Journal of Physiotherapy 69 (2023) 15–22

AUSTRALIAN PHYSIOTHERAPY ASSOCIATION

Journal of PHYSIOTHERAPY

journal homepage: www.elsevier.com/locate/jphys

Research

Bobath therapy is inferior to task-specific training and not superior to other interventions in improving arm activity and arm strength outcomes after stroke: a systematic review

Simone Dorsch [a,b], Cameron Carling [c], Zheng Cao [d], Emma Fanayan [a], Petra L Graham [e], Annie McCluskey [b,f], Karl Schurr [b], Katharine Scrivener [b,g], Sarah Tyson [h]

[a] Faculty of Health Sciences, Australian Catholic University, Sydney, Australia; [b] The StrokeEd Collaboration, Sydney, Australia; [c] Concentric Rehabilitation Services, Perth, Australia; [d] Concentric Rehabilitation Services, Sydney, Australia; [e] School of Mathematical and Physical Sciences, Macquarie University, Sydney, Australia; [f] Faculty of Medicine and Health, The University of Sydney, Sydney, Australia; [g] Department of Health Sciences, Macquarie University, Sydney, Australia; [h] School of Health Sciences, University of Manchester, Manchester, UK

K E Y W O R D S

Stroke
Physical therapy
Occupational therapy
Upper extremity
Rehabilitation

A B S T R A C T

Question: What is the effect of Bobath therapy on arm activity and arm strength compared with a dose-matched comparison intervention or no intervention after stroke? **Design**: Systematic review of randomised trials with meta-analysis. **Participants**: Adults after stroke. **Intervention**: Bobath therapy compared with no intervention or other interventions delivered at the same dose as the Bobath therapy. **Outcome measures**: Arm activity outcomes and arm strength outcomes. Trial quality was assessed with the PEDro scale. **Results**: Thirteen trials were included; all compared Bobath with another intervention, which were categorised as: task-specific training (five trials), arm movements (five trials), robotics (two trials) and mental practice (one trial). The PEDro scale scores ranged from 5 to 8. Pooled data from five trials indicated that Bobath therapy was less effective than task-specific training for improving arm activities (SMD –1.07, 95% CI –1.59 to –0.55). Pooled data from five trials indicated that Bobath therapy was similar to or less effective than arm movements for improving arm activities (SMD –0.18, 95% CI –0.44 to 0.09). One trial indicated that Bobath therapy was less effective than robotics for improving arm activities and one trial indicated similar effects of Bobath therapy and mental practice on arm activities. For strength outcomes, pooled data from two trials indicated a large benefit of task-specific training over Bobath therapy (SMD –1.08); however, this estimate had substantial uncertainty (95% CI –3.17 to 1.01). The pooled data of three trials indicated that Bobath therapy was less effective than task-specific training for improving Fugl-Meyer scores (MD –7.84, 95% CI –12.99 to –2.69). The effects of Bobath therapy relative to other interventions on strength outcomes remained uncertain. **Conclusions**: After stroke, Bobath therapy is less effective than task-specific training and robotics in improving arm activity and less effective than task-specific training on the Fugl-Meyer score. **Registration**: PROSPERO CRD42021251630. **[Dorsch S, Carling C, Cao Z, Fanayan E, Graham PL, McCluskey A, Schurr K, Scrivener K, Tyson S (2023) Bobath therapy is inferior to task-specific training and not superior to other interventions in improving arm activity and arm strength outcomes after stroke: a systematic review. *Journal of Physiotherapy* 69:15–22]**

Introduction

Bobath therapy, developed in the 1950s, has been a predominant approach to stroke rehabilitation globally for many years. Bobath therapy is based on the principles of facilitating automatic and volitional movement through specific handling techniques that are thought to optimise recovery.[1] Although the approach has evolved over time, there is still an emphasis on the role of sensory input, which is manipulated via therapists' facilitation of movement, focusing on postural and trunk control as the main contributors to activity.[2]

