Outcomes of the Bobath concept on upper limb recovery following stroke

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Received 6th December 2003; returned for revisions 30th March 2004; revised manuscript accepted 30th May 2004.

Objective: To determine the effectiveness of the Bobath concept at reducing upper limb impairments, activity limitations and participation restrictions after stroke.

Methods: Electronic databases were searched to identify relevant trials published between 1966 and 2003. Two reviewers independently assessed articles for the following inclusion criteria: population of adults with upper limb disability after stroke; stated use of the Bobath concept aimed at improving upper limb disability in isolation from other approaches; outcomes reflecting changes in upper limb impairment, activity limitation or participation restriction.

Results: Of the 688 articles initially identified, eight met the inclusion criteria. Five were randomized controlled trials, one used a single-group crossover design and two were single-case design studies. Five studies measured impairments including shoulder pain, tone, muscle strength and motor control. The Bobath concept was found to reduce shoulder pain better than cryotherapy, and to reduce tone compared to no intervention and compared to proprioceptive neuromuscular facilitation (PNF). However, no difference was detected for changes in tone between the Bobath concept and a functional approach. Differences did not reach significance for measures of muscle strength and motor control. Six studies measured activity limitations, none of these found the Bobath concept was superior to other therapy approaches. Two studies measured changes in participation restriction and both found equivocal results.

Conclusions: Comparisons of the Bobath concept with other approaches do not demonstrate superiority of one approach over the other at improving upper limb impairment, activity or participation. However, study limitations relating to methodological quality, the outcome measures used and contextual factors investigated limit the ability to draw conclusions. Future research should use sensitive upper limb measures, trained Bobath therapists and homogeneous samples to identify the influence of patient factors on the response to therapy approaches.
Introduction

As 69% of strokes affect the upper limb, a major goal of stroke rehabilitation is to improve upper limb function. Recent research has investigated the effect of approaches including electromyographic feedback, task-related training, bilateral training, and constraint-induced therapy. The Bobath concept was first developed in the 1950s and is the most commonly used approach for stroke rehabilitation. However, the effectiveness of this approach on upper limb outcomes is currently not known.

The Bobath concept is based on a number of assumptions. These assumptions have evolved from those published by Berta and Karl Bobath, in conjunction with advances in neuroscience and movement sciences. The most recent text by Berta Bobath in 1990 describes abnormal coordination of movement patterns combined with abnormal postural tone as the primary problems experienced by people with hemiplegia. These were seen as the result of lack of inhibition within the central nervous system (CNS). The treatment emphasis was on the therapist normalizing tone and facilitating automatic and volitional movement through specific handling of keypoints (pelvis, trunk, shoulder girdles, and hands and feet).

Lennon describes the evolution of the Bobath concept in response to the development of the systems model for motor control and the role of neuroplasticity in recovery. Abnormal tone and mass movement patterns were interpreted as plastic responses of the CNS brought about by the patient’s compensatory attempts to move. The aim of intervention focused on relearning normal movement through experience with active participation of the patient. An emphasis on postural control and selective movement using specific handling remained core features of intervention.

A summary of the current assumptions underlying the Bobath concept has been published on the International Bobath Tutors Association website. The concept is described as a problem-solving approach that emphasizes the multifactorial nature of movement dysfunction and the active participation of the individual to achieve optimal motor learning. Handling or facilitation is described as the application of specific proprioceptive input, such as stretch or joint compression that demands an active response from the patient during performance of a functional task. This handling is modified and gradually withdrawn as the individual becomes more efficient and independent in the motor task. The therapist integrates improved control into function and participation in daily life. In summary, the principles of intervention based on the Bobath concept are the importance of postural control as a basis for movement and the use of specific handling by the therapist to achieve motor goals.

Two previous systematic reviews on the effect of upper limb therapy after stroke provide some comparison of the effect of the Bobath concept to other therapy approaches. However, the Bobath intervention in the included studies was not clearly defined or it was used in conjunction with other approaches. Therefore, in these reviews, it is difficult to attribute the upper limb outcomes to the use of the Bobath concept. Another systematic review, investigating the effectiveness of the Bobath concept after stroke, had well-defined inclusion and exclusion criteria relating to the Bobath intervention. However, only three databases were searched and key words relating to the upper limb were not used. Accordingly, we conducted a systematic review of the literature to determine the effectiveness of the Bobath concept on upper limb recovery after stroke.

