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Does physiotherapy based on the Bobath concept, in conjunction with a task practice, achieve greater improvement in walking ability in people with stroke compared to physiotherapy focused on structured task practice alone? A pilot randomized controlled trial

Kim Brock[1], Gerlinde Haase[2], Gerhard Rothacher[2] and Susan Cotton[3]

Abstract

Objective: To compare the short-term effects of two physiotherapy approaches for improving ability to walk in different environments following stroke: (i) interventions based on the Bobath concept, in conjunction with task practice, compared to (ii) structured task practice alone.

Design: Randomized controlled trial.

Setting: Two rehabilitation centres

Participants: Twenty-six participants between four and 20 weeks post-stroke, able to walk with supervision indoors.

Interventions: Both groups received six one-hour physiotherapy sessions over a two-week period. One group received physiotherapy based on the Bobath concept, including one hour of structured task practice. The other group received six hours of structured task practice.

Outcome measures: The primary outcome was an adapted six-minute walk test, incorporating a step, ramp and uneven surface. Secondary measures were gait velocity and the Berg Balance Scale. Measures were assessed before and after the intervention period.

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Results: Following the intervention, there was no significant difference in improvement between the two groups for the adapted six-minute walk test (89.9 (standard deviation (SD) 73.1) m Bobath versus 41 (40.7) m task practice, $P = 0.07$). However, walking velocity showed significantly greater increases in the Bobath group (26.2 (SD 17.2) m/min versus 9.9 (SD = 12.9) m/min, $P = 0.01$). No significant differences between groups were recorded for the Berg Balance Scale ($P = 0.2$).
Conclusion: This pilot study indicates short-term benefit for using interventions based on the Bobath concept for improving walking velocity in people with stroke. A sample size of 32 participants per group is required for a definitive study.

Keywords
Stroke, physiotherapy, rehabilitation, bobath concept, walking, randomised, controlled trial

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Introduction

A key goal of stroke rehabilitation is regaining independence in walking. There is strong evidence (Level II) that repetitive task practice of walking is beneficial.[1] While practice of walking is an essential component for regaining walking ability, the effectiveness of other widely utilized physiotherapy interventions for improving walking is less clear. A recent systematic review of the efficacy of the Bobath concept demonstrated mixed findings for improving mobility following stroke, based on the results of seven studies.[2] Two studies yielded an enhanced benefit for the Bobath concept[3,4] compared to other approaches, one study showing no difference between two approaches,[5] and four studies showed enhanced benefit from alternate or adjunctive treatments, including treadmill training,[6] problem-orientated willed movement[7] and rhythmic auditory clapping.[8,9] The review concluded that further high quality trials need to be conducted.[2]

The purpose of this study was to determine whether the use of the Bobath concept, in conjunction with structured task practice, was more effective in improving walking ability than therapy focused on structured task practice alone. In the contemporary understanding of the Bobath concept, it is acknowledged that task practice is a key component of rehabilitation, and that practice should be context specific and varied.[10] The Bobath concept is best viewed as a framework for interpretation and problem solving of the individual patient's presentation, along with their potential for improvement.[11] Components of motor control that are specifically emphasized are the integration of postural control and task performance, the control of selective movement for the production of coordinated sequences of movement and the contribution of sensory inputs to motor control and motor learning.[10] Task practice is a component of a broad approach to treatment that includes in-depth assessment of the movement strategies utilized by the patient to perform tasks, and identification of specific deficits of neurological and neuromuscular functions. These include deficits in motor control, both postural and task related, sensory and perceptual functions, cognition, such as motor planning, and musculoskeletal problems, such as muscle shortening and weakness.[12] Interventions are designed to improve postural and movement strategies utilized by the patient and restore, at least to some degree, the neurological and neuromuscular functions that underlie motor function.

