (31). Our review also included two trials not included in Wevers et al.'s review (12); one that was quasi-randomized (11) and one published after Wevers et al.'s (12) review (16). Despite the differences in included trials, the results of the reviews were very similar. However, the magnitude of effect size in favour of CCT with regards to walking capacity (6MWT) and walking speed was greater in our review (42.5 m compared with 76.57 metres in our review and 0.07 m/scompared with 0.12 m/s in our review, respectively (12)). The difference in results may be due to the acuity of the participants relative to stroke onset. Wevers et al. (12) included only one trial conducted early after stroke (15) compared with two such trials in our review (11, 15). Further trials are required to determine the effect of latency post-stroke on the effectiveness of CCT.

In conclusion, the results of this review suggest that there is strong evidence for CCT to improve walking capacity in community-dwelling stroke survivors and moderate evidence for its effectiveness in improving walking speed and postural control in standing. There is also some suggestion that CCT may be effective in reducing length of hospital stay when provided earlier after stroke. There is no evidence of adverse events related to the implementation of CCT, although therapists and researchers should be aware of the potential for falls during any therapy sessions and put strategies in place to protect against this. However, more trials are required to investigate the effectiveness and cost-effectiveness of CCT early after stroke, as well as the long-term benefits of CCT in people later after stroke.

This paper is based on a Cochrane review first published in the Cochrane Library 2010, Issue 7 (13) (see http://www.thecochranelibrary.com/ for information). Cochrane reviews are regularly updated as new evidence emerges and in response to feedback. The Cochrane Library should therefore be consulted for the most recent version of the review. The results of a Cochrane review can be interpreted differently, depending on people's perspectives and circumstances. The conclusions presented should therefore be considered with care; they are the opinions of the review authors and are not necessarily shared by The Cochrane Collaboration.

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