Method

Study identification and selection

A reviewer (CL) searched electronic databases (CINAHL, MEDLINE, EMBASE, DARE, Cochrane Library, PEDro, PubMed, AMED, AMI, CSA Neurosciences and Psych Info) back to 1966 using a strategy of keywords (refer to Appendix). Each database search strategy is available from the author (CL). Citation tracking of all key article reference lists was also conducted. The search was limited to full papers written in English and published in peer-reviewed journals. The reviewers (CL and KD) independently determined if articles identified by the initial search strategy satisfied the following inclusion criteria: (1) a population of adults (18 years or older) diagnosed with a stroke; (2) stated use of the Bobath concept or neurodevelopmental therapy in isolation.
(i.e., not in conjunction with other approaches such as Proprioceptive Neuromuscular Facilitation, or motor learning); (3) a control for Bobath intervention in the form of either a group with no intervention, or a group with a comparison intervention, or a baseline phase; and (4) an outcome measure reflecting change in upper limb impairment, activity limitation or participation restriction. Only articles satisfying all criteria relating to population, intervention and outcome were included.

Quality assessment
Two reviewers (CL and KD) independently evaluated the methodological quality of the included articles. The quality of clinical controlled trials was rated with the PEDro Scale.20 This scale rates the following 10 aspects of methodological rigor as being either absent or present: randomization; concealment of treatment allocation; differences between groups at baseline; blinding of therapists; blinding of patients; blinding of outcome assessors; greater than 85% follow-up for at least one key outcome; intention to treat analysis; between-group statistical analysis for at least one key outcome; and point estimates of variability provided for at least one key outcome. Trials using single-case research designs were evaluated using a checklist of 12 criteria developed specifically for this review from Ottenbacher21 and Zhan and Ottenbacher.22 These criteria included the adequacy of explicit inclusion criteria; description of the intervention; systematic control of the intervention; appropriateness of time period of intervention for changes to occur; validity and reliability of outcome measures; randomization of interventions; blinding of the outcome assessor; establishment of a stable baseline; adequate number of data points; replication of the intervention effect; and appropriateness of the statistical analysis. The quality of each trial was rated by allocating one mark for each criterion met.

Data analysis
Outcomes were examined in terms of the three health domains described by the International Classification of Functioning and Disability (ICF).23 Impairment measures reflect changes in muscle activation, co-ordination, tone and strength. Activity restriction measures reflect changes in ability to perform tasks such as grasping and lifting an object. Participation restriction measures reflect changes in ability to perform work, leisure, family and other societal roles. Consistent with the ICF guidelines, we also examined the influence of environmental and personal contextual factors on outcomes.

To compare the outcomes across the clinical controlled trials, effect sizes (d) with 95% confidence intervals (CI) were calculated using web-based software.24 This software subtracts the mean of the control group post intervention from the mean of the Bobath group post intervention and then divides this by the pooled standard deviation of both groups. The 95% CIs were calculated using the critical value of t divided by the square root of the sample size.25

Results
A yield of 688 studies was obtained from the initial search strategy. Only eight of these met the inclusion criteria. Of these, five were randomized controlled trials,26–30 one used a single-group cross-over design,31 one used an alternating B-C-B-C single-case research design,32 and one used a mixed single-case A-B and randomized control trial design.33 Study characteristics are summarized in Table 1.