In this study, we addressed rehabilitation of patients with moderate to severe stroke at the time point where the patient has achieved the ability to walk in indoor environments without assistance but still requires supervision. Recovery of walking ability includes not only

practise of walking in indoor environments but also a range of environmental contexts, such as those experienced walking outdoors.[13] Patients who are able to walk indoors are keen to extend their skills and achieve independence in a wide range of situations. This pilot study was designed as a preliminary study towards the goal of determining the optimal approach to achieving this transition from walking indoors to walking outdoors.

The hypothesis for the study was that interventions based on the Bobath concept, in conjunction with structured task practice, would improve walking ability more than structured task practice alone.

Methods

This study was a prospective, multicentre randomized controlled trial with blinded outcome assessment. Participants in this study were recruited by consecutive sampling from two rehabilitation centres: St Vincent's Hospital Melbourne, Victoria and Kliniken Schmieder, Gailingen, Germany. Patients were eligible for the study if they fulfilled the following inclusion criteria:

- first or recurrent stroke, haemorrhage or infarct;
- between four weeks and 20 weeks post-stroke at commencement of trial;
- currently participating in an inpatient or outpatient rehabilitation programme;
- able to walk 15 metres indoors on a level surface, with or without an aid, with supervision.

Exclusion criteria were:

- independent mobility indoors achieved within four weeks post-stroke;
- premorbid mobility limited to walking indoors only;
- unable to follow single stage verbal commands with visual prompts;
- mobility disability due primarily to pathologies other than stroke.

The study was approved by the human research ethics committees of the two participating institutions. All participants provided written informed consent prior to participation.

Randomization was done through a computer-generated, stratified, blocked randomization procedure. Patients were stratified according to time period from date of stroke to date of commencement in the trial. The two strata were four weeks to eight weeks post-stroke at commencement of the trial and more than eight weeks post-stroke. This stratification aimed to improve the likelihood of the two groups being similar in terms of initial severity and speed of recovery post-stroke, as those with milder stroke and a quicker rate of recovery are likely to improve more rapidly during the time period of the study. Separate computer-generated randomizations were used for each site. Opaque envelopes were used to conceal group allocation. Participants were randomized and assigned to the intervention groups after the baseline assessments were carried out.

Intervention

Participants in both groups received six one-hour physiotherapy sessions over a two-week period. During the intervention period, participants did not receive any other physiotherapy aimed at improving mobility, posture, balance or lower limb function. Instead, the intervention sessions replaced the usual physiotherapy treatment for mobility. Additional physiotherapy was provided in sitting or lying for other rehabilitation goals, such as independence in bed mobility and recovery of upper limb function.

Intervention A was based on the Bobath concept. In this intervention, participants received individual treatment prescription based on the Bobath concept towards the goal of improving walking ability in different environmental contexts. This intervention included detailed assessment of the individual's movement strategies and the neurological and neuromuscular deficits underlying motor dysfunction. Treatment strategies were individualized and aimed at both

reducing the severity of impairments where they impacted on function, and optimizing postural and movement strategies to improve efficiency and maximize function.

Two detailed examples of interventions based on the Bobath concept for patients post-stroke who are able to walk independently but are limited in their ability to walk are described in Raine *et al.*[11,14] These examples show assessment, clinical reasoning and intervention processes related to assessment findings. Interventions described include:

- facilitated activation of postural activity and selective movement in the affected hip and knee in various postures including supine, standing and single leg stance;
- enhancing foot contact and balance through improving alignment of the talocrural joint, activation of musculature of the foot and shank, and facilitation of ankle strategy;
- facilitation of core stability during tasks of lying to sitting, and in standing;
- facilitation through a wide variety of postures requiring complex rotation movements to improve midline orientation.

These interventions are representative of the type of interventions utilized in this study with the aim of improving walking ability.

The specific goal of therapy in this study was to improve the ability of the participant to walk safely in different environments, including components of endurance, walking on slopes, going up and down a single step and walking over rough ground. The session incorporated structured task practice (as described below) for 1/6 of the treatment time allocated.

