



Fontys Paramedic University of Applied Sciences

Bachelor Thesis, Department of Physiotherapy

Effects of circuit class therapy on walking speed and distance in stroke patients compared to usual physiotherapy. A Systematic Literature Review

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PREFACE

During the four years of physiotherapy education, I completed two internships in neurological settings. Every setting and treatment approach differed depending on the country. Neurological treatment methods are constantly being renewed and have also recently been adjusted to the health care system with the aim of becoming more cost effective as well as efficient.

Circuit Class Therapy, one of the options available as a thesis topic, might be such a form of therapy applied to patients after stroke. Since I have not experienced this kind of treatment/approach before in my internships or during the education it caught my eye.

During the last few months I have looked deeper into this new treatment modality and tried to find differences and advantages of Circuit Class Therapy in contrast to other treatment forms used within the stroke population.

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ABSTRACT

Background. Stroke is considered to be one of the leading causes of impairment and disability throughout Western society. Each year millions of stroke survivors have to adapt to a new lifestyle, with 25-74% in need of some assistance and a great proportion losing their ability to walk. Recently, Circuit Class Therapy (CCT) has been introduced as an effective and cost saving method to treat stroke patients.

Objective. To find out, if CCT is more effective to improve the walking function, in terms of walking speed and distance, for the post acute and chronic stages of stroke than usual physiotherapy.

Research question. Does CCT show better outcomes, in terms of walking speed and distance, compared to usual physiotherapy according to the Dutch physiotherapy guideline?

Method. Potentially relevant articles were identified on various databases based on set inclusion and exclusion criteria. The selected literature was assessed based on its methodological quality using the PEDro scale. A best evidence synthesis was applied in order to come to an overall finding of the level of evidence.

Results. Seven articles, presenting with a “Good” or “Very Good” quality were found. The best evidence synthesis was applied separately according to the control interventions of the studies. Strong evidence was found that CCT significantly improves walking distance compared to upper limb exercises. Limited evidence was reported that CCT is more effective than relaxation and social educational sessions, usual outpatient physiotherapy and Bobath treatment to increase walking distance. Limited or no evidence exists that CCT significantly improves walking speed compared to the control interventions.

Conclusion. CCT is a therapy form, which can easily be applied in various health care settings. It has shown to be an effective method to improve walking competency with a lower ratio of staff per patients and therefore being a cost saving method.

Keywords. Stroke, Circuit Class Therapy, Walking competency

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INTRODUCTION

Stroke is considered to be one of the leading causes of impairment and disability throughout Western society.^{1,2} Each year millions of stroke survivors have to adapt to a lifestyle composed of restrictions in activities of daily living (ADLs).³ Of the 50 million stroke survivors worldwide, 25-74% are in need of some assistance or are regarded as fully dependent on caregivers in their ADLs.⁴ In a study by Jorgensen et al. 51% of stroke survivors had lost their walking function.⁵

Perry et al. reported that most stroke patients return home after rehabilitation and are not able to cross the street safely or walk safely within their community. This is a major problem at the level of participation of a person.⁶ Walking, in terms of safety, efficiency and endurance was reported as a primary goal of rehabilitation.⁷ Furthermore, gait and mobility were rated on the seventh rank of the top ten research priorities related to life after stroke identified by stroke survivors, caregivers and health professionals.⁸

However, in contrast to the high importance of mobility, very low levels of physical activity of stroke patients have been reported in both, community and hospital based settings. Stroke survivors spend less than 38 minutes per day of meaningful physical activity in acute hospital settings.⁹ This leads to reduced exercise tolerance as a result of inactivity and may lead to further complications such as reduced cardiorespiratory fitness, muscle atrophy and impaired circulation in the lower extremities.¹⁰

Rehabilitation after stroke is often focused on the impairment level, such as strength, aerobic fitness training or tone management, which may lead to improvements in strength and range of motion but has a lower effect on functional abilities.¹¹ The Dutch physiotherapy guideline (KNGF) describes a number of treatment methods used in the past for stroke patients, the Bobath concept or the Proprioceptive Neuromuscular Facilitation (PNF) are only two of them. However, surveys conducted by the KNGF show that the Bobath concept is still a commonly used treatment method among therapists in several countries all over the world.¹²

Next to other principles, specificity, repetition, intensity and time have shown to be of high importance for brain reorganization and functional outcome within rehabilitative training after brain damage.¹³ There is good evidence that physiotherapeutic treatment of stroke patients should focus on repetitive task specific functions of daily life as well as on increasing the amount of hours spent on therapy should be maximized.^{2,14-16} In addition to this, a study conducted by French et al. has also proved strong evidence that repetitive task training improves walking distance and speed.¹⁷

One possible approach for task orientated, repetitive training is Circuit Class Training (CCT). CCT is defined as a series of workstations focusing on task specific activities organized in a circuit. CCT contains at least three components of effective and efficient physical training.² Firstly, it is a treatment focusing on high intensity due to the different workstations that allows patients to work in a progressive way suiting their individual impairments.^{18,19} Secondly, more than two participants are supervised by

one therapist which is an efficient way to save costs and enhance therapist contact time while usual physiotherapy is a individually tailored, face to face treatment.^{16,19} This would be a potentially effective and cost saving way for health care systems. Thirdly, CCT facilitates group dynamics and social interactions.¹⁸ Working in a group enhances motor learning by observing others and learning new motor tasks within physical practice as well as increasing confidence and mood.^{2,20} It has been proven that CCT has a positive effect on stroke patients in terms of gait, walking speed, transfers and stair climbing.^{2,16}

This means compared to usual physiotherapy, physiotherapists could treat a patient for a longer period of time and simultaneously meet the criteria of a task orientated approach with high intensity. This might be one of the reasons why CCT is an effective way to increase walking ability in terms of walking speed and distance. Furthermore, walking speed and distance showed to be good markers to predict community walking of patients with stroke.²¹

Other reviews found CCT to be effective especially in the acute phase of stroke patients. However, more research is required to find out if this treatment can be used for patients in the subacute and chronic phase.¹⁶ Therefore the focus of this systematic review will be on patients in the post acute (1-6 months after onset of stroke) and chronic (6 months after onset of stroke) stages of stroke.¹² Keeping all of this in mind, the following research question is aimed to be answered by this systematic literature review.

Does circuit class therapy show better outcomes, in terms of walking speed and distance, compared to usual physiotherapy according to the Dutch physiotherapy guideline?¹²

METHOD

Databases and Search Strategy

The following databases were searched independently by the author: PubMed (1996 to April 2013), The Cochrane Library (1994 to April 2013), PEDro (1999 to April 2013), ScienceDirect (1999 to April 2013) and CINAHL (1977 to April 2013). Literature was identified using various keywords representing the patient group, the intervention and the outcome. This was done by the use of the Boolean operator (and/or) to combine the search terms. The combined search terms together with the search string can be found in Appendix I. In this review the search string was adjusted to the needs of the various databases. If the number of the found literature was >1000, the search was specified that the combinations of the search terms should appear in title and abstract of the article. In case the number of search results was insufficient, only two or three keywords were used.

In addition to the above mentioned databases, existing literature in the form of review articles was also examined to identify trials that met the inclusion criteria.

If access to selected articles was denied, biep.nu via the Fontys Mediatheek and Google Scholar was used to acquire the full text version. Other remaining literature, which was not possible to gain the full text version, was found by free access to the Technical University of Eindhoven.

Criteria for considering studies for this review

Before the start of this systematic review, in- and exclusion criteria were set. The content for these criteria were: the type of the study, the participants, the outcome measure and the language. The criteria is summarized in table 1 and furthermore explained in detail.