The methodological quality of the studies was generally poor. Quality scores obtained for the clinical controlled trials were five,30 two27,28,31 and one26,29 out of ten. Scores obtained for the single-case design studies were six32 and one33 out of twelve. Of the randomized controlled trials, none adequately reported the randomization procedures used. Five of the trials did not report blinding of assessors,26,29,31–33 four inadequately described concealment of treatment allocation,26,27,29,30 and only two reported point estimates and measures of variability for the primary outcome measures.27,30 In the two single-case design studies, blinding of the outcome assessor was not reported, therapies were not randomly assigned, a stable baseline was not adequately established and the intervention effect was not replicated across settings or clinicians. Therefore, all results should be interpreted with caution.
Impairment

Five trials investigated the effect of Bobath intervention on impairments including shoulder pain, muscle tone, muscle strength, and motor control. Motor control refers to the initiation and co-ordination of muscle activity during a movement. Figure 1 shows the results of the clinical controlled studies that reported sufficient data to calculate effect sizes for impairment measures. A meta-analysis (that is a statistically combined estimate of effect size and associated 95% CI across the different trials) was not performed because of the heterogeneity of outcome measures.

As Figure 1 shows, there is some limited evidence that interventions based on the Bobath concept can reduce muscle tone. Dickstein and Pillar in a study of 27 subjects who had experienced a stroke from six weeks to two years before the trial commenced, found that within a single therapy session the application of resting inhibiting patterns (which are sometimes used as a component of Bobath intervention) could significantly reduce biceps tone in patients with upper limb hypertonus. In this publication, tone referred to muscle overactivity. The effect size was 0.46 favouring Bobath intervention with confidence limits from 0.01 to 0.91. A randomized controlled trial by Dickstein et al. found Bobath intervention was more effective than the Proprioceptive Neuromuscular Facilitation (PNF) approach at reducing muscle tone. However, there was no significant difference between the effect of Bobath intervention and a functional approach on muscle tone. A functional approach involves repetitive and structured part or whole practice of a task.

There is some evidence that interventions based on the Bobath concept can improve shoulder pain better than cryotherapy. Partridge et al. investigated 65 stroke patients with shoulder pain and found that after four weeks of intervention the proportion of patients reporting no pain was significantly greater for patients receiving Bobath intervention compared to those receiving cryotherapy. In addition, the Bobath group reported pain less often ($p < 0.05$). However, after a further four weeks of therapy no significant difference was detected between the groups for pain outcomes.

The Bobath concept was found to be only as effective as other approaches at improving muscle strength. Dickstein et al. found no significant difference between the effect of Bobath intervention, PNF and functional approaches on wrist strength measured by manual muscle testing and pulling a gauged spring. There is some weak evidence from a within-group analysis that wrist-strengthening exercises in addition to Bobath intervention may be more effective than Bobath intervention alone at improving wrist strength for patients with active wrist and finger extension using a digital grip analyser, piezoelectric force transducer and a piezoelectric accelerometer.

The Bobath concept appeared to be no more effective than other approaches at improving motor control. Basmajian et al. found the effect size of Bobath intervention compared to a functional approach on the finger oscillation test to be $d = -0.02$. Dickstein et al. found no significant difference between the effect of Bobath intervention, PNF and functional approaches on active wrist range of movement measured by a goniometry.