Participants receiving Intervention B undertook physiotherapy based on structured task practice. The supervised exercise programme aimed to provide repeated task specific practice of environmental contexts frequently encountered in walking outdoors. The tasks practised focused on increasing endurance, walking on slopes, going up and down a single step and walking over rough ground. Based on principles of motor learning, the therapist provided instruction in how to perform the task, including demonstration, verbal cueing to correct ineffective adaptive motor patterns and feedback on the performance of the task as specified by the study protocol, as well as supervision for safety. The therapist did not provide hands-on assistance or guidance during tasks.

Half of the task practice component was conducted as repetitive practice using standardized equipment in the gymnasium, reflecting the closed skill stage of learning. The other half of the time was spent in environments outside the gymnasium, walking on varying surfaces indoors and outdoors, bringing in other environmental contexts, such as differing attentional demands and changes in direction.

Both interventions were performed by physiotherapists with at least five years' postgraduate experience and at least two years' experience in the fields of rehabilitation or neurology. In addition, therapists providing Intervention A had to have also completed a Basic Bobath Course and at least two Advanced Bobath Courses (a minimum of 180 hours of formal training acquired over a minimum of three years).

Main outcome measures

Measures were taken at baseline, and following treatment, by a physiotherapist who was blind to group assignment. Post-intervention assessment measures were recorded between one and five days following the intervention. The main outcome measure was an adapted six-minute walk test.[15] This measure was chosen to simulate walking in various environmental contexts, relating to the goal of the interventions. The adapted test utilized a walkway 12.5 metres long, and included a purpose built ramp and step, and thin, foam floor mats. The timber ramp had a gradient of 1:6, with dimensions of 1,000 mm in width, 960 mm in length and 160 mm in height at the highest point. The step was 1,000 mm in width, 750 mm in length and 160 mm in height. The ramp and step abutted each other and 25 mm non-slip strips were

Table 1. Baseline demographic characteristics of the control and experimental groups

Variables	Bobath Intervention ($n = 12$)	Task Practice Intervention ($n = 14$)
Age (years)	61.3 (13.0) [35–75]	56.6 (15.8) [29–77]
Post-stroke duration (days)	60.3 (24.0) [29–101)	63.6 (25.9) [40–126)
Gender (%)		
Male	7 (58.3)	12 (85.7)
Female	5 (41.7)	2 (14.3)
Pathology (%)		
Infarct	8 (66.7)	9 (64.3)
Haemorrhage (%)	2 (16.7)	4 (28.6)
Both	2 (16.7)	1 (7.1)
Side of hemiplegia (%)		
Right	2 (16.7)	10 (71.4)
Left	9 (75.0)	3 (21.4)
Bilateral	1 (8.3)	1 (7.1)
Gait aid used		
3 or 4 wheely walker	4	1
Single point stick/hiking pole	1	3

Note: Values are mean (SD) [range] or frequency (percentage).

applied to the surface every 150 mm. The participants crossed these obstacles in both directions during every 25 m of the test. The foam mats were 2,100 mm by 1,100 mm and 20 mm thick, with a firm foam density. Two mats, one placed on top of the other, were used to mimic an unstable surface for walking. Non-slip fabric was used underneath and between the mats to prevent slippage. Each participant had two practice runs prior to the initial assessment to familiarize themselves with the task. Two therapists walked with the participant during the test for safety, one on either side of the participant. If hand contact was made to steady the participant during a trial, that trial was discarded. If the participant was unable to walk the circuit without requiring hand contact on at least one attempt, then the assessment was deferred for one week then attempted again. The adapted six-minute walk circuit, with the specific equipment described, was not utilized during the practice sessions for either group.