Table 1: In- and Exclusion criteria summary

Inclusion criteria	<ul style="list-style-type: none"> • Studies that performed a randomized controlled trial or a clinical controlled trial • Articles including the study population of post acute and chronic type stroke patients • Articles including task orientated Circuit Class Therapy as therapy form or intervention method • Studies focusing on walking in their therapeutic intervention • The results of the intervention are compared by pre- and post tests according to walking speed: the Ten Meter Walking Test (10MWT), the Five Meter Walk Test (5MWT), the Five Meter Comfortable Walk Speed Test (5MCWST) and walking distance: the Six Minute Walking Test (6MWT) • Studies published in English language
Exclusion criteria	<ul style="list-style-type: none"> • Studies that are not available in full text

Types of participants

Participants in the studies had to be 18 years and older, and diagnosed with a stroke according to the definition of the WHO.²² Only studies presenting subjects in the post acute (from one to six months after onset of the stroke) or chronic (six months after the onset of stroke) stage of stroke were included.¹²

Types of intervention

Studies were only included if the intervention used task orientated CCT or a similar form of group training according to the definition of CCT in this paper: A form of therapy presenting a series of workstations organized in a circuit. The therapy is focusing on gait related activities to increase the walking ability. The therapy is provided in a group with >2 participants per therapist simultaneously. Furthermore, the control intervention of the various studies had to be a therapy form described in the Dutch physiotherapy guideline.¹²

Types of outcome measure

Studies were only included if the aim of the study was to increase mobility in terms of walking speed and distance. The 6MWT was used as an outcome measure to evaluate walking distance. According to Fulk et al. it has high test-retest reliability.²³ Furthermore the 10MWT, the 5MWT and the 5MCWST

are reliable and valid measurements to assess the walking speed and therefore considered as outcome measures in this study.²⁴

Selection of Studies

Screening by title and abstract

The results of the search were first screened by title if the found literature might be of importance to use for the systematic review. The in- and exclusion criteria were kept in mind during the process. If an article was accepted by considering the title, the abstract was screened for further details.

Screening by full text

The full text was read and a final conclusion was made as to whether or not the content of the paper met the inclusion criteria. If an article was in accordance with the set inclusion criteria, it was assessed further into detail and on quality.

Methodological Quality Assessment

The methodological quality of the included studies was examined by using the PEDro article rating method. The scale is frequently used in the field of physiotherapy presenting with a “good” reliability.²⁵ The PEDro scale consists of 11 criteria, though one criterion (criterion 1) relates to the external validity and is therefore not considered for the use to calculate the PEDro score. The purpose of the PEDro scale is to assess the internal validity (criteria 2-9) and state sufficient statistical information (criteria 10-11) of a study. One point was given to each item (except criterion 1 which was answered by YES or NO) fulfilling the criteria. Depending on their score, the articles were rated as “Very good”(9-10 points), “Good”(6-8 points), “Reasonably good”(4-5 points) and “Poor”(0-3 points) quality (table 2).¹² Furthermore, if disagreements occurred about the quality of an article, a second or third reviewer (HL, HH) was asked to evaluate the article and decide about the quality.

Table 2: Classification of PEDro score¹²

PEDro Score	Methodological Quality
0-3	“Poor”
4-5	“Reasonably good”
6-8	“Good”
9-10	“Very good”

Data Extraction

In order to extract the various data from the included studies, a Cochrane Collaboration data extraction form was used as a guideline for every article independently. The data are presented in an extraction table and can be found in Appendix II. The content of the extracted data includes:

- The study characteristics:* number of participating subjects; in- and exclusion criteria; type of intervention; duration of intervention; frequency of intervention.
- The patient characteristics:* age; disease specified criteria (type, severity, duration).

-*The data of measuring walking-related outcomes:* in specific matters of testing procedures the 10MWT, the 5MWT, the 5MCWST, the 6MWT at baseline and at post intervention.

Additionally, one data extraction table was drawn up in order to summarize the most determined criteria for reproducibility (table3). The table can be found in the results section of this review.

Best Evidence Synthesis

A best evidence synthesis was done to assess the statistical significance of this study and therefore the findings of the used literature in order to come to an overall finding. The synthesis was based on a significance level (p -value $< 0,05$). For this an analysis as proposed by Van Tulder et al. was used, by taking the methodological quality into account.²⁶ Articles scored with a “good” or “very good” quality by the PEDro scale were considered as high quality articles by the author of this paper in order to be consistent with the terms of the synthesis. The analysis consists of five levels of evidence (1) strong evidence, 2) moderate evidence, 3) limited evidence, 4) conflicting evidence, 5) no evidence) and takes the type of study and its outcome measures into account (table 3).

Table 3: Levels of evidence²⁶

Level	Criteria
Strong Evidence	Consistent, statistically significant findings among at least two high quality RCT's #
Moderate Evidence	Consistent, statistically significant findings among at least one high quality RCT's and at least one low quality RCT or high quality CCT #
Limited Evidence	Consistent, statistically significant findings among at least one high quality RCT # or two high quality CCT's # (in absence of high quality RCT's)
Conflicting Evidence	Consistent, statistically significant findings in at least one high quality CCT or one low quality RCT #
No evidence from trials	In case of results that do not meet the criteria for one of the above stated levels of evidence, or in case of conflicting results among RCT's and CCT's
RCT, Randomized Clinical Trial; CCT, Controlled Clinical Trial; #, If the proportion of studies that show evidence is $< 50\%$ of the total number of studies with the same category of methodological quality and study design, we state no evidence	

RESULTS

Selection of Studies

A total number of 1975 studies were identified via electronic computerized search on the various databases. Based on screening the title and abstract, 17 articles were selected for detailed screening of the full text. A summary of the search process and the main reasons for exclusion can be found in Figure 1. The main exclusion criteria were based on the type of study^{27,28}, the stage of stroke of the participants^{18,29} and the intervention method^{30,31}. Finally seven studies were selected and had met the inclusion criteria for this systematic review.^{15,32-37}. One³³ out of the seven final articles was found by screening of the references of articles and reviews² done on similar topics.

