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SUMMARY WITH CRITICAL APPRAISAL

Bobath Therapy for Patients with Neurological Conditions: A Review of Clinical Effectiveness, Cost-Effectiveness, and Guidelines

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Abbreviations

AMSTAR	Assessing the Methodological Quality of Systematic Reviews
BMI	Body mass index
cm	centimetre
CogLog	Cognitive Log
COP	Centre of foot pressure
CRD	Centre for Reviews and Dissemination
FAI	Frenchay Activities Index
FAT	Frenchay Arm Test
ICF	International Classification of Functioning, Disability and Health
IQR	Interquartile range
Kg	kilogram
MD	Mean Difference
MP	Mental Practice
MRC	Medical Research Council
NDT	Neurodevelopment treatment
NR	Not reported
NRS	Non-randomized studies
OT	Occupational therapy
PICO	Population, Intervention, Comparator, Outcome
PNF	Proprioceptive Neuromuscular Facilitation
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PROSPERO	International prospective register of systematic reviews
RCT	Randomized Controlled Trial
RoB	Risk of bias
SD	Standard Deviation
SMD	Standard mean difference
STREAM	Stroke Rehabilitation Assessment of Movement
UL	Upper limb
WMFT	Wolf Motor Function Test

Context and Policy Issues

Neurological disorders are conditions caused by injury or disease of the nervous system that affect nearly 1 billion people globally.[1] Neurorehabilitation is an important strategy to reduce the burden of neurological disorders.[1] Bobath therapy is the most widely used approach for neurological rehabilitation in the world, however, the superiority of this approach over other forms of treatment has been questioned.[2,3] For example, a 2009 systematic review of randomized controlled trials (RCTs) reported that, among 16 studies reviewed, Bobath therapy was not found to be superior to other physical therapies for sensorimotor control of upper and lower limb, dexterity, mobility, activities of daily living, or cost-effectiveness, and limited evidence favoured Bobath therapy for balance.[2] The study authors concluded that the Bobath concept is not superior to other approaches in stroke rehabilitation.[2]

Historically, treatment following a neurological lesion largely focused on teaching patients to rely more heavily on the less affected side, while stretching, bracing, and strengthening the affected side.[2] In contrast, the Bobath concept targets the more affected side based on the assumption that recovery is possible.[4] Since its introduction, our understanding of the mechanisms responsible for motor learning and functional recovery after stroke have evolved, and the Bobath concept has evolved by selectively incorporating this new knowledge.[2] The current Bobath concept is described as a comprehensive problem solving approach to assessment and treatment of patients with issues related to function,

movement, and tone as a result of a lesion to the central nervous system.[4,5] The International Bobath Instructors Training Association describes the treatment program as one that "focuses on movement analysis with respect to selective movement, postural control and the role of sensory information to develop a movement diagnosis guiding treatment and evaluation."[6] Expert participants in a Delphi study that set out to define the Bobath concept concluded that Bobath was developed as a living concept, evolving as the knowledge base grows.[5] The evolving nature of the Bobath concept has led to criticisms, as the inconsistently defined intervention has made measurement of clinical effectiveness difficult.[2]

This report expands upon a previously completed summary of abstracts report.[7] The objective of the current report is to summarize the evidence regarding the clinical effectiveness and cost-effectiveness of Bobath therapy for treatment of patients with neurological conditions as well as to summarize evidence-based guidelines.

Research Questions

1. What is the clinical-effectiveness of Bobath therapy for treatment of patients with neurological conditions?
2. What is the cost-effectiveness of Bobath therapy for treatment of patients with neurological conditions?
3. What are the evidence-based guidelines of Bobath therapy for treatment of patients with neurological conditions?

Key Findings

Moderate quality evidence from a systematic review and meta-analyses of randomized controlled trials (RCTs) and non–randomized studies suggested that compared with no treatment, there was a large effect in favour of Bobath therapy for upper limb physical functioning, and upper limb activity compared in patients with stroke-related upper limb impairment. When compared with other physical therapies, Bobath therapy was equally as effective as other physical therapies for the treatment of upper limb physical function. Bobath therapy had a small negative effect on upper limb function activity in patients who had suffered a stroke compared with other physical therapies.

Evidence of moderate quality from four RCTs of patients who had recently suffered a stroke suggested that Bobath therapy was equally as effective as other physical therapies in improving functional ability, functional activity, and balance and stability.

No cost-effectiveness studies or evidence-based guidelines were identified regarding Bobath therapy for the treatment of patients with neurological conditions.

Methods

Literature Search Methods

A limited literature search was conducted on key resources including PubMed, CINAHL via EBSCOHost, the Cochrane Library, University of York Centre for Reviews and Dissemination (CRD) databases, Canadian and major international health technology agencies, as well as a focused Internet search. No filters were applied to limit the retrieval by study type. Where possible, retrieval was limited to the human population. The search

was also limited to English language documents published between January 1, 2013 and October 11, 2018.

Selection Criteria and Methods

One reviewer screened citations and selected studies. In the first level of screening, titles and abstracts were reviewed and potentially relevant articles were retrieved and assessed for inclusion. The final selection of full-text articles was based on the inclusion criteria presented in Table 1.

Table 1: Selection Criteria

Population	Adults with neurological conditions (e.g., post-stroke)
Intervention	The Bobath therapy technique (also known as 'neurodevelopment treatment')
Comparator	Usual care (e.g., repetitive functional tasks, starting moving through motions w/ patients, giving aid to do by themselves, practice/weaning), other treatments
Outcomes	Clinical effectiveness (functionality, functional independence measure) Cost effectiveness Guidelines
Study Designs	Health technology assessments, systematic reviews, meta-analyses, randomized controlled trials, non-randomized studies, economic evaluations, evidence-based guidelines

Exclusion Criteria

Articles were excluded if they did not meet the selection criteria outlined in Table 1, they were duplicate publications, or were published prior to 2013. Guidelines with unclear methodology were also excluded.

Critical Appraisal of Individual Studies

The included systematic review was critically appraised by one reviewer using AMSTAR 2[8] and RCTs were critically appraised using the revised Cochrane risk of bias tool,[9] Summary scores were not calculated for the included studies; rather, a review of the strengths and limitations of each included study were described narratively.

Summary of Evidence

Quantity of Research Available

A total of 161 citations were identified in the literature search. Following screening of titles and abstracts, 155 citations were excluded and 6 potentially relevant reports from the electronic search were retrieved for full-text review. No potentially relevant publications were retrieved from the grey literature search for full text review. Of these potentially relevant articles, one publication was excluded due to ineligible outcome, and five publications met the inclusion criteria and were included in this report. These comprised one systematic reviews and four RCTs. Appendix 1 presents the PRISMA[10] flowchart of the study selection.

Summary of Study Characteristics

Additional details regarding the characteristics of included publications are provided in Appendix 2.