Activity limitation

Six of the eight studies included in this review used a measure of activity limitation. Figure 1 shows the individual effect sizes from trials where sufficient data were reported. As the figure shows, individual effect sizes did not demonstrate significant differences between the effects of the Bobath concept and the effects of other approaches. Gelber et al. did not detect a significant difference between Bobath and functional retraining groups on the Nine Hole Peg Test or the Block and Box test. Significant differences were not detected between the groups for change scores using the Upper Extremity Function Test, the Barthel Index, Motor Assessment Scale, Sodring Motor Evaluation Scale and the Action Research Arm Test. Butefisch et al. concluded that for higher level patients, wrist-strengthening exercises in addition to Bobath intervention were more effective than Bobath intervention alone at improving upper limb activity as measured by the Rivermead Motor Assessment Scale.
<table>
<thead>
<tr>
<th>Study</th>
<th>Inclusion criteria</th>
<th>Sample size</th>
<th>Age mean (years) (range)</th>
<th>Type of CVA</th>
<th>Time since stroke</th>
<th>Training of therapists</th>
<th>Control intervention</th>
<th>Therapy programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dickstein and Pillar 1983</td>
<td>Degree of hypertonus in limbs</td>
<td>Not specified</td>
<td>Not reported</td>
<td>Not specified</td>
<td>6 weeks – 2 years post CVA</td>
<td>‘Therapists experienced in all methods’ 2 refresher courses Familiarity with text books</td>
<td>No intervention</td>
<td>1 session</td>
</tr>
<tr>
<td>Dickstein et al. 1986</td>
<td>Clear minded</td>
<td>131</td>
<td>70.5</td>
<td>MCA</td>
<td>16 days</td>
<td>‘Specially trained therapists’</td>
<td>Functional activities PNF</td>
<td>30–45 min 5 ×/week 6 weeks</td>
</tr>
<tr>
<td>Basmajian et al. 1987</td>
<td>Able to communicate and follow instructions</td>
<td>29</td>
<td>62 (39–79)</td>
<td>MCA</td>
<td>Early severe and late mild</td>
<td></td>
<td>Intergrated behavioural physiotherapy</td>
<td>3 × 45 min exact per week 3 weeks</td>
</tr>
<tr>
<td>Wagenaar et al. 1990</td>
<td>40–80 years CT</td>
<td>7</td>
<td>Mean age not reported (40–77)</td>
<td>MCA infarct</td>
<td>5–9 days post CVA</td>
<td></td>
<td>Brunnstrom Method</td>
<td>Daily 30 min 20 weeks</td>
</tr>
<tr>
<td>Partridge et al. 1990</td>
<td>No memory or comprehension deficits</td>
<td>65</td>
<td>64 (40–86)</td>
<td>Not specified</td>
<td>Average 33 weeks (3 weeks – 9.5 years)</td>
<td></td>
<td>Cryoetherapy</td>
<td>Daily for the first 5 days then at therapist discretion for 4 weeks</td>
</tr>
<tr>
<td>Butefisch et al. 1995</td>
<td>CVA Shoulder pain for at least 2 weeks</td>
<td>27</td>
<td>61.5 (35–80)</td>
<td>Not specified</td>
<td>3–19 weeks post CVA</td>
<td></td>
<td>Wrist strengthening</td>
<td>2 × 15 min daily Duration unclear</td>
</tr>
<tr>
<td>Gelber et al. 1995</td>
<td>No trophic changes, pre-existing shoulder pain, recent shoulder fracture, arthroplasty or dysphasia</td>
<td>27</td>
<td></td>
<td>Pure motor</td>
<td>&lt; 1/12 post CVA</td>
<td></td>
<td>Functional retraining</td>
<td>Not reported</td>
</tr>
<tr>
<td>Langhammer and Stanghelle 2000</td>
<td>First CVA – infarct No cognitive, language, visual, sensory, bilateral motor deficits No premorbid use of assistive device</td>
<td>61</td>
<td>79 (49–95)</td>
<td>Control group</td>
<td></td>
<td>‘Trained therapists’</td>
<td>Motor Relearning Programme</td>
<td>5 ×40 min Duration of rehab admission</td>
</tr>
</tbody>
</table>

The table presents a summary of studies on the effectiveness of the Bobath Approach on the upper limb after stroke. Each study is identified by the name of the author(s) and the year of publication. The inclusion criteria, sample size, age range, type of CVA, time since stroke, training of therapists, control intervention, and therapy programme are listed for each study.
<table>
<thead>
<tr>
<th>Impairment outcome</th>
<th>EMG*</th>
<th>Muscle tone*</th>
<th>Finger oscillation test</th>
<th>None</th>
<th>Verbal rating scale on severity, frequency* of shoulder pain. Shoulder external rotation range of motion</th>
<th>Grip strength#</th>
<th>Isometric hand extension#</th>
<th>None</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity outcome</td>
<td>None</td>
<td>Barthel Index</td>
<td>Upper Extremity Function Test</td>
<td>Action Research Arm Test</td>
<td>None</td>
<td>Rivermead Motor Assessment – arm section#</td>
<td>Box &amp; Block Test Nine Hole Peg Test</td>
<td>Motor Assessment Scale</td>
<td>Sodring Motor Evaluation Scale</td>
</tr>
<tr>
<td>Participation outcome</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Length of stay</td>
<td>Discharge destination</td>
</tr>
</tbody>
</table>

CVA, cerebral vascular accident; CT, diagnosed by computerized tomography; PNF, proprioceptive neuromuscular facilitation; MAS, Motor Assessment Scale; EMG, electromyography.