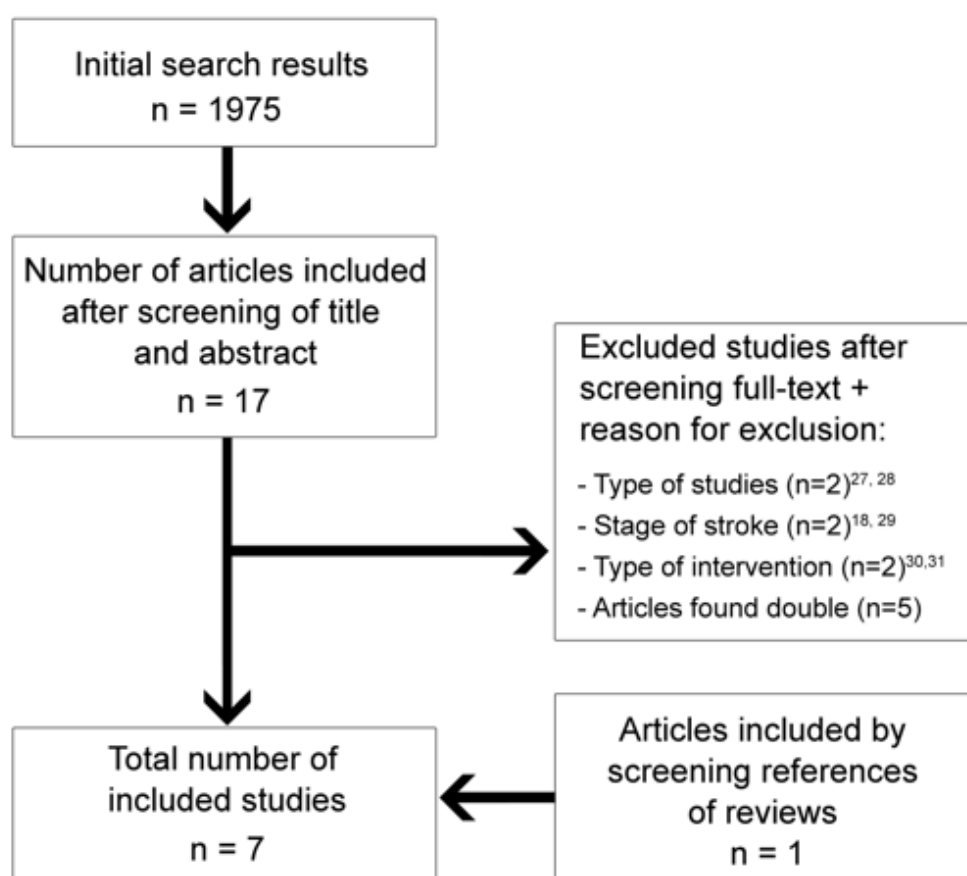


Figure 1. Search strategy

Methodological Quality Assessment

The PEDro scale was used to assess the quality of the included studies. Depending on their score, the articles were classified as "Very good", "Good", "Reasonably good" and "Poor" quality (table 4).¹² All studies included in this systematic review were of at least "Good" quality, four studies had an overall score of eight points^{15,32,35,37} and the remaining three articles^{33,34,36} scored seven points (Appendix III). In neither of the studies, the participants and the therapists were blinded. In the study of Mead et al. the assessor was not blinded.³³ Two of the studies reported no concealed allocation.^{34,36} Statistical

analysis to group differences, point estimates and measures of variability were stated in all of the studies.^{15,32-37}

Data Extraction and Findings

All of the included studies were randomized controlled trials (RCTs) comprising 709 subjects in the experiments. The mean age of all the included participants ranged from 53³⁷ years to 76³⁴ years and the onset time of stroke ranged from 91 days³⁶ to more than five years^{32,34}. The control interventions included training of the upper limbs^{15,32,35}, outpatient usual physiotherapy³⁶, Bobath method³⁷, relaxation intervention including deep breathing exercises³³ and social and educational sessions³⁴. A brief summary of the main characteristics and the outcome measures can be found in table 4.

Table 4: Summarized Study Characteristics (in order of surname of first author)

Author	Type of Study	Mean Age of the Subjects (years)	Intervention	Control Intervention	Duration of the Intervention	Outcome Measure
Dean 2012 ³²	RCT	I: 66,7 C: 67,5	CCT n=76	Upper Limb exercises n=75	40 weeks over a 1-year period	-6MWT (m) -10MWT fast speed (m/s) -10MWT comfortable speed (m/s)
Mead 2007 ³³	RCT	I: 72,0 C: 71,7	CCT n=32	Relaxation/ Breathing exercises n=34	12 weeks	-Comfortable walking through a 17m-circle (m/s)
Mudge 2009 ³⁴	RCT	I: 76,0 C: 71,0	CCT n=31	Educational classes n=27	4 weeks	-6MWT (m) -10MWT (m/s)
Pang 2005 ³⁵	RCT	I: 65,8 C: 64,7	CCT n=32	Upper Limb exercises n=31	19 weeks	-6MWT (m)
Port 2012 ³⁶	RCT	I: 56 C: 58	CCT n=126	Usual outpatient Physiotherapy n=124	12 weeks	-6MWT (m) -5MCWT (m/s)
Salbach 2004 ¹⁵	RCT	I: 71 C: 73	CCT n=44	Upper Limb exercises n=47	6 weeks	-6MWT (m) -5MWT comfortable speed(m/s) -5MWT max. speed (m/s)
Verma 2001 ³⁷	RCT	I: 53,27 C: 55,07	CCT + MI n=15	Bobath treatment n=15	2 weeks	-6MWT (m) -10MWT comfortable speed (m/s) -10MWT max. speed (m/s)
RCT, Randomized Controlled Trial; I, Intervention Group; C, Control Intervention Group; CCT, Circuit Class Therapy; 10MWT, Ten Minutes Walk Test; 6MWT, Six Minute Walk Test; 5MCWT, Five Meter Comfortable Walk Test; 5MWT, Five Meter Walk Test; MI, Motor Imagery;						

Characteristics of the interventions

The frequency of the intervention therapies varied between the studies. Five authors chose to exercise three times per week^{15,32-35}, whereby another study³⁷ performed the interventions seven times per week, and one study³⁶ exercised two times per week with the intervention group, whereas no restrictions were given to the outpatient usual therapy group. The study by Mudge et al. was the only study describing two different frequencies of exercise between the intervention group (three times per week) and the control group (two times per week).³⁴

The duration of the exercise sessions lasted from 40 minutes³⁷ up to 90 minutes³⁶, while one study¹⁵ did not state duration of exercises. However, two of the authors increased the exercise duration depending on the progression of the subjects.^{33,35}

All of the studies exercised in groups supervised by at least one supervisor, physiotherapist or occupational therapist.^{15,32-37} The content of the intervention group exercises was based to increase the walking ability by using gait related activities whereas the goals within the control groups of the studies varied depending on the control intervention. The exact exercises used by the studies can be found in Appendix II.

Dean et al. reported an exercise home program in addition to the exercise intervention for both the intervention and the control group.³² The study by Port et al.³⁶ included a warm-up before the intervention and two studies reported a cooling-down period at the end of each intervention.^{33,34} Port et al. was the only study including an additional group game at the end of the session for the intervention group.³⁶

Effects of the intervention

1) Effect of CCT compared to upper limb exercises

Three out of the seven studies compared CCT to upper limb exercises.^{15,32,35} Dean et al. reported a significant improvement of the intervention group in walking distance ($p < 0,001$) and during the fast walk ($p = 0,03$) after 12 months post-intervention.³² No significant difference was found between the groups at the comfortable walking speed. The study divided the subjects within the groups at baseline into faster walkers and slower walkers with a cut off point of 0,8 m/s walking speed. No significant outcome was recorded when comparing the slower walkers in both the fast walk ($p = 0,75$) and the walking distance ($p = 0,07$) between the two groups. However, the faster walkers of the CCT intervention improved in walking speed ($p = 0,02$) and in walking distance ($p < 0,001$) significantly compared to the faster walkers of the upper limb control group.

Pang et al. measured the difference in walking distance between the two groups. The intervention group receiving CCT as therapy improved significantly ($p = 0,025$) after 19 weeks when compared to the upper limb control group.³⁵

The study by Salbach et al. was the only study stating the results by using a confidence interval (CI 95%) instead of the p-value.¹⁵ The outcome was compared between the two interventions for walking distance and walking speed. Only the walking distance reported significant changes (CI 7,64) in favour of the intervention group.

In summary, walking distance improved significantly in all of the three studies^{15,32,35}. Fast walking in the study by Dean et al. was the only walking speed outcome that improved significantly.³²

2) Effect of CCT compared to relaxation exercises and social/educational sessions

The study by Mead et al. compared CCT to seated relaxation exercises including deep breathing and muscular relaxation.³³ A first comparison was made three months post-intervention and a follow-up

testing after seven months. There was no significant difference between the two groups at walking speed at post-intervention ($p=1,0$), neither after the follow-up ($p=0,14$).