Despite its extensive clinical use, the efficacy of Bobath therapy to improve outcomes for the affected arm after stroke has never been established. Five systematic reviews have compared Bobath therapy with other interventions targeting arm outcomes after stroke. Two of these reviews contain meta-analyses that pooled results from two trials, using different trials in each review.[3,4] Both reviews concluded that Bobath therapy is less effective than other interventions for improving arm outcomes after stroke. However, one concluded that Bobath is more effective than no intervention, based on a meta-analysis of four trials.[4] Of the three reviews without meta-analysis, two concluded that there is no clear

https://doi.org/10.1016/j.jphys.2022.11.008
1836-9553/

Box 1. Inclusion criteria

Design
- Randomised controlled trial

Participants
- Adults after stroke

Intervention
- One group received therapy based on the Bobath concept, targeting the affected arm

Outcome measures
- Arm activity
- Strength

Comparisons
- Bobath therapy versus a different intervention targeting the affected arm, delivered at the same dosage as the Bobath therapy
- Bobath therapy versus no intervention

indication of superiority of any approach,[5,6] while the most recent[7] found moderate evidence that other interventions were more effective than Bobath therapy for improving motor control and dexterity of the arm. In summary, the reviews to date have concluded that Bobath therapy is less effective than other interventions for arm outcomes after stroke but is more effective than no intervention.

None of the reviews discussed above contains a meta-analysis of all the available trials that investigate the use of Bobath therapy specifically targeting the affected arm after stroke. Therefore, this systematic review primarily aimed to evaluate the effect of Bobath therapy on arm outcomes after stroke by comparing it with no intervention or a dose-matched intervention, using all the available trials.

Therefore, the research questions for this systematic review of randomised trials with meta-analysis were:

1. What is the effect of Bobath therapy on arm activity outcomes compared with a dose-matched comparison intervention or no intervention after stroke?
2. What is the effect of Bobath therapy on arm strength outcomes compared with a dose-matched comparison intervention or no intervention after stroke?

Method

Identification and selection of trials

The systematic review was prospectively registered with PROSPERO and reported according to the PRISMA statement. An electronic search for relevant trials was conducted in September 2020 and updated in December 2021. The following databases were searched: Ovid MEDLINE, Embase, CINAHL and PEDro. The search included stroke-related terms, randomised controlled trial-related terms and therapy-related terms. See Appendix 1 on the eAddenda for the full details of the search strategy.

Titles and abstracts were screened independently by two authors (SD and EF) to identify relevant trials. Full-text copies of relevant papers were retrieved and reviewed independently by two of the following authors (KS, ST, CC, EF, AM, KS, SD and ZC) using predetermined criteria to determine eligibility (Box 1). If the two reviewers disagreed about the eligibility of a trial, a discussion was held with the author group until a consensus was reached. Where abstracts or full-text trials were only available in another language, Google Translate was used to translate the methods section into English. Where abstracts were only available in Chinese, one author (ZC) reviewed these trials. See Appendix 2 on the eAddenda for details of the full-text screening.

Assessment of characteristics of the trials

Quality

The PEDro database was searched to identify the PEDro scale score. Where a trial was not listed on the PEDro database, two authors independently rated the trial using the PEDro scale.

Participants

Participants in the included trials were adults at any stage after stroke. The number of participants, their age, time since stroke and inclusion criteria were recorded to describe the sample.

Intervention

Trials of Bobath therapy that targeted the affected arm were included. To determine whether Bobath therapy was used, trials had to meet one of the following criteria: the authors explicitly stated that the intervention was based on Bobath or neurodevelopmental training; or the authors referenced a Bobath textbook or publication when describing the intervention; or the intervention description suggested that it was based on Bobath therapy (ie, aimed to normalise movement, normalise tone, facilitate normal movement or inhibit reflex activity). If it was unclear whether the intervention was based on Bobath therapy, the trial's authors were contacted. If the intervention was mixed types of therapy, the publication needed to clearly state that at least half of the intervention targeting the affected arm was Bobath therapy. If the Bobath therapy targeted multiple activities including lower limb activities, the amount of therapy targeting the affected arm needed to be clearly stated.

Comparison

The comparisons of interests were 'another intervention' or 'no intervention'. Where another intervention targeting the affected arm was used, it needed to be delivered at the same dose (ie, the same amount of time) as the Bobath therapy. Two authors reviewed all comparison interventions (SD, EF) and grouped them into broad categories.