Study Design

One 2018 systematic review was identified for inclusion in this report.[11] Databases were searched from inception to June 14, 2016.[11] Eligible study designs were RCTs, case series, and non-randomized studies with pre-posttest design; eight RCTs and two non-randomized studies were included in the review.[11]

One multi-center,[12] and three single-centre[12-15] RCTs were identified for inclusion in this report. Among them, three studies described blinded outcome assessment[12,13,15] and blinding was not mentioned in the fourth study.[14]

Country of Origin

The systematic review was conducted in Australia[11] and the RCTs were conducted in treatment centres in Turkey,[13,15] Poland,[14] and the Netherlands.[12]

Patient Population

The systematic review included studies that examined adult patients within 4 weeks of either first-ever or recurrent stroke with upper limb impairment. The subset of patients of relevance to this report received an intervention of Bobath therapy compared with usual care, sham therapy, or another technique. The ten studies that examined Bobath therapy included 844 patients.

Across the RCTs included in this review, patients (N = 178) were eligible to participate in the study if they had experienced their first ever stroke and were in the subacute and chronic stages since stroke onset (range: 6 weeks[12] to 6 months [14]). Sample sizes of included studies ranged from 22 to 72 patients.[14,15] All studies were carried out in a rehabilitation centre. Mean ages of included patients ranged from 53.7 years (overall study sample)[14] to 59.7 years (comparator group sample). Patients ranged in age from 20[14] to 73 years.[15] Patients were described as having hemiparesis,[14] hemiparesis with affected trunk,[15] hemiplegia, [13] and upper extremity paresis[12] as a result of their stroke. Ability to participate in the training program was an inclusion requirement of all RCTs in this report.

Interventions and Comparators

All included studies examined Bobath therapy. In the systematic review, Bobath therapy was defined as any therapeutic approach based on neurophysiological and neurodevelopmental knowledge and theories.[11] Four RCTs compared Bobath therapy to usual care and four RCTs compared Bobath therapy to no rehabilitation.[11] Comparators in the RCTs were physiotherapist-led exercises,[15] Proprioceptive Neuromuscular Facilitation,[14] Nintendo Wii exercises with video feedback and motivational support,[13] and mental practice based treatment.[12] Among the RCTs, duration of therapy for intervention and comparators ranged from 6 weeks[12,14] to 12 weeks,[15] frequency ranged from 3 days per week[13,15] to 7 days per week,[12] once per day[13-15] or at least three times per day,[12] and session duration ranged from 10 minutes[12] to 60 minutes per bout.[13,15] Insufficient detail was provided in the systematic review to determine the duration and frequency of interventions.[11]

Outcomes

Within the systematic review, eligible studies examined upper limb impairment or upper limb activity assessed using any measure.[11]

Function was assessed using various measures within the four included RCTs:

Balance was assessed in one study using the 14-item Berg Balance Test – Turkish version.[15] Higher scores reflect higher quality performance and shorter duration of time to complete an activity or posture. Authors did not report measurement properties or minimal clinically important difference.[15]

Functional capacity was assessed in one study using the Stroke Rehabilitation Assessment of Movement (STREAM).[15] The STREAM assesses coordination, functional mobility, and range of motion. Higher scores for each item reflect one's ability to complete the movement in a manner equivalent with the unaffected side. Authors did not report measurement properties or minimal clinically important difference.[15] Related to this, basic level of functioning (self care and mobility) was assessed using the 10-item Barthel Index and the Frenchay Activities Index.[12] Higher scores on both measures reflect better functional ability related.[12] Both items were reported as having acceptable reliability and validity.[12] Improvements of ≤10% of the total range of the scale are considered a clinically meaningful difference.[12]

Trunk function was assessed in one study using the Turkish version of the Trunk Impairment Scale. Higher scores on the Trunk Impairment Scale indicate less impairment; Authors did not report measurement properties or minimal clinically important difference.[15]

Stability was assessed in one study using the Functional Reach Test, which measures the maximum distance (the difference between the start and end positions) a person can reach forward while standing in a fixed position (average of last 2 of 3 trials). Greater scores indicate better stability. Authors did not report measurement properties or minimum clinically important difference.[15]

Walking performance was assessed in one study as the time taken to walk 10 metres (average of 3 trials). Shorter times indicate better performance. Authors did not report measurement properties or minimum clinically important difference.[15]

Functional independence in daily activities was assessed using the 18-item Functional Independence Measure – Turkish version. Higher scores represent better functioning and greater independence. Authors did not report measurement properties or minimum clinically important difference.[13]

Cognitive functioning was assessed in one study using the 10-item CogLog.[12] Higher scores reflect better cognitive functioning.[12] Measurement properties were not reported. Improvements of ≤10% of the total range of the scale are considered a clinically meaningful difference.[12]

In one study, upper extremity functioning and ability were defined according to the International Classification of Functioning, Disability and Health (ICF).[12]. Upper extremity function was assessed using the arm motor function section of the Fugl-Meyer test.[12] Upper extremity activity was assessed using the Wolf Motor Function Test, Frenchay Arm Test, and accelerometery.[12] Shorter durations and higher scores on the Wolf Motor Function Test and Frenchay Arm Test indicate better speed and quality of movement.[12] Activity count

ratios calculated from accelerometer readings reflect whether arm activity was higher, equal to, or lower than the unaffected arm.[12] Authors reported good psychometric properties associated with use of the measures.[12] Authors did not report minimum clinically important difference.[12]

Risk of falling was assessed in one study using the timed up-and-go. Time taken to complete the task was measured in seconds. Shorter time indicates better performance. Authors did not report minimum clinically important difference.[15]

Path length of movement of the centre of pressure was assessed using an ALFA balance platform. Participant displacement was recorded by a computer as a curve length (the length of the path which the centre of pressure followed during the test). Longer path length curves indicate more impaired balance control. Authors did not report minimum clinically important difference [14]

Surface area of support was assessed using the ALFA balance platform, with patient s standing still for 30 seconds. Displacement values were recorded by computer. The surface area of the support was captured as an envelope line established from a combination of extreme stabilograph points forming an irregularly-shaped polygon. Authors did not report minimum clinically important difference.[14]

Summary of Critical Appraisal

Systematic Review and Meta-Analyses

There were several strengths and limitations associated with the conduct of the included systematic review. In terms of strengths, the research questions and inclusion criteria for the review were clear and included all of the components of a PICO. A comprehensive literature search strategy was developed, which included searching 10 electronic databases and 4 trial registries, and hand searching systematic reviews, increasing the likelihood of capturing as many relevant studies as possible. Study selection was completed in duplicate, with two reviewers independently agreeing on selection of eligible studies; reasons for exclusions were provided in a PRISMA flow chart. Finally, risk of bias in included RCTs was assessed by study authors using the Cochrane Risk of Bias Tool.