Prior to the commencement of this study, the inter-rater and test-retest reliability of the adapted six-minute walk test was investigated. Fourteen participants able to walk independently with or without an aid following stroke were recruited to this preliminary study. Two assessors simultaneously measured the distance covered on Day 1, and this was repeated on Day 2. Intra-rater reliability was calculated, using Day 1 and Day 2 measures, yielding ICCs (2,1) of 0.98, $P < 0.001$ and 0.99 ($P < 0.001$). Inter-rater reliability was similarly high, with an ICC (2,1) 0.98, $P < 0.001$. This high level of reliability is similar to the reliability of the standard six-minute walk test in community dwelling people with stroke.[15]

Two additional measures were included: walking velocity[16] and the Berg Balance Scale.[17] These measures were chosen as measures most likely to reflect improvement related to the interventions provided, i.e. a more efficient and fluent gait pattern and improved

balance. Walking velocity was measured using a stop watch over the central six metres of a 10-metre walkway, while the participant walked at their usual walking speed. Reliability and validity of this measure is well established.[16] For both tests of walking ability, participants used their usual gait aid. If a gait aid was used in the initial assessment, the same aid was used in the post-treatment assessment. Gait aids used during assessment are listed in Table 1. The Berg Balance Scale is an ordinal scale of 14 balance tasks, with each task scored between 0 (cannot perform) to 4 (normal performance). Inter-rater and test-retest reliability and aspects of validity have been established for this scale.[17,18]

Data analysis

A series of analysis of covariance (ANCOVA) were conducted with the group as the between subject variable, the covariate as initial scores and the dependent variable as final scores. Significance was set at $P < 0.05$ for the primary outcome measure and $P < 0.025$ for secondary measures. In addition, t test for independent samples was utilized for assessing difference between groups at baseline and paired t tests were performed to assess within group change. Post hoc power analysis was utilized to determine the sample size required for a definitive trial.

Results

Twenty-nine participants were recruited to the study. The flowchart for recruitment and retention is shown in Figure 1, showing that 26 participants completed the study. Note that two participants did not complete the study because they were discharged from inpatient rehabilitation earlier than anticipated and could not

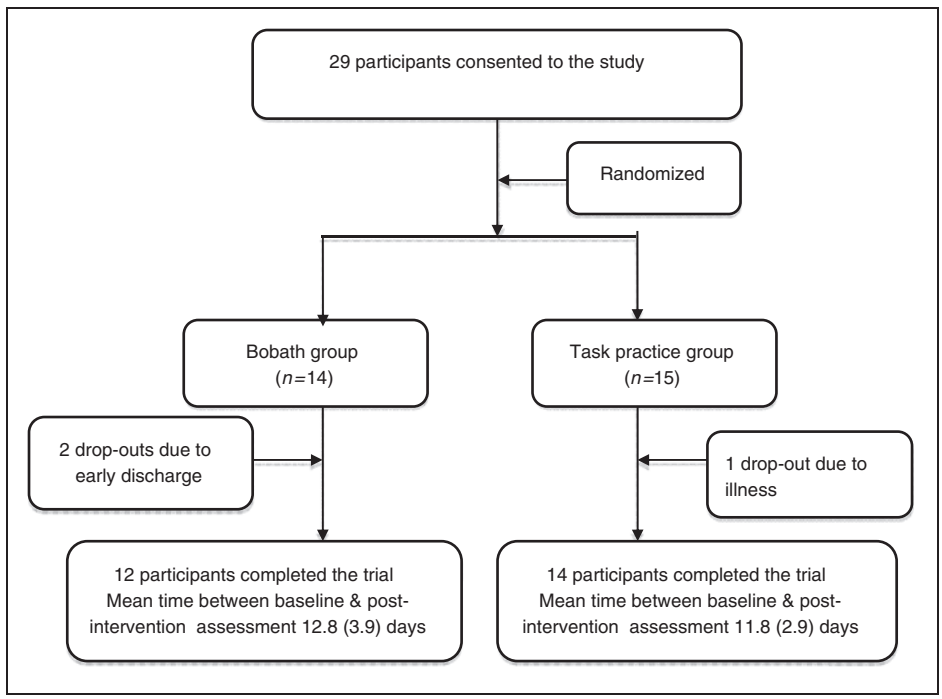

Figure 1. Flowchart for recruitment and retention of participants.

complete the study as outpatients. One participant was withdrawn due to ill health. No data are available regarding the number of patients eligible to participate or reasons for not participating. However, for both centres, the main limiting factor to recruitment was planned discharge to a distant locality shortly after achieving walking with supervision, preventing participation.