Outcome measures

The outcomes of interest were arm activity and arm strength. Activity outcomes were defined as assessments of the ability to perform a task. This included standardised outcome measures such as the Wolf Motor Function Test or Box and Block test, or customised assessments such as a timed reaching task.[8,9] Arm strength outcomes were defined as assessments of force production. The Fugl-Meyer motor assessment was included as a measure of arm strength, as this composite impairment outcome measure predominantly assesses strength. Fifty-six of the 66 points are allocated to volitional movements of the arm, scored as 0 for no movement, 1 for partial movement or 2 for full movement.

Data extraction and analysis

Two authors (EF and SD) independently examined the full-text version of the included trials to extract data. A variety of arm activity and arm strength outcome measures were reported. Where multiple outcome measures were reported, a hierarchy of choice was applied to decide which outcome measure to include in the pooled analysis. For the activity outcome measures, the measure used was (listed in order of preference): ARAT, Wolf Motor Function Test, Frenchay Arm Test, Upper Extremity function test, Box and Block test and customised outcome measures that involved reaching tasks.[8,9] For the arm strength outcome measure, the strength measures used were (again listed in order of preference): grip strength, shoulder flexion strength, elbow extension strength, Motricity Index and the Fugl-Meyer upper limb motor score. Mean post-intervention and change scores and standard deviations were retrieved where possible. Where standard deviations for change scores were not provided, they were imputed as suggested in the Cochrane Handbook,[10] whereby the available pre and post standard deviations were combined with an estimated correlation calculated from other studies. Data were extracted from graphs for two trials.[9,11] Seven authors were contacted to request additional data and one author responded.[12]

Where a variety of outcome measures for activity and strength outcomes were reported, SMD based on change scores was used. Where only a single score was used to measure the outcome, WMD based on change scores was used. Pooled estimates of intervention effect were calculated via DerSimonian and Laird random-effects meta-analyses.[13] All pooled results were reported as SMD or WMD (Bobath therapy – comparator therapy) with 95% CI. For the few outcome measures in which lower scores indicated a better outcome, negative signs were added to the mean scores so that the outcomes were all in the same direction. Where post-intervention results were reported as medians and interquartile ranges, the methods described by Hozo and colleagues were used to convert results into estimated means and standard deviations.[14] Heterogeneity between trials was assessed using Cochrane's Q. Sensitivity analyses were undertaken whereby studies with imputed SD were excluded from the analysis. R statistical software with the *meta* package was used for all analyses.[15]

Results

Flow of trials through the review

The electronic search strategy identified 1,684 papers. After screening of titles and abstracts, 188 full-text publications were retrieved and screened for eligibility. After screening the reference lists of other systematic reviews, five additional papers were identified. Titles and abstracts of these five papers were screened, and one full-text publication was retrieved and screened for eligibility. A total of 188 full-text publications were evaluated. To determine eligibility, 11 authors were contacted to confirm whether at least 50% of the intervention was Bobath therapy in one group of their trial: three authors did not respond; one author responded that one group had received intervention based on Bobath therapy;[12] and the remaining authors responded that their trial did not include an intervention where at least 50% was Bobath therapy. After screening full texts, 172 papers failed to meet the inclusion criteria. Three trials had resulted in two published papers each (one with the full data set and one with a subgroup of the data); the two papers that reported the full data set for those two trials were included. Therefore, a total of 13 trials were included in this systematic review. See Figure 1 for a summary of the flow of trials through the review.

Characteristics of the included trials

Of the 13 included trials, all were published in English. No trials compared Bobath therapy with no intervention. Although trials of Bobath therapy compared with no intervention were mentioned in the Introduction, none of these trials met our inclusion criteria, as the Bobath therapy targeted multiple activities rather than specifically targeting the affected arm. Together the trials included 636 unique participants. See Table 1 for details of the included trials.

Quality

The PEDro scores ranged from 5 to 8 out of 10. No trials used blinding of participants or therapists to group allocation. One trial did not use blinded assessors, nine did not use concealed allocation, five did not use intention-to-treat analysis and two did not have adequate follow-up (ie, $\leq$ 85% of the sample). See Table 2 for further details.

Participants

The participants were between 14 days and 4.5 years after their stroke, with five trials including participants in the acute/sub-acute stages after stroke (< 6 months) and eight trials including participants late after stroke (> 6 months). The average age of participants ranged from 49 to 73 years.