Limitations of the systematic review include the absence of a list of excluded studies. Additionally, participants and interventions in included studies were not described in adequate detail to understand the generalizability of study findings. Finally, the review protocol was prospectively registered with PROSPERO and no deviations from the protocol were reported in the paper. However, examination of the protocol revealed there was a deviation from the protocol. Specifically, the authors planned to use the Modified Evidence-Based Learning Critical Appraisal tool. They revised the PROSPERO protocol to indicate that non-randomized studies would be assessed using the Cochrane Risk of Bias tool, explaining that this was done to be consistent with how randomized studies were assessed. However the Cochrane tool does not assess confounding, selection bias, methods used to ascertain exposures and outcomes, or selection of the reported result from among multiple measurements or analyses of a specified outcome. As a result, the quality of the included non-randomized studies is not known.

Randomized Controlled Trials

There was a low risk of bias arising from the randomization process. All four RCTs used some method of random allocation to intervention groups, however not all described the

method of allocation.[12-15] Simsek et al. and Timmermans et al. described the random sequence generation process,[12,13] and only Simsek described using sequentially numbered, opaque, sealed envelopes to conceal group allocation.[13] Randomization was not described at all in the study by Krukowska, with the only reference to simple randomization occurring in the abstract.[14] Despite the poor reporting, there is a low risk of bias arising from the randomization process, as randomization appears to have been generally effective. Only Simsek reporting a significant difference in any variable (i.e., body mass index) between groups at baseline following randomization.[13]

There was a low risk of bias due to deviations from the intended interventions. Due to the nature of exercise interventions, participants and physiotherapists were aware of assigned interventions during the trial. However, deviations from intended interventions were not reported and were unlikely; intention-to-treat analysis was used to estimate the effect of assignment to intervention in two[12,15] of the three[13] studies that reported missing outcome data.

There is a moderate risk of bias due to missing outcome data. There were little[13,15] to no[14] missing outcome data in three studies, and missingness was not likely related to the true value. However, there was a large amount of missing outcome data reported in the study by Timmermans et al., and the proportions missing differ between groups, with more missingness in the Bobath treatment group (7/21) compared with the mental practice comparator (3/21).[12] It is possible the value of the data that are missing are related to the reasons they are missing.

Overall, there was a moderate risk of bias in measurement of the various function outcomes examined in the included studies. Outcome assessors were blinded to intervention received in three studies,[12,13,15] while blinding was not mentioned in the fourth.[14] Measurement properties for outcome measures were not reported in the articles by Kilinc et al. or Krukowska et al.,[14,15] and properties were not reported for one outcome (functional independence) in the article by Simesk et al.[13] This does not necessarily mean outcome measures were inappropriate, rather the psychometric properties for these outcomes were not reported. All outcome measures included in the study by Timmermans et al. were reportedly valid and reliable.[12]

There is a moderate risk of bias in the selection of the reported result. None of the included studies prospectively registered their protocols, and therefore it is not possible to determine with certainty if a pre-specified plan that was finalized before unblended outcome data were available for analysis was followed. It is also not possible to know if numerical results were selected based on results from multiple analyses of the data. There is some reason for concern in the study by Timmermans et al., as authors reported that cognitive function and basic level of functioning were measured at baseline only, however basic level of functioning was reported at follow-up time points, raising questions regarding the cognitive outcome.[12]

Additional details regarding the strengths and limitations of included publications are provided in Appendix 3.

Summary of Findings

Clinical Effectiveness of Bobath Therapy for Treatment of Patients with Neurological Conditions

Physical Functioning

In the included systematic review, one meta-analysis was conducted to examine the comparative effectiveness of Bobath therapy on upper limb impairment versus no rehabilitation. Findings from two pooled studies suggest that Bobath therapy had a large significant effect on upper limb impairment compared with no rehabilitation.[11]

There was no difference between usual care plus Bobath therapy and usual care plus mental practice for basic level of functioning assessed using the Barthel Index, Frenchay index, or Fugl-Meyer test at post-test, 6-months, or 12-months.[12]

One RCT showed that functioning, assessed using the STREAM measure (composite score and individual subscales), the trunk impairment scale (composite score and coordination subscale), and the 10-meter walk test, was not statistically different for Bobath therapy compared with standard exercises used in physical rehabilitation (i.e., strengthening, stretching, mat activities, functional activities, and range of motion exercises).[15]

There was no statistical difference in functional independence (composite score or motor and cognitive subscales) between Bobath therapy and Nintendo Wii in one study.[13]

Functional Activity

In the included systematic review, meta-analyses were conducted to examine the comparative effectiveness of Bobath therapy on upper limb activity versus no rehabilitiation. Findings from two pooled studies suggest that Bobath therapy had a large significant positive effect on upper limb activity relative to no rehabilitation. When compared with usual care, two pooled studies showed a small negative effect of Bobath therapy on upper limb activity.[11]

There was no difference between Bobath Therapy plus usual care compared with Mental Practice plus usual care at any time point for upper extremity functional activity measured with the Frenchay Arm Test, activity ratio (affected side versus non-affected arm) measured with accelerometry, or motor function measured with the Wolf Motor Function Test (composite and subscales).[12]

Balance and Stability

In the study by Kilinc et al., there was no difference between Bobath therapy and comparator exercises on scores from the Berg Balance test,[15] Functional Reach test,[15] Timed Up-and-Go test,[15] or the static sitting balance or dynamic sitting balance components of the trunk impairment scale.[15] Another study showed that Bobath treatment was associated with improved stability assessed examining path length of movement of the centre of pressure of the foot assessed and surface area of support, both assessed by stabilography.[14]

Cost-Effectiveness of Bobath Therapy for Treatment of Patients with Neurological Conditions

No cost-effectiveness studies regarding Bobath therapy for patients with neurological conditions were identified for inclusion in this report. Therefore, no summary can be provided.

Guidelines

No evidence-based guidelines regarding Bobath therapy for patients with neurological conditions were identified for inclusion in this report. Therefore, no summary can be provided. presents a table of the main study findings and authors' conclusions.

Limitations

The included studies were of moderate methodological quality (Appendix 3), however there were limitations related to gaps in the literature. While studies were identified regarding the use of Bobath therapy for the treatment of patients with physical impairments resulting from a recent stroke, eligibility criteria for the included studies was narrow. Specifically, patients were required to have sufficient ability to participate in physical rehabilitation exercises somewhat independently and to have sufficient cognitive functioning in order to participate in the intervention or comparator exercises. The result is that patients with more severe physical and cognitive impairments due to stroke were excluded. Therefore, the effectiveness of Bobath therapy for patients with severe impairments as a result of their stroke and those with other neurological conditions is not known. Finally, No cost-effectiveness studies or evidence-based guidelines were identified regarding the use of Bobath therapy.