*Indicates a significant result for Bobath intervention; # indicates a significant result for the control intervention.
Participation

Two studies investigated the effect of intervention on participation restriction. Langhammer and Stanghelle\textsuperscript{30} failed to find a significant difference between Bobath intervention and a motor relearning programme using the Nottingham Health Profile. However, patients receiving Bobath intervention had significantly longer hospital stays than patients participating in a motor relearning program, which would limit their societal participation in the short term. In the longer term, no significant difference in discharge destination was found between the Bobath group and the motor relearning programme group. Gelber \textit{et al.}\textsuperscript{20} found no significant difference between Bobath intervention and a functional approach on length of hospital stay.

Environmental factors were similar across the studies. All interventions were given by a physiotherapist, on a one-to-one basis, in a gymnasium setting. The frequency of all treatments was 30–45 minutes and provided five times per week with the exception of one study\textsuperscript{27} that provided treatment three times per week. All patients were in patients of a rehabilitation unit. Duration of the treatment programme varied from five weeks\textsuperscript{27} to 20 weeks\textsuperscript{32} and within a study depending on length of rehabilitation stay.\textsuperscript{30}

Therapist training was poorly described in all studies. Three studies referred to the therapist as “trained” without further description\textsuperscript{26,29,32} and another study devised a manual from text books.\textsuperscript{30} Four studies provided no information about therapist training.

The effect of personal contextual factors on the outcome of Bobath intervention has not been thoroughly investigated. There was a broad age range of subjects in each study and the effect of this factor was not analysed. The time since stroke varied within and between studies from five to nine days after stroke\textsuperscript{32} to up to nine years after stroke.\textsuperscript{28} Two studies investigated strokes of the
middle cerebral artery specifically\textsuperscript{27,32} and failed to find a significant effect of Bobath intervention. Two other studies investigated patients with motor deficits only and excluded patients with sensory loss and cognitive deficits.\textsuperscript{29,33} These studies failed to find a significant effect.

The effect of other impairments on the response to a therapy approach has not been thoroughly investigated. Wagenaar \textit{et al.}\textsuperscript{32} tested subjects on 15 neuropsychological deficits, including comprehension and neglect, at the beginning of each phase in a single case design study comparing the Bobath and Brunnstrom approaches. However, no comment was made on the relationship between neuropsychological factors and response to each approach.

Adverse effects of Bobath intervention such as pain or fatigue were not reported in any of the studies. Dropouts occurred due to subjects moving to a different community or death.

\section*{Discussion}

The poor quality of the trials reviewed severely limits the conclusions that can be drawn. However, it seems that currently there is no evidence that interventions based on the Bobath concept are more effective than other approaches, with all studies finding nonsignificant differences between groups for measures of impairment, activity and participation. One study showed an improvement in muscle over-activity after the use of reflex inhibiting postures.\textsuperscript{31} However, the Bobaths discouraged the use of these postures in their 1990 publication. There is some evidence that strengthening exercises given in conjunction with Bobath intervention are more effective at improving wrist strength and upper limb activity than Bobath intervention given alone.\textsuperscript{33} However, this finding should be viewed with caution, because this study, which used a mixed single-case and group research design, contains serious methodological flaws. With respect to the single-case A-B research design, weekly data points were presented for only three of the 27 patients, making visual analysis of the changes impossible, and statistical analysis of change in slope, level and range was not reported for any of the outcome measures. With respect to the group design, all 27 participants were given four weeks of Bobath therapy then allocated to either a strength training and Bobath group (four weeks) or a TENS (two weeks, a placebo treatment) then strength training (two weeks) group, the statistical analyses used in this part of the study simply investigated a series of pre-post group analysis with no between-group data or analyses reported.