Intervention

Bobath therapy was described as 'Bobath' therapy or therapy following 'Bobath principles' by authors in six trials.[8,11,16–19] Bobath therapy was described as 'neurodevelopmental' therapy in seven trials.[9,12,20–24] See Appendix 3 on the eAddenda for details of the Bobath interventions.

Comparison interventions were allocated to one of four categories; see Appendix 4 on the eAddenda for operational definitions of each category. Interventions that involved general arm movements without reaching, grasping or manipulation of everyday objects were called *arm movements*. The comparison interventions were categorised as *arm movements* in five trials.[8,12,17,18,22] Interventions that involved reach, grasp and manipulation of everyday objects such as cups, combs and light switches were termed *task-specific training*; constraint-induced movement therapy shaping was included in this category. The comparison interventions were categorised as *task-specific training* in five trials.[11,19–21,24] Interventions that involved arm movements using a device that could assist movement and provided gaming interaction were termed *robotics*. The comparison interventions were categorised as *robotics* in two trials.[9,16] Interventions that involved motor imagery of the affected arm whilst performing reaching, grasping and manipulation activities were termed *mental practice*. The comparison intervention was categorised as *mental practice* in one trial.[23] See Appendix 5 on the eAddenda for details of the comparison interventions. With the exclusion of one trial that delivered 6 hours of intervention to both groups,[20] the average dosage of Bobath therapy and the comparison therapies was 51 minutes per session (range 20 to 120 minutes) over 5 weeks (range 2 to 8 weeks).

Outcome measures

Of the included trials, all provided data that could be included in both the activity and arm strength analyses, except for one trial that had no activity level outcome measure[16] and two trials that had no arm strength outcome measure.[18,22]

Effect of Bobath therapy versus other interventions on arm activity outcomes

The effect of Bobath therapy compared with task-specific arm training was examined by pooling outcomes from five trials involving 247 participants (Figure 2). The pooled SMD was large (SMD –1.07) in favour of task-specific training, with the confidence interval indicating that the effect was moderate to large (95% CI –1.59 to –0.55, I^2 = 68%). For a detailed forest plot, see Figure 3 on the eAddenda.

The effect of Bobath therapy compared with arm movements was examined by pooling outcomes from five trials involving 262 participants (Figure 4). The pooled SMD indicated that arm movements have a similar or better effect on arm activities than Bobath therapy (SMD –0.18, 95% CI –0.44 to 0.09, I^2 = 11%). There was substantial heterogeneity in the first pooled analysis but there were no predictors to explore that could potentially explain this heterogeneity. For a detailed forest plot, see Figure 5 on the eAddenda.

The effect of Bobath therapy compared with robotics was examined in one trial of 19 participants. The MD in forward reach distance showed 6.6 cm more change from robotics than Bobath therapy, with the confidence interval indicating between 1.1 and 12.1 cm greater change in reach for robotics than Bobath therapy.[9]

The effect of Bobath therapy compared with mental practice was examined in one trial of 39 participants. The median and interquartile range of the change scores was converted to mean and SD.[25,26] The mean difference in Wolf motor function test (time) scores indicated similar effects of Bobath therapy and mental practice; the test was completed a mean of 0.65 seconds faster in the mental practice group.