Conclusions and Implications for Decision or Policy Making

One systematic review and four RCTs regarding the clinical effectiveness of Bobath therapy for treatment of patients with neurological conditions were included in this review.

Overall, the evidence suggests Bobath therapy is more effective than no therapy for the treatment of adults with neurological conditions. When compared with other physical rehabilitation-based therapies, studies in this review showed Bobath therapy was as effective as other therapies for treatment of physical functioning and balance and stability. For functional activity, studies showed Bobath therapy was as effective or less effective than other physical therapy comparators. The findings generally suggest Bobath therapy was not more effective than other types of physical therapy for the treatment of neurological conditions. This is consistent with evidence from a previous systematic review of 16 studies, which concluded that Bobath concept was not superior to other forms of physical rehabilitation.[2]

The included studies were of moderate quality, and were subject to some limitations. An important limitation exists with regard to the limited generalizability of the findings. Patients examined in the included studies were required to have a baseline physical and cognitive function level that would allow comprehension of the treatment protocol and participation in physical exercises. Each RCT indicated excluding patients who did not meet those eligibility criteria. Therefore, it is not known how patients with more severe impairments due to stroke would experience a benefit from treatment with Bobath therapy. A further limitation with respect to generalizability is that many neurological conditions exist,[1] however, only studies examining stroke were identified for inclusion in this report. This review does not provide insight into the effectiveness of Bobath therapy for the treatment of other neurological conditions

This review did not find evidence to suggest Bobath therapy differs from other physical therapies. The authors of the systematic review concluded that Bobath therapy was more effective than no therapy but did not differ from other therapies with respect to treatment of

upper limb activity and impairment.[11] Bobath therapy had a significant negative effect in the meta-analysis compared with usual care, leading them to conclude there was sufficient evidence to discourage routine use in clinical practice.[11] The review authors found a positive effect in favour of Bobath therapy compared with no rehabilitation, which they interpreted as meaning some type of rehabilitation is more effective than not doing any physical rehabilitation.[11]. Further research addressing the use of Bobath for other patients who have experienced severe impairments due to stroke or have other neurological conditions is needed to determine its effectiveness in those populations. Cost-effectiveness evidence was not identified in this review and no evidence-based guidelines were identified to inform best practices.

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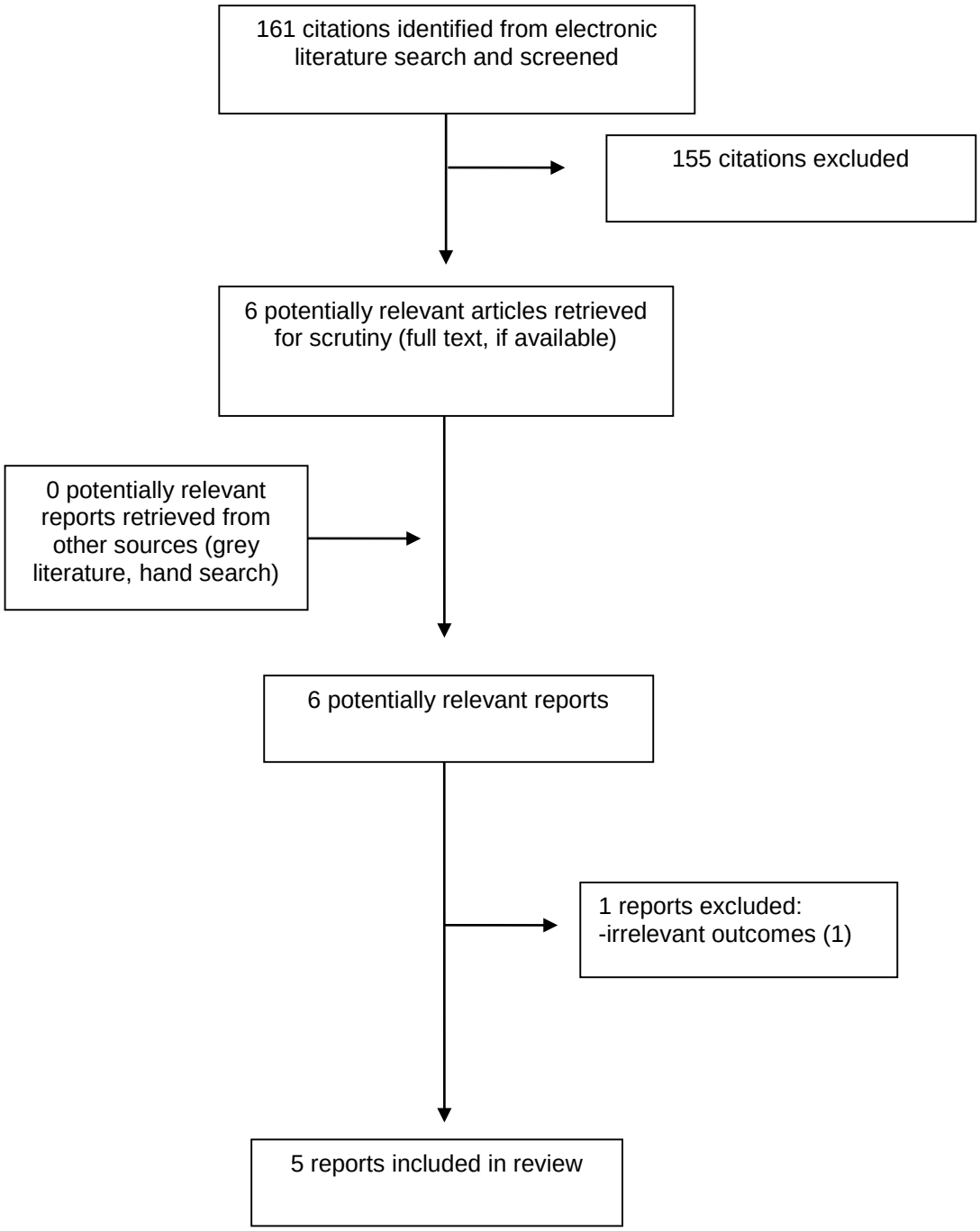
Appendix 1: Selection of Included Studies



Appendix 2: Characteristics of Included Publications

Table 2: Characteristics of Included Systematic Review and Meta-Analysis

First Author, Publication Year, Country	Study Designs and Numbers of Primary Studies Included	Population Characteristics	Intervention and Comparator(s)	Clinical Outcomes, Length of Follow-Up
Wattchow, 2018[11] Australia	8 RCTs and 2 non-randomized studies examined Bobath therapy Meta-analysis of RCTs (20 comparisons); and narrative synthesis	N=844 adults within 4 weeks of stroke (first-ever or recurrent) with upper limb impairment.	**Intervention**: Bobath therapy defined as any therapeutic approach based on neurophysiological and neurodevelopmental knowledge and theories. **Comparator**: Any comparator	Upper limb impairment or activity Follow up duration not reported