Mudge et al. compared the difference between CCT and social/educational sessions.³⁴ The CCT group had a significant improvement in walking distance ($p=0,03$), but no significant difference was found at the walking speed ($p=0,09$). After the three months follow-up, the CCT intervention group decreased in walking distance ($p=0,116$). However, the walking speed was significantly better in favour of the CCT group after seven months ($p=0,038$) compared to the social/educational group.

In summary, CCT compared to relaxation exercises has shown no significant improvement in walking speed. Mudge et al. reported a significant improvement in walking distance between the CCT group and the social/educational group.³⁴ The walking speed did not show significant results. After three months, no significant results were found for the walking distance, whereas the walking speed increased significantly.

3) Effect of CCT compared to usual outpatient physiotherapy

Port et al. compared walking speed and walking distance between the CCT group and the group receiving usual outpatient physiotherapy.³⁶ Significant results were found in the walking speed ($p<0,001$) and in the distance walked ($p=0,01$) in favour of the CCT group. The same measurements were taken after 24 weeks and compared with those 12 weeks post-intervention. The walking speed improved significantly at the CCT group ($p=0,04$), whereas walking distance showed no significant results ($p=0,06$).

In summary, the walking speed and the distance walked improved significantly in favour of the CCT group after 12 weeks. After the 24-week follow-up, only the walking speed was still significantly better within the CCT group.

4) Effect of CCT compared to Bobath treatment

The study by Verma et al. compared Motor Imagery in addition to CCT to the Bobath technique.³⁷ Measurements taken at the comfortable walking speed ($p=0,04$) and at the walking distance ($p=0,005$) showed significant improvements at post-intervention and at follow-up for the intervention group. The maximum walking speed outcome at post-intervention ($p=0,120$) showed no significant outcome, whereas it was significant ($p=0,045$) in favour of the CCT group after the follow-up period. In summary, besides the maximum walking speed measure at post-intervention, the CCT group showed significant improvements in all of the speed and walking distance outcomes at post-intervention and at follow-up.

Best evidence synthesis

A best evidence synthesis according to van Tulder et al. was performed to analyze the data of the various studies.²⁶ The author of this paper took the participants, the interventions, the controls, the outcomes and the methodological quality of the original articles into account. The study by Salbach et al. was not included in the synthesis due to the use of the confidence interval instead of the p-value to report the outcomes.¹⁵ An overview of the synthesis can be found in table 5.

Table 5: Best evidence synthesis

Author	Control Intervention	Methodological Quality	Outcome Significance (P-value)	
			Walking Speed (Comfortable Walking Speed)	Walking Distance
Dean 2012 ³²	Upper Limb exercises	High	P=0,35	P<0,001
Mead 2007 ³³	Relaxation exercises	High	P=1,0	-
Mudge 2009 ³⁴	Educational classes	High	P=0,090	P=0,038
Pang 2005 ³⁵	Upper Limb exercises	High	-	P=0,025
Port 2012 ³⁶	Usual outpatient physiotherapy	High	P<0,001	P=0,01
Verma 2011 ³⁷	Bobath treatment	High	P=0,04	P=0,005

Since the included studies used different control interventions, it was not possible to apply an overall quality assessment. The studies using the same or similar control interventions were put together and the best evidence synthesis was applied separately to those groups: 1) Upper limb exercises^{32,35} 2) Relaxation exercises/Educational sessions^{33,34} 3) Usual outpatient physiotherapy³⁶ 4) Bobath treatment.³⁷

1) Effectiveness of CCT compared to upper limb exercises

There is strong evidence that the CCT method shows a significant improvement in the walking distance when compared to upper limb exercise due to the significant difference of two high quality RCTs.^{32,35} However, there is no supporting evidence showing that CCT significantly improves the walking speed compared to upper limb exercise. The two studies did not show significant differences between the two groups concerning walking speed.

2) Effectiveness of CCT compared to relaxation exercises and social/educational sessions

Because only one high quality RCT³⁴ stated significant difference, limited evidence exists that CCT improves the walking distance compared to relaxation exercises and social/educational sessions. No evidence can be stated that CCT is a more effective treatment method than relaxation exercises and social/educational sessions to increase the walking speed significantly due to non significant findings of the two studies.

3) Effectiveness of CCT compared to usual outpatient physiotherapy

Only one high quality RCT that showed significant improvement was included in this synthesis.³⁶ Due to this fact, there is limited evidence that CCT leads to a significant change in walking speed and distance compared to usual outpatient physiotherapy treatment.

4) Effectiveness of CCT compared to Bobath treatment

A significant difference was found in favour of the CCT group to improve walking speed and distance. Yet, due to being the only high quality RCT in this synthesis, limited evidence exists for CCT to be a more effective treatment method with regard to improving walking speed and distance significantly compared to the Bobath treatment.³⁷

DISCUSSION

The purpose of this study was to find out if CCT shows better outcomes in walking capacity, in terms of speed and distance compared to individual tailored physiotherapy. The computerized search in various databases provided seven articles to be included in this systematic literature review.^{15,32-37} All of those studies focused on CCT as their intervention method. Three of the included articles compared CCT to upper limb exercises^{15,32,35}, whilst the remaining studies focused on relaxation exercises³³, social sessions³⁴, usual outpatient physiotherapy³⁶ and Bobath treatment³⁷ as their control intervention. In order to assess whether CCT shows better outcomes in walking capacity in comparison to the above mentioned treatment methods, four analyses were done. Due to the use of different control interventions, the groups were separated according to similarity of the intervention; 1) CCT compared to upper limb exercises, 2) CCT compared to relaxation exercises and social sessions, 3) CCT compared to usual outpatient physiotherapy and 4) CCT compared to Bobath treatment.

1) CCT compared to upper limb exercises

Three studies^{15,32,35} were included using upper limb exercises as a control intervention, while one study by Salbach et al. was excluded from the synthesis as it stated the Confidence Interval as an outcome instead of the p-value.¹⁵ Significant results were found in all of the three studies, showing CCT to be more effective in increasing the walking distance than upper limb exercises. Furthermore, the best evidence synthesis has shown strong evidence that CCT significantly improves walking distance compared to upper limb exercises. No evidence was found that CCT is superior to increase walking speed than upper limb exercises. The outcome measurements of the study by Dean et al. were recalculated by the author of this review and his colleagues (HL,JB,HH).³² The difference within groups of the baseline and the post-intervention measures showed slight differences. A reason for the difference has not been found and remains unclear.

The two studies by Dean et al.³² and Salbach et al.¹⁵ divided the participants at baseline depending on their walking speed. Dean et al. stratified the subjects by walking speed with a cut off point of 0,8 m/s above this number as fast walkers and below this number as slow walkers.³² Salbach et al. divided the participants into three levels: mild ($\geq 0,7$ m/s), moderate (0,3 to $< 0,7$) and severe ($< 0,3$ m/s).¹⁵ The fast walkers in the study of Dean et al., improved significantly in both walking speed and distance.³² In the study by Salbach et al. the greatest disparity in the 6MWT between groups was observed in the subjects with a moderate walking deficit.¹⁵ These findings correlate with previous studies reporting most improvements are made by stroke patients in the subacute phase with moderate to severe deficits.^{38,39} However, this does not apply to the study by Dean et al., who used chronic stroke patients.³² According to their findings, the therapy is most effective for patients with mild deficits, leading to the assumption that depending on the phase of stroke, the recovery differs between milder or more severe deficits.