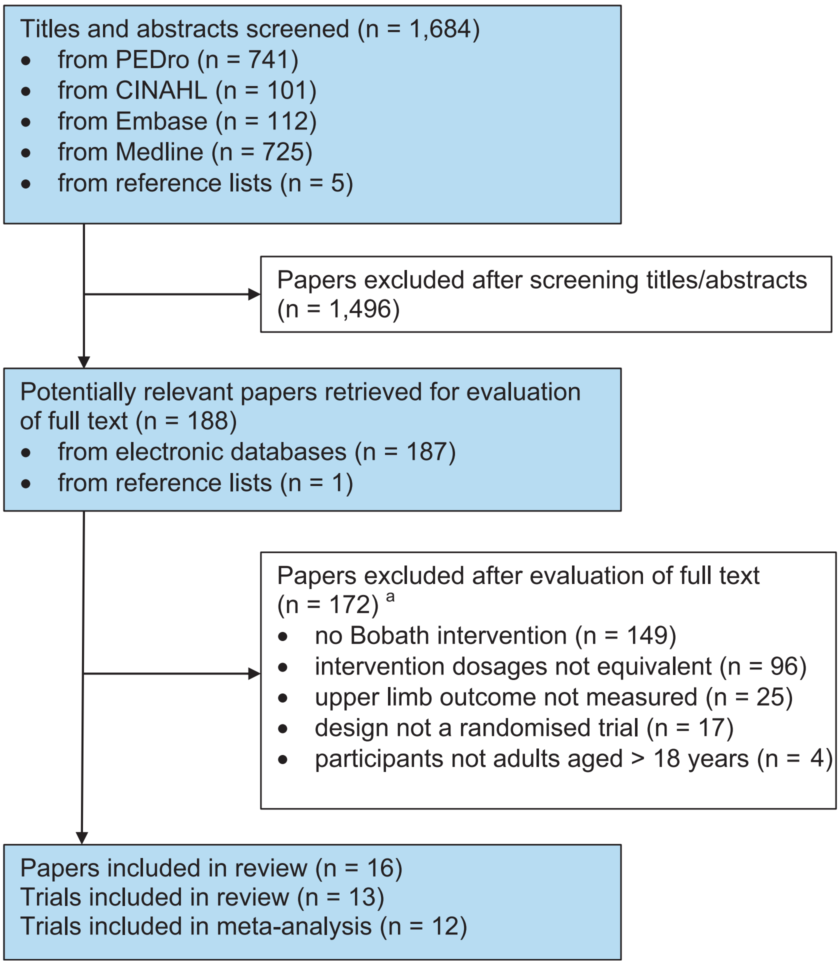

Figure 1. Flow of trials through the review.
[a] Papers may have met more than one exclusion criterion.

However, this estimate had substantial uncertainty (MD –0.65 s, 95% CI –2.12 to 0.82).[23]

Sensitivity analyses

Sensitivity analyses of the effect of Bobath therapy compared with other interventions on arm activity using no imputed data were calculated. These meta-analyses had very similar results to the analyses with imputed data. The SMD of Bobath therapy compared with task-specific training (two trials involving 36 participants) was –1.16, 95% CI –1.89 to –0.44. The SMD of Bobath therapy compared with arm movements (three trials involving 186 participants) was –0.13, 95% CI –0.42 to 0.16. See Figures 6 and 7 on the eAddenda.

Effect of Bobath therapy versus other interventions on arm strength outcomes

The effect of Bobath therapy compared with task-specific training was examined by pooling outcomes from three trials involving 138 participants (Figure 8). The pooled WMD of Fugl-Meyer motor outcome scores was in favour of task-specific training (MD –7.84 points), although the true size of the effect may be substantially smaller or larger than this estimate (95% CI –2.69 to –12.99 points, I^2 = 40%). For a detailed forest plot, see Figure 9 on the eAddenda.

The effect of Bobath therapy compared with task-specific training was also examined by pooling strength outcomes from two trials involving 109 participants (Figure 10). The SMD point estimate was a large effect in favour of task-specific training (SMD –1.08), although the confidence interval showed substantial uncertainty in this estimate (95% CI –3.17 to 1.01, I^2 = 95%). For a detailed forest plot, see Figure 11 on the eAddenda.

The effect of Bobath therapy compared with arm movements was examined by pooling outcomes from three trials involving 179 participants (Figure 12). The pooled MD point estimate of Fugl-Meyer motor score indicated slightly more benefit from arm movements (MD –2.46), although the confidence interval showed substantial uncertainty in this estimate (95% CI –7.09 to 2.16, I^2= 76%). For a detailed forest plot, see Figure 13 on the eAddenda.

The effect of Bobath therapy compared with robotics was examined by pooling strength outcomes from two trials involving 81 participants (Figure 14). The pooled SMD indicated slightly better benefit from robotics (SMD –0.25), although the confidence interval showed substantial uncertainty in this estimate (95% CI –0.69 to 0.19, I^2 = 0%). There was substantial heterogeneity in some of the pooled analyses but there were no predictors to explore that could potentially explain this heterogeneity. For a detailed forest plot, see Figure 15 on the eAddenda.