RCT = randomized controlled trial

Table 3: Characteristics of Included Primary Clinical Studies

First Author, Publication Year, Country	Study Design	Population Characteristics	Intervention and Comparator(s)	Clinical Outcomes, Length of Follow-Up
Kilinc, 2016[15] Turkey	Single-centre, blind assessor, pilot RCT Participants recruited from the outpatient clinic of the Physiotherapy and Rehabilitation Department of a single University Study conducted between June 2013 and October 2014	N = 22 adult patients with first-ever stroke hemiparesis and affected trunk in the subacute and chronic stages (time since onset < 6 months at inclusion); patients had an affected trunk; could sit and walk independently; Mean age intervention = 55.91 years (range = 38 to 72); comparator = 54 years (range = 27 to 73)	**Intervention:** Bobath therapy. Individual training programs were created based on identification of the most important factor responsible for each functional impairment by experienced physiotherapists. The physiotherapists led patients through the programs in accordance with the fundamental principles of the Bobath method. 12 week duration, 3 days / week, 1 hour per session **Comparator**: Physiotherapist-led strengthening and stretching exercises, functional activities, and range of motion exercises 12 week duration, 3 days / week, 1 hour per session	Balance: 14-item Berg Balance Test – Turkish version; scores per item 0 to 4; higher scores reflect higher quality performance and shorter duration of time to complete an activity or posture; validity and reliability not reported. Functional Capacity (coordination, functional mobility, and range of motion 30-item STREAM; scores range from 0 to 70 points; (i) limb movements scored from 0 (unable to perform the test movement through any appreciable range) to 2 (able to complete the movement in a manner that is comparable to the unaffected side); (ii) basic mobility movements had an additional response option: able to complete the movement with the help of a mobility aid. Validity and reliability not reported.

Table 3: Characteristics of Included Primary Clinical Studies

First Author, Publication Year, Country	Study Design	Population Characteristics	Intervention and Comparator(s)	Clinical Outcomes, Length of Follow-Up
				Trunk Function assessed using the 17-item Trunk Impairment Scale – Turkish version; scores range between 0 and 23 points; higher scores represent better static sitting balance, dynamic sitting balance, and coordination; Validity and reliability not reported Stability assessed using the Functional Reach Test. Scores are determined by assessing the difference between the start and end position, which is the reach distance (average of last 2 of 3 trials). Validity and reliability not reported Walking performance was assessed by the time taken to walk 10 metres (average of 3 trials). Validity and reliability not reported Risk of falling assessed using the timed up-and-go. Time taken to complete the task was measured in seconds. Validity and reliability were not reported.
Krukowska, 2016[14] Poland	Single-centre 4-arm Randomized controlled trial Location and dates of patient recruitment not described; the study was carried out in a rehabilitation clinic	N = 72 Patients (40 women, 32 men; mean age = 53.7 years; age range 20 to 69; within 6 months of first-ever ischemic stroke with hemiparesis at time of treatment) ; Excluded patients had suffered more than one stroke or other neurological disease with central nervous system damage; could not remain standing;	**Intervention**: NDT-Bobath (method not described) **Comparator**: PNF method (method not described) 35 daily sessions, 6 days per week for 6 weeks, bout duration not described	Path length of movement of the COP was assessed using an ALFA balance platform. Participant displacement was recorded by a computer as a curve length (the length of the path which the COP followed during the test). Longer path length curves indicate more impaired balance control. Surface area of support was assessed using the ALFA balance platform, with patient s standing still for 30 seconds. Displacement values were recorded by computer. The

Table 3: Characteristics of Included Primary Clinical Studies

First Author, Publication Year, Country	Study Design	Population Characteristics	Intervention and Comparator(s)	Clinical Outcomes, Length of Follow-Up
		had incomplete or no logical-verbal contact; with pusher syndrome and / or heminegolect syndrome; with a limited range of motion in the lower extremities due to osteoarthritis or amputation of lower limbs.		surface area of the support was captured as an envelope line established from a combination of extreme stabilograph points forming an irregularly-shaped polygon. Follow up at post-test (after 6-weeks)
Simsek, 2015[13] Turkey	Single-centre, single-blind, RCT Patients recruited from the a hospital-based department of physical therapy and rehabilitation Dates not reported	Patients (N = 42) with first-ever unilateral ischemic or hemorrhagic stroke; mean time since stroke = 55.2 days; mean age 58.04 years Bobath group were 61.5% female, 38.5% male; Comparator group were 48.3% female, 51.7% male	**Intervention:** Bobath therapy (method not described) 10 weeks (45-60 hours* / day, 3 days / week **Comparator:** Nintendo Wii exercises; recorded video of patients performing exercises to enable them to see their mistakes; recorded maximum score of each patient to improve motivation in next session; 10 weeks (45-60 hours* / day, 3 days / week *Believed to be a typographical error. Hours should be considered as minutes	Functional Independence status in daily activities was assessed using the 18-item Functional Independence Measure -Turkish version. Responses selected on a 7-point scale. Higher scores represent better functioning and greater independence. Validity and reliability were not reported. Adverse effects were assessed; the method for collecting this information was not described Follow up at 10 weeks (immediately post-treatment)
Timmermans, 2013[12] The Netherlands	Multi-center, single-blind, RCT Participants recruited from rehabilitation departments in 4 medical centres between Study conducted from March 2008 and November	Patients (N = 42) with first-ever stroke, upper extremity paresis ; recruited in the subacute phase after stroke (2 – 6 weeks after stroke at inclusion); Central paresis of the arm-hand with elbow flexor	**Intervention**: Usual therapy plus bimanual upper extremity techniques based on NDT principles; duration = 6 weeks, instructed to practice for 10 minutes / bout at least three times / day. **Comparator**: Usual therapy plus 6 weeks of Mental Practice-	Basic Level of Functioning assessed using: (1) the 10-item Barthel Index; scored at 0, 5, or 10; scores range from 0 to 100; authors reported acceptable reliability; (2) the FAI; scores range from 15 to 60 points; authors reported acceptable reliability and validity Cognitive functioning was assessed using the 10-item