The study by Pang et al. measured VO₂max as criterion measure of cardiorespiratory fitness.³⁵ Post-hoc analysis showed significant improvements in VO₂max in the CCT group in comparison to the

control group. These are important findings, considering that low VO2max levels are related to risks of various forms of cardiovascular diseases.⁴⁰

2) CCT compared to relaxation exercises and social/educational sessions

The two studies by Mead et al.³³ and Mudge et al.³⁴ measured walking speed. However, post-intervention analyses found no significant difference and no evidence was found that CCT significantly improves walking speed. The study by Mudge et al. found a significant change in walking distance in favour of the CCT intervention resulting in limited evidence in the best evidence synthesis.³⁴ However, the baseline measures showed the intervention group to already be able to walk a much longer distance. It is also worth to mention that Mudge et al. used post-intervention and follow-up outcomes with baseline values as covariates.³⁴ Those adjusted means were used to state the p-value and not the observed outcome measures. Both studies did a follow-up assessment three months³⁴ and seven months³³ after the start of the interventions. Mead et al. did not state baseline measures for walking speed, neither the difference between group measurements for post-intervention or follow-up measurements.³³ However, the performance of the intervention group at follow-up on walking speed decreased, whereas the outcome of the relaxation group increased. Mudge et al. stated no significant change in walking distance at the three months follow-up assessment, whereas walking speed did improve significantly.³⁴ An explanation for the significant improvement of walking speed at the follow-up measurement could be that the control group had a greater decline than the intervention group resulting in greater differences than at post-intervention. Yet, it remains unclear whether the wash out period or the intervention of CCT was responsible for the lesser decline in the CCT group. The contradicting outcomes at follow-up do not give a clear picture on maintaining performance after therapy. However, it does show a decline in performance of the CCT group on walking speed³³ and walking distance³⁴.

Some differences between the two studies were found that could have an influence on the outcomes. The duration of the exercise programs differed from 4 weeks by Mudge et al.³⁴ to 12 weeks by Mead et al.³³ Mead et al. described low levels of full attendance of both the intervention group (59%) and the control group (50%).³³

3) CCT compared to usual outpatient physiotherapy

The study by Port et al. showed significance that CCT is a more effective method to improve walking distance and speed when compared to usual outpatient physiotherapy.³⁶ The best evidence synthesis reported limited evidence that CCT leads to a significant change in both walking speed and distance when compared to usual outpatient physiotherapy. Yet, small differences were found at baseline in favour of the CCT group. The well powered study, presenting a sample size of 250 patients, provided 4461 treatment sessions to the CCT group and only 4378 sessions to the control group. The average time of the treatment sessions was 72 minutes for the CCT group and 34 minutes for the outpatient group. Considering the differences of the amount of sessions provided and the time per session to be in favour of the CCT group. Port et al. performed a regression model, including time, group and the interaction between group.³⁶ Additionally, the baseline value of the dependent variable and possible

significant covariates at baseline were added to the model. The reported p-values of the outcomes were stated after applying the regression model.

The follow-up assessment showed no significance between the two groups except for walking speed ($P=0,04$). It should be stated however that the difference at follow-up for walking distance was still high ($P=0,06$). Port et al. suggest therefore that patient's physical condition can still be improved even after being discharged from a rehabilitation centre.³⁶ However, whether the intervention method of CCT is responsible for the follow-up difference is unclear. Further research is suggested to consider this effect.

4) CCT compared to Bobath treatment

The study by Verma et al. found significant improvements in the intervention group on walking distance and walking speed compared to the control intervention.³⁷ Yet, only limited evidence can be reported that CCT improves walking speed and distance significantly compared to Bobath treatment. It is the only study included in this systematic review combining another treatment method, Motor Imagery, additionally to CCT. Verma et al.³⁷ followed the suggestions by Butler et al.⁴¹ and Lang et al.⁴² who stated that the plastic neural networks undergo a positive cortical reorganization post stroke if the therapy implies intensive, task orientated training and Motor Imagery.

The sample size of 30 participants was relatively small, influencing the power of the study. The interventions were applied within two weeks with a high intensity of sessions (seven days per week), which might influence the outcomes. A follow-up assessment was done after six weeks, a comparatively short period following the intervention. However, the follow-up assessment showed significant improvements in both the walking distance and walking speed in favour of the CCT group.

A relevant aspect, when interpreting the high significance of the included studies of this review that have been reported to increase the walking distance, is that all of the studies used gait related activities as treatment in the CCT group.^{15,32-37} When comparing it to the control interventions, only one study focused on walking competency, although the exact exercises have not been described in the study.³⁶ The rest of the included studies focused either on upper limb exercises^{15,32,35}, relaxation exercises³³, educational sessions³⁴ or Bobath treatment³⁷. More studies are needed to compare CCT to other therapy forms, where both interventions use gait related exercises in order to see what is more effective in improving walking distance.

Besides the outcome of walking speed by Mead et al.³³, all of the other studies^{15,32,34-37} reported an improvement in favour of the CCT group. Yet only two studies^{36,37} stated significant differences in walking speed. None of the included studies used specific exercises to improve walking speed, while other studies have shown that it needs to be exercised specifically in order to increase.⁴³

Furthermore, it has been reported that walking speed may overestimate community ambulatory ability.⁴⁴ The Cochrane review by English et al. suggests the 6MWT to be a more clinical meaningful measurement than gait speed.¹⁶ The 6MWT and therefore walking distance has also shown to be significantly associated with the quality of life.⁴⁵ However, a recent study by Bijleveld-Uitman et al.

does not support this theory and states both walking speed and distance are associated with community walking.²¹ According to the findings of Flansbjer et al.⁴⁶ and Fulk et al.²³ the reason for the above mentioned relationship between walking speed and distance, could be the similar aspects of speed tests and the 6MWT.

Clinical Relevance

In order to gain an idea about the clinical relevance, this review took measurements of the Minimal Detectable Change (MDC) and Minimal Clinical Important Difference (MCID) into account.

The MCID reports the smallest change of a score in an outcome measure that would be of benefit to the patient.⁴⁷ Furthermore, it enables professionals to interpret the clinical relevance of changes in an individual post stroke.⁴⁸ This is in contrast to the MDC, which indicates the amount of change that is required to exceed measurement variability.⁴⁹ Tilson et al. furthermore states that the MDC shows the smallest change on an outcome measure that would be considered “real”.⁴⁸

Perera et al.⁵⁰ reported a MCID for the 6MWT of 50m, whereas Tilson et al.⁴⁸ stated 0,16m/s as MCID for gait speed. Flansbjer et al. showed the MDC for both the 6MWT and gait speed. The study reported MDC values of 36,6m for the 6MWT and 0,16m/s for gait speed.⁴⁶ The above mentioned measurements were used to give more insight into the clinical relevance of the included studies.

The study by Mead et al. was not taken into account, due to the missing baseline measurements.³³ Outcome measurements at post-intervention between groups were used for the MCID and the MDC. Two studies^{34,37} did not state the outcome measurements for the between group difference. These measurements were therefore calculated by the author of this review, with the help of the given baseline and post-intervention measurements.