The effect of Bobath therapy compared with mental practice was examined in one trial of 39 participants. The median and interquartile range of the change scores was converted to mean and SD.[25,26] The MD of grip strength indicated similar effects of Bobath therapy and mental practice (0.43 kg in favour of the mental practice group), although the estimate is unclear (95% CI –2.83 to 3.69).[23]

Discussion

Bobath therapy was less effective than task-specific training and robotics in improving arm activity after stroke. Arm movements were

Table 1
Characteristics of included trials.

Trial	Participants	Intervention	Outcome measures	
Arya 2012[19]	N = 103 Age *(yr)* Bobath = 50 (SD 8) Comparison = 52 (SD 8) Chronicity *(wk)* Bobath = 12 (SD 7) Comparison = 12 (SD 6)	Bobath (n = 52): training based on the Bobath neurodevelopmental technique Comparison (n = 51): task-specific training (motor learning and shaping) Dosage: 60 min, 4 to 5/wk, 4 wk	Activity • ARAT[a] • WMFT • MAL Timing: 0 wk, 4 wk	Impairment • FMA
Basmajian 1987[18]	N = 29 Age *(yr)* All = 62 (39 to 79) Chronicity *(wk)* All = 16 (4 to 44)	Bobath (n = 16): therapy based on Bobath therapeutic exercises Comparison (n = 13): arm movements (skill acquisition with EMG biofeedback) Dosage: 45 min, 3/wk, 5 wk	Activity • UEFT Timing: 0 wk, 5 wk	Impairment • Finger oscillation test
El-Bahrawy 2012[11]	N = 40 Age *(yr)* Bobath = 49 (SD 3) Comparison = 51 (SD 3) Chronicity *(mo)* Bobath = 8 (SD 1) Comparison = 9 (SD 2)	Bobath (n = 20): training based on Bobath principles Comparison (n = 20): task-specific training (drinking task involving reach, grasp and release) Both: electrical stimulation at the wrist for 30 min, 3/wk, 6 wk Dosage: 45 min, 3/wk, 6 wk	Activity • PPT Timing: 0 wk, 6 wk	Impairment • Grip strength • Modified Ashworth scale
Lum 2002[9]	N = 27 Age *(yr)* Bobath = 66 (SD 2) Comparison = 63 (SD 4) Chronicity *(mo)* Bobath = 29 (SD 6) Comparison = 30 (SD 6)	Bobath (n = 14): training based on neurodevelopmental therapy Comparison (n = 13): robotics (reaching to target with upper limb in a robotic device) Both: tone normalisation and limb positioning for 10 min, 24 in 8 wk Dosage: 50 min, 24 in 8 wk	Activity • Reach distance Timing: 0 wk, 8 wk	Impairment • FMA[a] • Shoulder muscle strength[a] • Elbow muscle strength
Moon 2018[24]	N = 18 Age *(yr)* Bobath = 63 (SD 12) Comparison = 71 (SD 9) Chronicity (d) Bobath = 21 (SD 5) Comparison = 18 (SD 5)	Bobath (n = 9): neurodevelopmental therapy-based manual exercise Comparison (n = 9): task-specific training (upper limb circuit training using putty, skate, incline board, stacking cones, range of motion arc and ring) Dosage: 20 min, 5 to 6/wk, 4 wk	Activity • MAL Timing: 0 wk, 4 wk	Impairment • FMA
Piron 2010[8]	N = 50 Age *(yr)* Bobath = 62 (SD 10) Comparison = 59 (SD 8) Chronicity *(mo)* Bobath = 15 (SD 12) Comparison = 15 (SD 13)	Bobath (n = 23): specific exercises based on Bobath principles Comparison (n = 27): arm movements (reach and grasp movements with affected arm using motion-tracking equipment) Dosage: 60 min, 5/wk, 4 wk	Activity • Timed reach task Timing: 0 wk, 4 wk	Impairment • FMA
Platz 2005[17]	N = 40 Age *(yr)* Bobath = 61 (SD 11) Comparison = 63 (SD 13) Chronicity *(wk)* Bobath = 7 (SD 4) Comparison = 6 (SD 4)	Bobath (n = 20): therapy following a Bobath manual, supervised by a senior Bobath instructor. Comparison (n = 20): arm movements (repetitive training of arm movements through available range of motion) Both: usual standard rehabilitation therapy (activities of daily living, arm activities, stance, gait, speech and cognition) Dosage: 45 min, 20 in 4 wk	Activity • ARAT Timing: 0 wk, 4 wk	Impairment • FMA • Ashworth Scale
Schuster-Amft 2018[22]	N = 54 Age *(yr)* Bobath = 61 (SD 11) Comparison = 61 (SD 13) Chronicity *(yr)* Bobath = 3.6 (SD 3.7) Comparison = 2.4 (SD 2.4)	Bobath (n = 32): therapy based on neurodevelopmental training principles Comparison (n = 22): arm movements (virtual reality-based training of upper limb movements) Dosage: 45 min, 16 in 4 wk	Activity • BBT[a] • CAHAI-13 Timing: 0 wk, 4 wk	Impairment • CMSA • Line bisection test
Suputtitada 2004[20]	N = 69 Age *(yr)* Bobath = 59 (SD 4) Comparison = 60 (SD 5) Chronicity *(yr)* > 80% of participants (range) = 1 to 3	Bobath (n = 36): activities based on the neurodevelopmental training method Comparison (n = 33): task-specific training (CIMT) Dosage: 6hr, 5/wk, 2 wk	Activity • ARAT Timing: 0 wk, 2 wk	Impairment • Grip strength[a] • Pinch strength
Tariah 2010[21]	N = 18 Age *(yr)* Bobath = 61 (SD 5) Comparison = 55 (SD 11) Chronicity *(mo)* Bobath = 9 (SD 6) Comparison = 10 (SD 4)	Bobath (n = 8): facilitation of arm movement based on neurodevelopmental principles Comparison (n = 10): task-specific training (reach, grasp and manipulation tasks, restraint applied to intact arm) Dosage: 120 min, 7/wk, 8 wk	Activity • WMFT[a] • MAL Timing: 0 wk, 8 wk	Impairment • FMA