The conclusions of this review are consistent with previous systematic reviews, despite the more specific inclusion criteria. This review identified different papers to two previous systematic reviews.\textsuperscript{17,18} Hiraoka\textsuperscript{17} conducted a meta-analysis of upper limb intervention after stroke and found that there was no significant difference between Bobath intervention and conventional physiotherapy $(d = -0.01)$. Van der Lee \textit{et al.}\textsuperscript{18} also conducted a systematic review of exercise therapy on arm function after stroke and failed to find evidence that one approach was more effective than the other.

The inability to detect differences between the therapy approaches may be due to study design factors such as the choice of outcome measures. Retest reliability has not been reported for any of the impairment measures and three of the activity measures used in the trials reviewed. The five studies that used functional scales for activity did not find a significant difference between therapy approaches.\textsuperscript{26,27,32,30,33} These assessment tools have ordinal rating scales, which may not be sensitive enough to distinguish between effects of interventions.

Lack of consideration of external contextual factors may also have limited the findings in the studies. The amount of Bobath training the therapists in the studies received may have limited the ability to detect a difference between the approaches. None of the studies adequately described the Bobath training of the therapists. Studies on gait and mobility that reported using trained Bobath therapists all found a significant effect of Bobath intervention.\textsuperscript{34–37}

The equivocal results of the literature may also be due to a lack of consideration of personal contextual factors. Heterogeneous samples without stratification for personal factors may limit the ability to detect a difference in intervention effect. Given that stroke patients vary widely on
Clinical messages

- There is currently no evidence that Bobath intervention is more or less effective than other therapy approaches for upper limb rehabilitation following stroke.
- The small number of studies have major design limitations.
- Future research should use a homogeneous sample of patients with stroke, sensitive upper limb assessments and trained Bobath therapists.

Factors such as physical impairments, cognitive impairments, speech impairments, severity of impairments, in addition to individual personality and learning styles, it cannot be assumed that one approach will be superior for all individuals and at every stage of their recovery. It is not known if Bobath intervention is more beneficial for certain subgroups of stroke patients. For example, is one approach more effective for patients with severe paresis? Is one approach more effective for chronic stroke patients? Factors such as depression, cognition, comprehension, spatial awareness and sensory loss could also have an impact on the response to an approach.

Although this is a comprehensive review, the results may be limited by factors relating to the search strategy. The search strategy only included papers written in English and published in a peer review journal. No attempt was made to contact key authors or search for grey literature. These factors could have introduced some bias to the results.

It is suggested that future studies compare the effect of the Bobath concept to other approaches using sensitive, reliable outcome measures, trained Bobath therapists and a homogenous sample of stroke patients. Research on specific sample groups would provide therapists with clinical indicators to choose the most appropriate approach for each individual patient at their particular stage in recovery.

Studies in this review were conducted over a period of 13 years. During that time developments have occurred in the theoretical assumptions and practice of the Bobath concept. This suggests that the treatment interventions provided in these studies may have varied greatly, despite the use of the encompassing term. A further problem is the lack of clear description of the theoretical assumptions and definitions of the Bobath concept which make it difficult to evaluate the principles that underpin the intervention. Therefore it is important that future studies clarify the analysis and interventions used within the Bobath concept to enable accurate evaluation of the study and the potential for replication.

References


Appendix – Search strategy

The search used both mesh terms and free text in title and abstract

1# Stroke
2# CVA
3# Cerebrovascular accident
4# Cerebrovascular disorder
5# Cerebral ischaemia
6# Cerebral haemorrhage
7# Cerebral infarction
8# Brain injury
9# Hemiplegi*
10# Hemiparesis
#11 #1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10
#12 Neuromuscular facilitation
#13 Bobath
#14 NDT
#15 Neurodevelopmental therapy
#16 Therapeutic facilitation
#17 Proprioceptive facilitation
#18 #12 or #13 or #14 or #15 or #16 or #17
#19 Arm
#20 Hand
#21 Upper limb
#22 Upper extremity
#23 #19 or #20 or #21 or #22
#24 #11 and #18 and #23