A MCID of the 6MWT was found by two studies and can be considered as a meaningful improvement in walking distance.^{32,37} None of the outcomes of the others studies did reached the MDC and are likely to be due to measurement variability.^{15,34-36} The outcomes of gait speed did not reach MCID or MDC in any of the studies.^{15,32,34-37}

Quality of Studies

An important consideration when interpreting the outcome of the best evidence synthesis is the methodological quality of the included studies. Although the studies have been rated as “high quality” using the PEDro scale, due to splitting up of the studies according to their control intervention in the synthesis, the amount of high quality RCTs per synthesis was low. This automatically lows the level of evidence. Another relevant aspect to consider when interpreting the outcomes and the synthesis is the sample size, which influences the power of the studies. According to Hintze et al. the ideal power of any study is 80%.⁵¹ Power analysis in the current review was done by five studies.^{15,32,34,35,37} However, only two^{15,32} out of the five studies calculated the 80% power to detect a significance based on the 6MWT. The rest calculated the 80% power based on outcomes not taken into account by this review. The sample sizes of the included articles ranged from 30 in the study by Verma et al.³⁷ to 250 used by Port et al.³⁶

Findings of previous Reviews

Four other systematic reviews have been done on the same topic.^{2,16,52,53} However, the included studies used were different compared to the current review. This systematic review excluded the studies used by those four reviews due to the type of study⁴⁸, the stage of stroke^{18,29} or due to the intervention and outcome measures used^{30,31}. The overall outcome of the review by Wevers et al. showed improvements of walking distance and speed in favour of CCT. Furthermore the author suggests that CCT is more beneficial if it is provided in the subacute phase rather than in the chronic phase of stroke.² Tsaih et al. concluded that 12 to 57 hours of walking-related circuit class training sessions seem to be beneficial to improve the outcome of the 6MWT at various stages of stroke.⁵³

The Cochrane review and English et al. both found CCT to be effective in improving walking distance and speed.^{16,52}

Strengths and Weaknesses of the Study

Although other reviews have been done with the aim to find out about the effectiveness of CCT compared to other treatment methods, this paper also included current studies on the topic. This is considered to be a strength of this study. Due to the various control interventions of the included studies, it was not possible to come to one overall conclusion, which can be seen as a disadvantage. However, in the author's opinion this systematic review gives a more specific view on the effects of CCT solely compared to the various control interventions.

A weakness of this study is that an inexperienced researcher carried out the search procedure independently. This may mean that during the search process potential relevant articles have been missed. Furthermore, due to limited access to full text articles some publication bias is possible. However, the article was peer reviewed by three colleagues (HL, HH, JB) for methodological faults and readability, minimising these biases.

The unavoidable subject variations, variable treatment programs and different control interventions among the included studies are clearly a disadvantage when it comes to comparing and generalizing of the outcomes. The author tried to account for this difficulty by setting strict inclusion and exclusion criteria. However due to the limited number of articles present regarding the effectiveness of CCT, it was nevertheless difficult to avoid.

Implications for Future Research

This systematic literature has shown that there is a need for more high quality articles comparing CCT to a control interventions including gait related activities, in order to come to an overall conclusion about the efficacy of CCT in relation to other current treatment modalities. Port et al. is a good example of using that approach³⁶. Furthermore, the effects of CCT regarding stroke severity as well as its long-term effectiveness have not yet been investigated in detail. Therefore future researchers should take the severity level of the stroke subjects into account and attempt to find out about the effect of CCT on the different levels, unlike how it was done by Dean et al.³² and Salbach et al.¹⁵ The studies included in this review use different lengths of intervention, diverse therapy frequencies and durations per session, demonstrating the lack of knowledge about the optimal length, frequency and

duration of CCT. Furthermore, CCT could be a cost saving therapy method for the rehabilitation of stroke. A study by Port et al. investigated the effectiveness and cost effectiveness of CCT compared to usual face to face outpatient treatment. The results of this study were expected in August 2011, but are not yet available.⁵⁴

Implications for Practice

In order to be able to apply CCT as a therapy form, several requirements and criteria need to be described. CCT can be performed on every patient group, independent of sex and age of the participants. It can be applied worldwide, either in a hospital setting or in a private practice. Since it is performed in a group and several workstations are needed, enough space is a precondition. Furthermore, no extra training material is needed in order to apply the therapy. The training itself must be task oriented and a therapist-patient ratio of 1:3 has been recommended to be feasible for CCT^{2,16}. Although, homogeneous findings of length, frequency and duration of the therapy are not yet established well, according to the findings, this review suggests a frequency of at least three times per week. The duration of the therapy should last at least 60 minutes per session, even though rehabilitation centres might use an even higher intensity of therapy sessions, shown to be effective by Verma et al.³⁷ Having this in mind, CCT offers a training principle that is cost saving, effective, applicable to a wide range of patients and easy to apply, and is thus recommended to health care professionals.

CONCLUSION

The findings of this systematic review show strong evidence that CCT improves walking distance compared to upper limb exercises. Limited evidence was found showing that CCT is more effective in increasing walking distance than social/educational sessions and relaxation exercises, usual outpatient physiotherapy and Bobath treatment. With respect to walking speed, limited evidence was reported that CCT improves walking speed significantly when compared to usual outpatient physiotherapy and Bobath treatment. No evidence was found that CCT is more effective than upper limb exercises, social/educational sessions and relaxation exercises to increase walking speed.

CCT, presenting a lower ratio of staff per patients, is a cost saving method for the rehabilitation of stroke patients. Due to the group and workstation setting, it saves time for therapists, gives patients a chance to exercise more intensively and enhances social interaction. CCT is a therapy form that can easily be applied on a wide range of stroke patients, the workstations can be adjusted to the individual needs of the patients without any extra training material needed and thus recommended to professionals to use.

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* Literature according to the Fontys Writer's Guide 2012

APPENDICES

- Appendix I. Keywords and Search String
- Appendix II. Data Extraction of Included Studies
- Appendix III. PEDro Scores of Included Studies
- Appendix IV. Assessment Form of Project Plan

Appendix I. Keywords and Search String

Category	Patient group	Intervention	Outcome measures
Keywords/Synonyms	"Stroke"	"physical therapy"	"walking"
	"cerebrovascular disease" (CVA)	"rehabilitation"	"ambulation"
	"cerebrovascular accident"	"circuit training"	"locomotion"
		"circuit class training"	"mobility"
		"circuit class therapy"	"walking capacity"
		"group training"	"walking distance"
		"task training"	"walking speed"
		"group task training"	"participation"
		"group task therapy"	"gait"
		"task specific"	"gait endurance"
		"community based"	"gait rehabilitation"

Search string:

"stroke" OR "cerebrovascular disease" (CVA) OR "cerebrovascular accident" AND "physical therapy" OR "rehabilitation" OR "circuit training" OR "circuit class training" OR "circuit class therapy" OR "group training" OR "task training" OR "group task training" OR "group task therapy" OR "task specific" OR "community based" AND "walking" OR "ambulation" OR "locomotion" OR "mobility" OR "walking capacity" OR "walking distance" OR "walking speed" OR "participation" OR "gait" OR "gait endurance" OR "gait rehabilitation"

Appendix II. Data Extraction of the Included Studies

Dean³², 2012: Exercise to enhance mobility and prevent falls after stroke: the community stroke club randomized trial

<u>Characteristics of study</u>	Method of intervention: WEBB program: calf raises while standing, sit-stand, step-ups, standing with reduced base of support, graded reaching activities in standing and forward, backward, sideways stepping and walking	Method of control intervention: Upper limb function: manage upper limb contracture with task related strength and coordination training, improve cognition with matching, sorting and sequencing tasks.	Duration + Frequency of interventions: 40 weeks over a 1-year period; home exercises 3x/week	
<u>Characteristics of participants</u>	Stroke data: Side of brain lesion (n): 34 right side in intervention group; 28 right side in control group	Age of participants (years) mean: 66,7 intervention group; 67,5 control group	Number of participants: 76 intervention group; 75 control group	Inclusion criteria: Suffered >1 stroke; able to walk 10m independently with/without aid; medical clearance; join the NSW Stroke Recovery Association; commit to weekly exercise and home program for 12 months. Exclusion criteria: Folstein Mini- Mental State Exam score <20; insufficient language skills; medical condition such as cardiovascular disease;
<u>Outcome Measures</u>	Speed: 10MWT (comfortable speed P=0,35; fast speed) P=0,03 (m/s)	Distance: 6MWT(m) P<0,001		
10MWT, Ten Meter Walk Test; 6MWT, Six Meter Walk Test				