Table 1 (*Continued*)

Trial	Participants	Intervention	Outcome measures	
			Activity	Impairment
Taveggia 2016[16]	N = 54 *Age (yr)* Bobath = 68 (SD 13) Comparison = 73 (SD 10) Chronicity *(mo)* All (range) = 0.5 to 12	Bobath (n = 27): passive and active-assisted mobilisation based on the Bobath concept Comparison (n = 27): robotics (upper limb movements in 'Armeo Spring' robotic device) Both: conventional treatment 30 min, 5/wk, 6 wk Dosage: 30 min, 5/wk, 6 wk	Activity Timing: 0 wk, 6 wk	Impairment • MI[a] • Modified Ashworth Scale • Hand pain
Timmermans 2013[23]	N = 42 *Age (yr)* Bobath = 59 (SD 10) Comparison = 60 (SD 7) Chronicity (d) Bobath = 32 (SD 18) Comparison = 36 (SD 27)	Bobath (n = 21): exercise based on neurodevelopmental training principles Comparison (n = 21): mental practice (mental practice of functional arm movements) Both: usual therapy Dosage: 30 min, 7/wk, 6 wk	Activity • FAI • WMFT[a] • Arm accelerometry Timing: 0 wk, 6 wk	Impairment • FMA[a] • Grip strength[a]
Whitall 2011[12]	N = 92 *Age (yr)* Bobath = 58 (SD 13) Comparison = 60 (SD 10) Chronicity *(yr)* Bobath = 4.1 (SD 5.2) Comparison = 4.5 (SD 4.1)	Bobath (n = 50): exercises based on neurodevelopmental training principles Comparison (n = 42): arm movements (reaching task within a training apparatus of handlebars moved along linear tracks) Dosage: 60 min, 3/wk, 6 wk	Activity • WMFT Timing: 0 wk, 6 wk	Impairment • FMA[a] • Shoulder muscle strength • Elbow muscle strength • Wrist muscle strength • Shoulder ROM • Elbow ROM • Wrist ROM • Thumb ROM

ARAT = Action Research Arm Test, WMFT = Wolf Motor Function Test, MAL = Motor Activity Log, FMA = Fugl-Meyer Assessment, UEFT = Upper Extremity Function Test, PPT = Purdue Pegboard Test, MI = Motricity Index, FAI = Frenchay Activities Index, BBT = Box and Block Test, CAHAI-13 = Chedoke McMaster Arm and Hand Activity Inventory, CMAS = Chedoke-McMaster Stroke Assessment.
[a] Indicates outcome measure used for analysis.