Table 3: Characteristics of Included Primary Clinical Studies

First Author, Publication Year, Country	Study Design	Population Characteristics	Intervention and Comparator(s)	Clinical Outcomes, Length of Follow-Up
	2011	strength MRC grades 1 to 3; no severely impaired cognition, no severe neurologic, orthopedic, rheumatoid, or cardiac impairments before stroke Patient mean ages were 58.7 years in the Bobath treatment group and 59.7 years in the comparator group.	based treatment on arm-hand performance. During the first week, the patients were taught how to use the MP techniques to improve arm function. A training task tailored to the functional level of the individual patients was selected by the occupational therapist. 6-week duration, practice 3 times per day, 10 minutes per session	CogLog; items scored out of 0 (incorrect response despite cueing, more than 2 errors, or inability to complete) to 3 (a spontaneously correct response, no errors); measurement properties not reported. Upper extremity functioning was defied according to the ICF. Improvements of ≤10% of the total range of the scale are considered a clinically meaningful difference: (1) Upper extremity functioning at the ICF *function* level was assessed using the arm motor function section of the Fugl-Meyer test; scores range from 0 to 66. Authors report very high interrater and test-retest reliability. (2) Upper extremity functioning at the ICF *activity* level was assessed using: (i) the WMFT assesses performance on 15 timed tasks and 2 strength tasks; quality of movement rated on a 6-point scale; time varies from 0.1 to 120 second; authors reported the tool has good psychometric properties for patients with stroke; (ii) the FAT assesses performance on 5 tasks scored 0 or 1; scores range from 0 to 5; authors reported good reliability and validity in patients with stroke. (iii) Upper extremity use in a daily life situation over 3 days was measured using wrist-worn Actiwatch AW7 accelerometers; activity was

Table 3: Characteristics of Included Primary Clinical Studies

First Author, Publication Year, Country	Study Design	Population Characteristics	Intervention and Comparator(s)	Clinical Outcomes, Length of Follow-Up
				measured in counts; an activity index was calculated as a ratio of the activity of the impaired arm movement relative to the unimpaired arm movement; authors reported acceptable validity and reliability for assessment of arm-hand performance in patients with stroke Follow-up at post-treatment and 6, 9, and 12 months post-baseline

COP = Centre of foot pressure; CogLog = Cognitive Log; FAI = Frenchay Activities Index; FAT = Frenchay Arm Test; ICF = International Classification of Functioning, Disability and Health; MRC = Medical Research Council; NDT = Neurodevelopmental Treatment; PNF = Proprioceptive Neuromuscular Facilitation; RCT = randomized controlled trial; STREAM = Stroke Rehabilitation Assessment of Movement; WMFT = Wolf Motor Function Test

Appendix 3: Critical Appraisal of Included Publications

Table 4: Strengths and Limitations of Systematic Review and Meta-Analysis using AMSTAR 2[8]

Strengths	Limitations
Wattchow, 2018[11]	
The research questions and inclusion criteria for the review included the components of PICO The review protocol was registered prospectively with PROSPERO A comprehensive literature search strategy was developed, which included searching 10 electronic databases and 4 trial registries, and hand searching systematic reviews. It is unclear who contributed to the search strategy, but study authors appear to have expertise in the field Two reviewers independently agreed on selection of eligible studies and achieved consensus on which studies to include; reasons for exclusions were provided RoB in included RCTs was assessed using the Cochrane RoB Tool	The review authors did not provide a list of excluded studies. Included studies were not described in adequate detail. Further, the authors of the review reported that included studies that examined usual care as the comparator group described usual care poorly No deviations from the protocol were reported in the paper. However deviations existed regarding the method of risk of bias assessment of NRSs. Authors originally planned to use the Modified Evidence-Based Learning Critical Appraisal tool, and revised the protocol to indicate that NRS would be assessed using the Cochrane RoB tool, explaining that this was done to be consistent with how randomized studies were assessed. However the Cochrane tool does not assess confounding, selection bias, methods used to ascertain exposures and outcomes, or selection of the reported result from among multiple measurements or analyses of a specified outcome

NRS = non-randomized studies; PICO = Population, Intervention, Comparator, Outcome; PROSPERO = International Prospective Register of Systematic Reviews and Meta-Analyses Protocols; RCT = randomized controlled trial; RoB = risk of bias

Table 5: Strengths and Limitations of Clinical Studies using the RoB 2.0[9]

Strengths	Limitations
Kilinc, 2016[15]	
Risk of bias arising from the randomization process Allocation sequence was random; there were no significant differences between intervention groups **Risk of bias due to deviations from the intended interventions** Due to the nature of exercise interventions, participants and physiotherapists were aware of assigned interventions during the trial. However, deviations from intended interventions were not reported and were unlikely; Intention-to-treat analysis was used **Risk of bias due to missing outcome data** Data were available for nearly all participants randomized for all outcomes. Missing data were relatively balanced between groups. Missingness is not likely related to the	**Risk of bias arising from the randomization process** Allocation concealment was not reported **Risk of bias in selection of the reported result** It is unclear if the trial was analyzed in accordance with a prespecified plan that was finalized before unblinded outcome data were available for analysis **Risk of bias in measurement of the outcome** Validity and reliability of outcomes measures was not reported **Other** A power calculation was not conducted and the sample size was small (i.e., N = 22)

Table 5: Strengths and Limitations of Clinical Studies using the RoB 2.0[9]

Strengths	Limitations
outcomes of interest **Risk of bias in measurement of the outcome** Outcome measures were appropriate. Outcome measurement is not likely to have differed between groups. Outcome assessors were blinded to intervention received	
Krukowska, 2016[14]	
Risk of bias arising from the randomization process "There were no significant differences between the 4 groups before treatment in terms of age, movement distance or the COP surface." (p.451) **Risk of bias due to deviations from the intended interventions** Due to the nature of exercise interventions, participants and physiotherapists were aware of assigned interventions during the trial. However, deviations from intended interventions were not reported and were unlikely **Risk of bias due to missing outcome data** There were no missing data	**Risk of bias arising from the randomization process** Sequence generation and randomization process were not described. The only reference to simple randomization occurred in the abstract. **Risk of bias in selection of the reported result** It is unclear if the trial was analyzed in accordance with a prespecified plan that was finalized before unblinded outcome data were available for analysis **Risk of bias in measurement of the outcome** There is no mention of blinded outcome assessors. Authors did not report validity and reliability of the outcome measures. It is unclear if outcome assessment could have differed between groups
Simsek, 2015[13]	
Risk of bias arising from the randomization process Sequentially numbered, opaque, sealed envelopes were used to conceal group allocation **Risk of bias due to deviations from the intended interventions** Due to the nature of exercise interventions, participants and physiotherapists were aware of assigned interventions during the trial. However, deviations from intended interventions were not reported and were unlikely **Risk of bias in measurement of the outcome** Outcome assessors were blinded to the intervention received **Other** Power calculation was completed	**Risk of bias arising from the randomization process** A simple randomization technique was used. The method of random sequence generation was not further described. Only BMI differed between groups at baseline; mean BMI of patients in the Bobath group falls in the overweight category and mean BMI in the comparator group falls in the normal weight category. It is unknown what effect this may have had on the results **Risk of bias due to deviations from the intended interventions (effect of assignment to intervention)** Intention to treat analysis was not used **Risk of bias in selection of the reported result** It is unclear if the trial was analyzed in accordance with a prespecified plan that was finalized before unblinded outcome data were available for analysis **Risk of bias due to missing outcome data** Two patients withdrew from the comparator group for reasons unrelated to the intervention or outcomes of