Demographic and medical data for both groups are provided in Table 1. Nineteen participants were recruited at St Vincent's Hospital and 10 were recruited at Kliniken Schmieder, Gailingen. Other than those participants who withdrew, all participants completed the intervention and assessment procedures. Time between completion of the intervention and the post-treatment assessment was 12.8 (SD = 3.9) days for the Bobath intervention and 11.8 (SD = 2.9) days for the structured task practice intervention.

Table 2 shows the pre- and post-test measures for both groups. There were no significant differences between groups at baseline for the six-minute walk test ($P = 0.79$), gait velocity ($P = 0.27$) and Berg Balance Scale ($P = 0.77$). Both groups improved significantly on all measures during the intervention period. For the adapted six-minute walk test, difference between groups did not reach significance; $F(1,23) = 3.49$, $P = 0.07$, though there was a trend towards greater improvement in the Bobath intervention group. Calculation of effect size showed a large effect, Cohen's $d = 0.83$. The results demonstrate a significant difference in gait velocity for those in the Bobath intervention compared to the task practice intervention, $F(1,23) = 6.83$, $P = 0.01$ There were no significant differences between the groups for the Berg Balance Scale. Comparisons were also made between the two groups for each site of the study. Due to the small numbers, only mean improvement was considered. Both sites showed a similar pattern, with the mean of improvement in the Bobath intervention group being higher than the task practice group for each of the outcome measures at both sites.

Sample size calculations for a definitive trial utilized between group differences in change scores for the six-minute walk test. With alpha set at 0.05, power at 0.9, and a two-tailed test, 32 participants per group are required for a definitive trial.

Discussion

This preliminary study investigated the efficacy of interventions based on the Bobath concept in

Table 2. The mean (standard deviation) for all outcome measures of subjects in both treatment groups at pre- and post-test

	Intervention A Group		Change scores (post-pre)	*P*-value[a]	Intervention B Group		Change scores (post-pre)	*P*-value[a]	*P*-value[b]
	Pre-Rx	Post-Rx			Pre-Rx	Post-Rx			
Adapted six-minute walk test(m)	102.6 (64.5)	192.5 (113.5)	89.8 (73.1)	<0.01	78.5 (61.3)	119.5 (80.2)	41 (40.7)	<0.01	=0.07
Gait velocity (m/min)	30.6 (16.2)	56.8 (28.3)	26.2 (17.2)	<0.001	26.4 (18.9)	36.2 (27.9)	9.9 (12.9)	<0.02	=0.01
BBS	40.2 (6.1)	47.3 (4.6)	7.1 (3.1)	<0.001	43.3 (5.7)	47.4 (5.0)	4.0 (4.6)	<0.01	=0.2

[a]Significance level for within-group comparison.
[b]Significance level for between-group comparison.

conjunction with task practice, compared to task practice alone, for improving walking ability in patients with moderate to severe stroke, who were able to walk with supervision. The study did not show a significant difference between groups for the primary outcome measure, the six-minute walk test, though a trend was observed for greater improvement for those in the Bobath concept group, with a large effect size. Both groups improved significantly between the pre- and post-intervention tests.

For gait velocity, those in the Bobath concept group achieved greater improvement in comparison to those participating in structured task practice alone. Gait velocity is a key outcome parameter for walking ability, as it has been shown to have strong correlations with many temporal and spatial components of gait,[19,20] with gait energy expenditure and energy cost[21] and ability to walk in the community.[22] The mean difference between groups for gait velocity recorded in this study, 16.3 m/min, is similar to the mean difference in gait velocity between groups recorded by Eich *et al.*[6] (9 m/min, favouring treadmill training in conjunction with the Bobath concept, following a six-week period of training) and Thaut *et al.*[8] (13.1 m/min, favouring rhythmic auditory stimulation, following a three-week period of training). For the Berg Balance Scale, both groups improved between the pre- and post-interventions assessments. There were no significant differences between the groups.