Mead³³, 2007: Stroke: A Randomized Trial of Exercise or Relaxation

<u>Characteristics of study</u>	Method of intervention: Cycle ergometry, raising and lowering a exercise ball, shuttle walking, standing chest press, between each circuit station patients walked, upper back strengthening, triceps ext both seated using elastic band, pole-lifting exercise in standing, sit to stand et; cool down; Stair climbing and descending exercise was added in week 4.	Method of control intervention: Seated: deep breathing and progressive muscular relaxation; techniques involved: muscular contraction	Duration + Frequency of interventions: 12 weeks, 3x/week	
<u>Characteristics of participants</u>	Stroke data: Side of brain lesion (n): 12 right side, 19 left side of intervention group; 15 right side, 18 left side of control group; Type of stroke(n): 28 Ischemic type, 4 Hemorrhagic(or unknown)type of intervention group; 32 Ischemic type, 2 Hemorrhagic(or unknown) type of control group	Age of participants(years)mean: 72 intervention group; 71,7 control group	Number of participants: 32 intervention group; 34 control group	Inclusion criteria: Independently ambulatory, living within central or south Edinburgh, absence of dysphasia or confusion severe enough to prevent informed consent or impair safety in exercises classes, absence of medical contraindications to exercise training(uncontrolled angina pectoris, resting systolic blood pressure >100mmHg, resting heart rate>100 beats per minute, unstable or acute heart failure, uncontrolled systemic illness, uncontrolled visual or vestibular disturbance, recent injurious fall without medical examination, and proven inability to adhere to exercise program)
<u>Outcome Measures</u>	Speed: Comfortable walking velocity measured around a marked 17m circuit (m/s) P=1,0	Distance: -		

Mudge³⁴, 2009: Circuit-Based Rehabilitation Improves Gait Endurance but Not Usual Walking Activity in Chronic Stroke: A Randomized Controlled Trial

<u>Characteristics of study</u>	Method of intervention: Exercises: sit to stand, self sway, standing balance, step ups, balance beam, standing hamstring curl, tandem walk, swiss ball squats, tandem stance, calf raise, backwards walk, lunges, side leg lifts, marching in place, obstacle course;	Method of control intervention: Educational classes, quiz, card games, discussions;	Duration + Frequency of interventions: 4 weeks, 3x/week	
<u>Characteristics of participants</u>	Stroke data: Side of brain lesion, (n): 20 right side, 11 left side of intervention group; 14 right side, 12 left side, 1 brain stem/other of control group;	Age of participants(years) mean: 76 intervention group; 71 control group	Number of participants: 31 intervention group; 27 control group	Inclusion criteria: 1 or more strokes more than 6months earlier; discharged from rehab; walk independently (with aid if necessary); gait difficulty was required –less than 2 on at least 1 of the walking items of physical functional scale of the 36-Item Short Form Health-Survey. Exclusion criteria: Progressive neurological disease, other significant health problems that affect walking ability, more than 2 falls in the previous 6 months, unstable cardiac conditions, uncontrolled hypertension, or congestive heart failure.
<u>Outcome Measures</u>	Speed: 10MWT (m/s) P=0,090	Distance: 6MWT (m) P=0,030		
10MWT, Ten Meter Walk Test; 6MWT, Six Meter Walk Test				

Pang³⁵, 2005: A Community-based Fitness and Mobility Exercise (FAME) Program for Older Adults with Chronic Stroke: a Randomized Controlled Trial

<u>Characteristics of study</u>	Method of intervention: Brisk walking, sit to stand, stepping onto low risers, walking in diff directions, tandem walking, walking through an obstacle course, sudden stops and turns while walking, walking on diff surfaces, standing on a foam, standing with one foot in front of the other, kicking ball with foot, partial squats, toe raises	Method of control intervention: Shoulder muscle strength, elbow/wrist strength, hand activities	Duration + Frequency of interventions: 19 weeks, 3x/week	
<u>Characteristics of participants</u>	Stroke data: Paretic side (left)(n): 19 in intervention group; 22 in control group; Type of stroke (n): Ischemic stroke: 18 in intervention group; 19 in control group;	Age of participants(years) mean: 65,8 intervention group; 64,7 control group	Number of participants: 32 intervention group; 31 control group	Inclusion criteria: Single stroke more than 1 year onset, age>50y., ability to walk>10m independently with or without walk aid, living at home. Exclusion criteria: History of serious cardiac disease, uncontrolled blood pressure, pain while walking, neurological conditions in addition to stroke, other serious diseases that preclude the individual from participating in the study
<u>Outcome Measures</u>	Speed: -	Distance: 6MWT(m) P=0,025		
6MWT, Six Meter Walk Test				

Port³⁶, 2012: Effects of circuit training as alternative to usual physiotherapy after stroke: randomised controlled trial

<u>Characteristics of study</u>	Method of intervention: (1) standing and reaching; (2) stair walking including transfer; (3) walking and picking up various objects from the ground; (4) kicking a ball; (5) stepping up and down; (6) walking course with obstacles; (7) transfers (lying to standing and sitting); and (8) speed walking. Graded progression will be achieved by (1) increasing the difficulty of the task; (2) adding weights; or (3) increasing the number of repetitions. No special (fitness) equipment is needed to perform the tasks.	Method of control intervention: Outpatient physiotherapy, one to one treatment, sessions to improve standing balance, physical condition, walking competency according to Dutch Physiotherapy Guidelines ¹² . No restrictions to content, time or duration of therapy	Duration + Frequency of interventions: 12 weeks, 2x/week	
<u>Characteristics of participants</u>	Stroke data: Side of brain lesion (n): 57 right hemisphere, 49 left hemisphere, 6 brainstem, 14 cerebellum of experimental group; 61 right hemisphere, 43 left hemisphere, 14 brain stem, 6 cerebellum of control group; Type of stroke (n): 103 Ischaemic, 23 Haemorrhagic of intervention group; 100 Ischaemic, 24 Haemorrhagic of control group	Age of participants (years) mean: 56 intervention group; 58 control group	Number of participants: 126 intervention group; 124 control group	Inclusion criteria: Stroke according to WHO definition, completed an inpatient rehab, walk a min of 10m without physical assistance, discharged home from rehab centre, need to continue physiotherapy during outpatient care to improve walking or physical condition or both, be able to give informed consent and be motivated to participate in a 12 week intensive programme of physiotherapy Exclusion criteria: Cognitive deficits evaluated by mini-mental state exam < 24 points, unable to communicate or lived more than 30km from rehab centre
<u>Outcome Measures</u>	Speed: 5MCWT (m/s) P<0,001	Distance: 6MWT (m) P=0,01		
5MCWT, Five Meter Comfortable Walk Test; 6MWT, Six Meter Walk Test				

Salbach¹⁵, 2004: A task-orientated intervention enhances walking distance and speed in the first year post stroke: a randomized controlled trial