Table 5: Strengths and Limitations of Clinical Studies using the RoB 2.0[9]

Strengths	Limitations
	interest **Risk of bias in measurement of the outcome** It is unclear how adverse effects were assessed. Psychometrics were not reported for functional independence measure
Timmermans, 2013[12]	
Risk of bias arising from the randomization process Patients were randomized with a computerized block randomization scheme, with block sizes of 6. There were no significant differences between randomized groups at baseline, suggesting randomization was successful. **Risk of bias due to deviations from the intended interventions** Due to the nature of exercise interventions, participants and physiotherapists were aware of assigned interventions during the trial. However, deviations from intended interventions were not reported and were unlikely. Intention-to-treat analysis was used to estimate the effect of assignment to intervention. **Risk of bias in the measurement of the outcome** Outcome measures were reported by authors to be valid and reliable Measurement is not likely to have differed between intervention groups. Outcome assessors were blinded to intervention received.	**Risk of bias arising from the randomization process** Unclear if allocation sequence was concealed until participants were enrolled and assigned to interventions. **Missing outcome data** Large amount of missing data and the proportions of missing outcome data differ between groups, with more missingness in the Bobath treatment group (7/21) compared with the mental practice comparator (3/21). It is possible the missingness in outcome depended on its true value. **Risk of bias in selection of the reported result** The trial was not registered a priori and it is not possible to know if there was a pre-specified plan that was finalized before unblended outcome data were available for analysis. However, authors assessed cognitive function and basic level of functioning and reported that these were only completed at baseline. However, basic level of functioning was reported at follow-up time points, raising questions regarding the cognitive outcome.

BMI = body mass index; COP = centre of pressure; RoB 2.0 = Revised Cochrane risk-of-bias tool for randomized trials;

Appendix 4: Main Study Findings and Authors' Conclusions

Table 6: Summary of Findings Included Systematic Review and Meta-Analyses

Main Study Findings	Authors' Conclusion
Wattchow, 2018[11]	
10 studies total; n = 844 **UL Activity** <u>Bobath and usual care vs. usual care</u> 2 studies pooled (n = 80): SMD = –0.49; 95% CI, –0.94 to –0.05; *P* = *NR* I^2 = 0% 2 studies not pooled. Findings not reported. <u>Bobath vs. no rehabilitation</u> 3 studies pooled (n = 217): MD = 19.28; 95% CI, 7.54 to 31.02; *P* = NR I^2 = 93% **UL Impairment:** <u>Bobath vs. no rehabilitation</u> 2 studies pooled (n = 156) MD = 19.64; 95% CI, 17.41 to 21.87; *P* = NR I^2 = 0% 2 non-randomized studies reported a significant improvement in UL impairment ; data NR	"*Evidence was found to… discourage the use of Bobath therapy*." (p.377)

MD = mean difference; NR = not reported; SMD = standard mean difference; UL = upper limb; vs. = versus

Table 7: Summary of Findings of Included Primary Clinical Studies

Main Study Findings	Authors' Conclusion
Kilinc, 2016[15]	
Bobath therapy, n = 12; Other exercises, n = 10 **Balance - Berg Balance Test** (0 to 56) Bobath vs. comparator exercises Mean = 45.80(2.53) vs. 46.67(2.60); *Z* = –0.74; *P* = 0.47 **Balance - Functional reach** (cm) Mean = 21.84(4.23) vs. 22.00(4.50); *Z* = –0.08; *P* = 0.94 **Mobility - Timed up-and-go** (seconds) Mean = 16.12(5.32) vs. 16.18(6.15); *Z* = –0.02; *P* = 0.98 **Mobility – 10-meter walking test** (seconds) Mean = 14.25(5.72) vs. 14.24(5.40); *Z* = 0.01; *P* = 1.00 **Trunk impairment overall** (0 to 23) Mean = 15.60(4.14) vs. 16.56(4.16); *Z* = –0.50; *P* = 0.62	"*It can be suggested that individually developed exercise programs according to the Bobath concept improve trunk performance, balance, and walking activities in stroke patients*." (p.57)

Table 7: Summary of Findings of Included Primary Clinical Studies

Main Study Findings	Authors' Conclusion
Trunk impairment - Static sitting balance Mean = 5.30(1.64) vs. 6.00(1.66); *Z* = –0.93; *P* = 0.37 **Trunk impairment - Dynamic sitting balance** Mean = 7.40(2.22) vs. 7.78(2.17); *Z* = –0.37; *P* = 0.71 **Trunk impairment - Coordination** Mean = 2.90(2.23) vs. 2.78(2.28); *Z* = 0.12; *P* = 0.91 **STREAM overall** (0 to 70) Mean = 96.00(20.12) vs. 91.44(25.21); *Z* = 0.44; *P* = 0.67 **STREAM Upper extremity** (0 to20) Mean = 24.50(13.02) vs. 23.81(14.18); *Z* = 0.11; *P* = 0.91 **STREAM Lower extremity** (0 to 20) Mean = 30.00(6.20) vs. 29.11(6.75); *Z* = 0.30; *P* = 0.77 **STREAM Mobility** (0 to30) Mean = 41.40(6.45) vs. 39.89(7.04); *Z* = 0.49; *P* = 0.63	
Krukowska, 2016[14]	
Stability – Changes in path length of movement of the COP Right paresis / Bobath vs. Right paresis / PNF Means = 126.16 vs. 87.79 (SDs = NR) MD = 0.000807; *P* < 0.05 Right paresis / Bobath vs. Left paresis / PNF Means = 126.16 vs. 59.89 (SDs = NR) MD = 0.000151; *P* < 0.05 Left paresis / Bobath vs. Group 3 Right paresis / PNF Means = 128.16 vs. 87.79 (SDs = NR) MD = 0.000459; *P* < 0.05 Left paresis / Bobath vs. Left paresis / PNF Means = 128.16 vs. 59.89 (SDs = NR) MD = 0.000151; *P* < 0.05 **Stability – Changes in Surface Area of Support** Right paresis / Bobath vs. Right paresis / PNF Means = 104.43 vs. 40.44 (SDs = NR) MD = 0.000151; *P* < 0.05 Right paresis / Bobath vs. Left paresis / PNF Means = 104.43 vs. 58.41 (SDs = NR) MD = 0.000151; *P* < 0.05 Left paresis / Bobath vs. Right paresis / PNF Means = 99.80 vs. 40.44 (SDs = NR) MD = 0.000151; *P* < 0.05	"*1. The NDT-Bobath and PNF methods commonly used in the physiotherapy of patients after stroke have important therapeutic effects.* *2. The NDT-Bobath method is an effective to reduce of the field support and total path length measure foot pressure (COP).* *3. The side of paresis in patients after stroke does not affect the reduction on the field support and total path length measure foot pressure (COP) in patients after stroke, but greater improvement tested parameters are observed in patients with right-sided hemiparesis.* *4. The evaluation of the field support and total path length measure foot pressure (COP) using posturagraphy is useful in the assessment of patients and monitoring treatment outcomes*." (p.453)