Five previous studies have investigated the efficacy of interventions based on the Bobath concept utilizing outcome measures used in this study. Four of these studies investigated gait velocity, with two studies[6,8] favouring other interventions compared to the Bobath concept, one study showing no differences between groups,[5] and one favouring the Bobath Concept.[4] One study[3] utilized the Berg Balance Scale as an outcome measure, favouring the Bobath concept. Comparisons between these studies and the current study are difficult because of major differences in inclusion criteria, comparator interventions or intervention and assessment time frames.

In this study, interventions based on the Bobath concept were investigated in a holistic manner, without attempting to standardize the treatment interventions. Interventions were developed in response to the individual's presentation; their functional level, movement strategies, and specific deficits from the lesion. A process of clinical reasoning was used to develop the treatment interventions trialled, and treatments were adapted according to the patient's response. It has been argued by Pollock *et al.*[23] that 'future research should concentrate on investigating the effectiveness of clearly described individual techniques and task-specific treatments, regardless of their historical or philosophical origin'. The authors of this study question this statement. In testing the Bobath concept holistically, inclusive of assessment and clinical reasoning, we are investigating the effectiveness of the application of the concept to the specific rehabilitation goal of recovery of walking ability. The focus on a specific goal of treatment provides some common themes in treatment (as can be observed in published case examples[11,14]), while not reducing the interventions to a list of techniques.

The design of this study reflects a snapshot in time at a particular stage of rehabilitation. We chose to do this for three reasons. First, we aimed to have participants who were similar in ability, with regard to their independence level in walking, and working towards the same functional goal. Second, we chose a short intervention period of six treatments to ensure that the interventions were delivered in the manner intended, and that there was no contamination of the intervention delivery. This problem has been identified as a possible cause for failure to show differences between different types of treatment.[5] Third, we chose to assess the immediate post-intervention period only, again, because participants are likely to receive aspects of the other intervention in their ongoing therapy as an

inpatient and/or outpatient, washing out any difference in effect between the two treatments for the time period of the study. Investigating specific rehabilitation goals for patients at a specific stage of their recovery over a specific time frame may be a useful approach for future research, compared to previously published studies comparing treatment approaches that assessed global outcomes for patients with wide ranging levels of ability over the entire rehabilitation episode.[5,24]

With regard to the limitations of the study, the sample size was small and therefore a larger, adequately powered study is necessary to answer this question definitively. Also, it is important to note that there were no longer-term follow-up assessments and that differences observed were in the immediate post-treatment phase only. Therefore, we do not know whether the difference in improvement in gait velocity between the groups was maintained over time. We can say that more improvement in walking ability occurred in those treated with the Bobath concept during the time period of the study. This observation still has value as patients are usually keen to improve their walking ability as quickly as possible and walking ability is often a determinant of discharge from rehabilitation.

The outcomes of the study indicate that, for people with moderate to severe stroke, who are able to walk unassisted but require supervision, interventions based on the Bobath concept, combined with task practice, are likely to be more beneficial in terms of gait velocity at this time point than task practice alone. This suggests that treatment based on the key areas of focus in the Bobath concept (integration of postural control and task performance, the control of selective movement for the production of coordinated sequences of movement and the contribution of sensory inputs to motor control and motor learning), in conjunction with treatment aimed at the specific neurological and neuromuscular deficits identified in the individual, are beneficial in the recovery of walking ability.

Clinical message

- For patients with moderate to severe stroke, who are able to walk with supervision, interventions based on the Bobath concept, in conjunction with task practice, may be more beneficial than structured task practice alone for improving gait velocity. A larger clinical trial, with a sample size of 64 participants, is required to answer this question definitively.

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Conflict of interest

Authors Kim Brock and Gerlinde Haase are members of the International Bobath Instructor Training Association and teach short courses for postgraduate physiotherapists for a teaching fee.

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