<u>Characteristics of study</u>	Method of intervention: 10workstations: sitting at a table and reaching in different directions for objects located beyond arms length to promote loading of the affected leg and activation of leg muscles. Sit to stand. Stepping forward,backward,and sideways onto blocks of various heights. Heel lifts in standing. Standing with base of support constrained, feet in parallel and tandem conditions reaching for objects. Reciprocal leg flexion and ext using kinetron in standing. Standing up from chair,walking short distance and returning to chair. Walking on treadmill. Walking over slopes and stairs	Method of control intervention: Upper extremity functional tasks. Manipulating cards, using a keyboard and writing. Practise these tasks at home.	Duration + Frequency of interventions: 6weeks, 3x/week	
<u>Characteristics of participants</u>	Stroke data: Side of brain lesion (n): 27 right hemisphere, 17 left hemisphere of intervention group; 24 right hemisphere, 22 left hemisphere, 1 bilateral of control group; Type of stroke (n): 40 Ischaemic, 4 Haemorrhagic of intervention group; 36 Ischaemic, 11 Haemorrhagic of control group	Age of participants(years) mean: 71 intervention group; 73 control group	Number of participants: 44 intervention group; 47 control group	Inclusion criteria: Diagnosis of 1st or recurrent stroke, residual walking deficit resulting from most recent stroke, mental competency using the Mini-Mental-state Examination, walk 10m independently (aid or orthotic) with or without supervision, ability to comprehend the instructions for testing procedures, residence in the community, discharge from rehab, time interval between the most recent stroke and time of recruitment of one year or less Exclusion criteria: Neurological deficit caused by metastatic disease, recovery of walking ability, defined as the achievement of age-and gender specific norms on the 6MWT that were computed using a regression equation, discharge to a permanent care facility, comorbidity precluding participation in either intervention
<u>Outcome Measures</u>	Speed: 5MWT (comfortable speed) 0,03;0,19 CI(95%); (maximum speed) 0,12;0,30 CI(95%) (m/s)	Distance: 6MWT (m) 7,64 CI(95%)		
5MWT, Five Meter Walk Test; CI, Confidence Interval; 6MWT, Six Meter Walk Test				

Verma³⁷,2011: Task-Oriented Circuit Class Training Program with Motor Imagery for Gait Rehabilitation in Poststroke Patients: A Randomized Controlled Trial

<u>Characteristics of study</u>	Method of intervention: MI: walking in a real life situation, previous way of walking, practice of a missing component during walking, walking with long steps, fast walking, running, jumping, symmetrical walking, goal directed walking; standing activities: sit to stand, standing unsupported, standing with eyes closed, standing unsupported with feet together, reaching, picking object and turning while standing, one limb standing; Walking related activities: walking through obstacles, walking for a goal, walking while picking up objects, walking carrying a object, stepping-forward and sideward, stair climbing, fast walking	Method of control intervention: Bobath treatment	Duration + Frequency of interventions: 2weeks, 7x/week	
<u>Characteristics of participants</u>	Stroke data: Side of brain lesion (n): 8 right hemisphere, 7 left hemisphere of intervention group; 7 right hemisphere, 8 left hemisphere of control group; Type of stroke(n): 11 Ischaemic, 4 Haemorrhagic of intervention group; 12 Ischaemic, 3 Haemorrhagic of control group	Age of participants (years) mean: 53,27 intervention group; 55,07 control group	Number of participants: 15 intervention group; 15 control group	Inclusion criteria: First episode of unilateral stroke with hemiparesis during the last month, functional ambulation classification level II and above ability to understand instructions (Hindi mental state examination [HMSE] >24), ambulatory before stroke, ability to cope with the intensive training program, ability for mental imaging(Movement Imagery Questionnaire—revised second version [MIQ-RS] ≥ 25), and National Institutes of Health Stroke Scale (NIHSS) score less than 14 Exclusion criteria: History of any other neurological pathology such as Parkinson disease and epilepsy, conditions affecting balance, neglect,

				dementia, impaired vision, impaired conscious level, concomitant medical illness, musculoskeletal conditions affecting lower limbs, cardiovascular instability (resting systolic blood pressure > 200 mm Hg and resting diastolic blood pressure > 100 mm Hg), and serious cardiac conditions (hospitalization for heart disease within 3 months, active angina, serious cardiac arrhythmias, hypertrophic cardiomyopathy, severe aortic stenosis)
<u>Outcome Measures</u>	Speed: 10MWT (comfortable speed) P=0,04 ; (maximum speed) P=0,120 (m/s)	Distance: 6MWT (m) P=0,005		
MI, Motor Imagery; 10MWT, Ten Meter Walk Test; 6MWT, Six Meter Walk Test				

Appendix III. PEDro Scores of Included Studies

Study	1)	2)	3)	4)	5)	6)	7)	8)	9)	10)	11)	Total Score
Dean et al	YES	1	1	1	0	0	1	1	1	1	1	8
Mead et al	YES	1	1	1	0	0	0	1	1	1	1	7
Mudge et al	YES	1	0	1	0	0	1	1	1	1	1	7
Pang et al	YES	1	1	1	0	0	1	1	1	1	1	8
Port et al	YES	1	0	1	0	0	1	1	1	1	1	7
Salbach et al	YES	1	1	1	0	0	1	1	1	1	1	8
Verma et al	YES	1	1	1	0	0	1	1	1	1	1	8
1) Eligibility criteria 2) Randomization 3) Concealed allocation 4) Similar groups at baseline 5) Blinding subjects 6) Blinding therapist 7) Blinding assessor 8) Measured key outcome >85% subjects 9) All subjects received intervention as allocated or intention to treat analysis 10) Results between group statistical comparison 11) Point measurement and measures of variability												

Appendix IV. Assessment Form of Project Plan

B4 Assessment form project plan

Name: Julian Kainz

Student no: 21474086

Date: 26/4/2017

Title: ~~Does CCT have a better outcome in terms of walking capacity when compared to individualized treatment~~
stroke patients PT in

General

- The project plan is according to format yes / no
- Spelling and language are correct yes / no

Problem description and problem definition (introduction)

- The problem description is sufficiently clearly formulated yes / no
- The problem description reflects social and paramedical relevance yes / no
- A concrete and relevant research question (or questions) can be formulated based on the problem definition, including possible sub questions yes / no

Objective

The objective is:

- Sufficiently clearly and concretely formulated yes / no
- Relevant for a selected target group within the (paramedical) professional practice yes / no
- Practically feasible yes / no
- Achievable within the set time yes / no

Project product

The project product:

- Is in line with the problem definition, research question and objective yes / no
- Is usable for the selected target group yes / no
- Is in line with the client's wishes yes / no
- The product requirements are accurately described yes / no

Activities/method

Sufficient insight is given into the type of activities and types of sources for the performance of the research and the realization of the product

yes / no

Time schedule

- The time schedule gives a global phasing and time investment for the project as a whole and for the coming weeks an increasingly detailed schedule yes / no
- Important moments are recorded in the table (typographically noticeable) (e.g. contact moments, handing-in moments) yes / no
- The time schedule gives a global task division of the planned activities yes / no

Estimated costs

Clear insight is given in:

- The costs to be expected concerning money and hours yes / no
- The division of these costs (project leader, student, programme) yes / no

Literature

- Used and planned literature is specific and mentioned to a sufficient extent yes / no
- Relevant and recent literature is referred to yes / no
- Literature references, in the text and in the literature list, are made according to the Writer's Guide (Wouters 2012) yes / no

Comments:

Method section is clear. Have to make some adjustments in the data analysis section. The research question has to be 'what is the effect of ...' not a question. The funnel has to be sharper in the intro. But it is clear what the student is going to do. y/n

All points under B3.1 up to and including B3.8 must be answered with a 'yes' in order to receive a GO for the project. The supervisor discusses with the student which points need adjustment.

GENERAL:

GO

Name assessor:

Date + Signature

R. Wouda



26-5-2013

Jago Jansen

26-5-2013