Table 7: Summary of Findings of Included Primary Clinical Studies

Main Study Findings	Authors' Conclusion
Left paresis / Bobath vs. Left paresis / PNF Means = 99.80 vs. 58.41 (SDs = NR) MD = 0.000151; *P* < 0.05	
Simsek, 2015[13]	
Mean (SD) **Functional independence – FIM composite** Bobath vs. Comparator Baseline: 101.09 (21.69) vs. 96.80 (22.33); z = -0.630; *P* = 0.52 10 weeks: 107.09 (19.24) vs. 111.7 (15.06); z = -0.785; *P* = 0.43 **Functional independence – FIM motor subscale** Bobath vs. Comparator Baseline: 70.68 (18.24) vs. 64.60 (20.89); z = -1.008; *P* = 0.31 10 weeks: 75.04 (17.08) vs. 77.95 (12.99); z = -0.368; *P* = 0.71 **Functional independence – FIM cognitive subscale** Bobath vs. Comparator Baseline: 30.04 (4.99) vs. 32.30 (2.36); z = -1.683; *P* = 0.09 10 weeks: 31.59 (4.14) vs. 33.30 (2.79); z = -1.515; *P* 0.13	"The results of the study showed that both N-Wii and NDT groups improved over time. However, no statistical differences in improvement were found between groups in terms of daily life functions and health related quality of life." (p. 1068)
Timmermans, 2013[12]	
Median [IQR] **Basic Level of Functioning – Barthel Index** Bobath therapy vs. Mental Practice Comparator Baseline: 85 [60 to 90] vs. 75 [65 to 80]; *P* = NS 6 months: 90 [82.5 to 90] vs. 90 [74.25 to 90]; *P* = NS 12 months: 88.5 [80.75 to 90] vs. 90 [75 to 90]; *P* = NS **Basic Level of Functioning Frenchay Index** Intervention vs. Comparator Baseline: 56 [55 to 58] vs. 57 [54.5 to 59.0]; *P* = NS Post-test: 54 [51 to 57] vs. 51.5 [49.25 to 55.50]; *P* = NS 6 months: 55 [50.25 to 58.00] vs. 54 [51.00 to 57.25]; *P* = NS 12 months: 54 [52.75 to 58.25] vs. 54 [53 to 58]; *P* = NS **Upper Extremity Function – Fugl-Meyer test** Intervention vs. Comparator Baseline: 47 [35.2, 60.0] vs. 47.5 [31.0, 5.5]; *P* = NS Post-test: 52 [41, 61] vs. 51 [42, 61]; *P* = NS 6 months: 57 [48, 63] vs. 53.5 [49.2, 58.7]; *P* = NS 12 months: 60 [48, 64] vs. 58 [52.0, 63.7]; *P* = NS Upper Extremity Functioning at the ICF Activity Level: **Upper Extremity Functional Activity – Frenchay Arm Test** Intervention vs. Comparator Baseline: 4.5 [3 to 5] vs. 3 [2 to 5]; *P* = NS	"It can be concluded that, in a broad spectrum of subacute stroke patients, no differential effects could be found that favor the additional use of MP to therapy as usual for the improvement of upper extremity performance. However, training-specific effects were found for the experimental group [MP, not Bobath], supporting the use of a client-centered training approach."

Table 7: Summary of Findings of Included Primary Clinical Studies

Main Study Findings	Authors' Conclusion
Post-test: 5 [2 to 5] vs. 5 [3 to 5]; *P* = NS 6 months: 5 [5 to 5] vs. 5 [4 to 5]; *P* = NS 12 months: 5 [3.5 to 5.0] vs. 5 [4 to 5]; *P* = NS **Motor Function – WMFT; composite of time, lift weight, grip strenghth** Intervention vs. Comparator Baseline: 2.8 [2.2 to 4.2] vs. 3.3 [2.2 to 3.9] ; *P* = NS Post-test: 3.4 [2.9 to 4.7] vs. 3.6 [3.1 to 4.2]; *P* = NS 6 months: 4.0 [3.5 to 4.8] vs. 4.0 [3.2 to 4.4]; *P* = NS 12 months: 4.6 [3.2 to 4.9] vs. 4.4 [3.8 to 4.9]; P = NS **Motor Function - WMFT Time (sec)** Intervention vs. Comparator Baseline: 4.3 [2.7 to 6.3] vs. 4.1 [3.6 to 8.2]; *P* = NS Post-test: 3.6 [2.5 to 5.7] vs. 4.4 [2.2 to 5.8]; *P* = NS 6 months: 2.2 [2.1 to 3.2] vs. 3 [2.4 to 4.1]; *P* = NS 12 months: 2.4 [1.7 to 2.9] vs. 2.2 [1.9 to 3.5]; *P* = NS **Motor Function - WMFT Lift weight (kg)** Intervention vs. Comparator Baseline: 4.2 [3.0 to 4.8] vs. 4.5 [1.2 to 5.0]; *P* = NS Post-test: 4.2 [2.6 to 4.5] vs. 3.7 [1.1 to 4.6]; *P* = NS 6 months: 4.5 [4.5 to 5.0] vs. 4.5 [2.7 to 5.0]**;** *P* = NS 12 months: 4.7 [4.1 to 5.0] vs. 4.5 [3.7 to 5.0]; *P* = NS **Motor Function - WMFT Grip strength (kg)** Intervention vs. Comparator Baseline: 13 [4.7 to 28.0] vs. 11.5 [3.7 to 22.2]; *P* = NS Post-test: 12.7 [4.75 to 26.6] vs. 12 [5.2 to 22.5]; *P* = NS 6 months: 23.2 [13.6 to 35.5] vs. 16.5 [11.7 to 23.2]; *P* = NS 12 months: 27 [23 to 42] vs. 24 [15.5 to 37.0]; *P* = NS **Accelerometer** Intervention vs. Comparator Activity ratio [affected arm/non-affected arm] Baseline: 0.4 [0.2 to 0.5] vs. 0.38 [0.3 to 0.7], *P* = NS Post-test: 0.53 [0.3 to 0.7] vs. 0.37 [0.2 to 0.6], *P* = NS 6 months: 0.59 [0.3 to 0.7] vs. 0.33 [0.2 to 0.6], *P* = NS 12 months: 0.47 [0.2e0.6] vs. 0.61 [0.2 to 0.7], *P* = NS	

BI = Barthel index; FAS = functional ability scale; FIM = Functional independence measure; IQR = interquartile range; kg = kilogram; M = mean; MD = mean difference; MP = mental practice; NR = not reported; SD = standard deviation; WMFT = Wolf motor function test;