Table 2
PEDro scores of included studies.

Study	Random allocation	Concealed allocation	Groups similar at baseline	Participant blinding	Therapist blinding	Assessor blinding	< 15% dropouts	Intention-to-treat analysis	Between-group difference reported	Point estimate and variability reported	Total *(0 to 10)*
Ayra 2012[19]	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8
Basmajian 1987[18]	Y	N	Y	N	N	Y	N	N	Y	Y	5
El-Bahrawy 2012[11]	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8
Lum 2002[9]	Y	N	Y	N	N	Y	Y	N	Y	Y	6
Moon 2018[24]	Y	N	Y	N	N	N	Y	N	Y	Y	5
Piron 2010[8]	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8
Platz 2005[17]	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8
Schuster-Amft 2018[22]	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8
Supittitada 2004[20]	Y	N	Y	N	N	Y	Y	Y	Y	Y	7
Tariah 2010[21]	Y	N	Y	N	N	Y	Y	N	Y	Y	6
Taveggia 2016[16]	Y	N	Y	N	N	Y	Y	Y	Y	Y	7
Timmermans 2013[23]	Y	N	Y	N	N	Y	Y	Y	Y	Y	7
Whitall 2011[12]	Y	N	Y	N	N	Y	N	Y	Y	Y	6

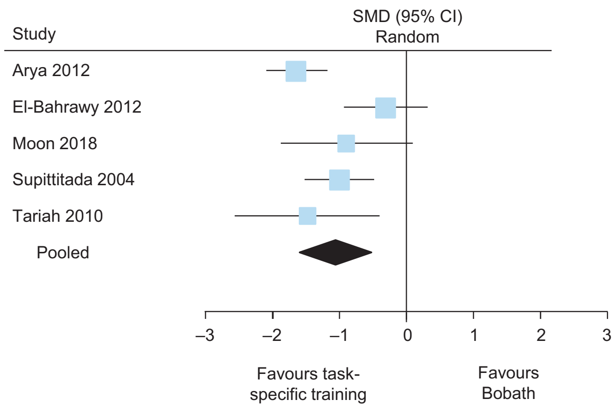

Figure 2. Standardised mean difference (95% CI) in the effect of Bobath therapy versus task-specific training on activity outcomes.

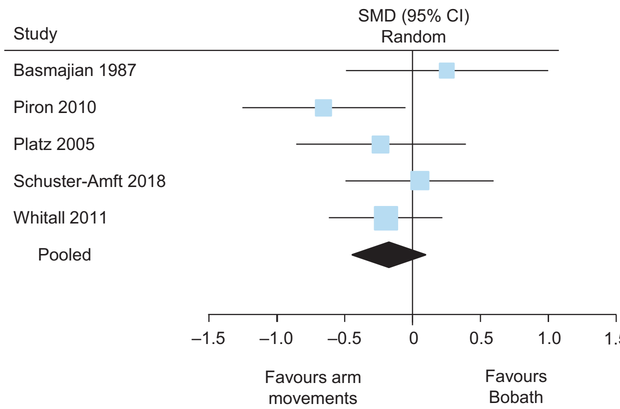

Figure 4. Standardised mean difference (95% CI) in the effect of Bobath therapy versus arm movements on activity outcomes.

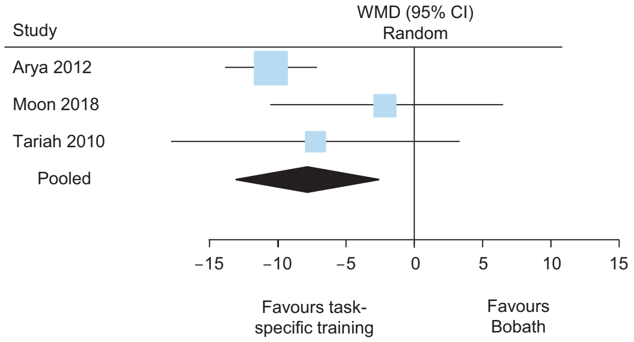

Figure 8. Weighted mean difference (95% CI) in the effect of Bobath therapy versus task-specific training on Fugl-Meyer Assessment score.

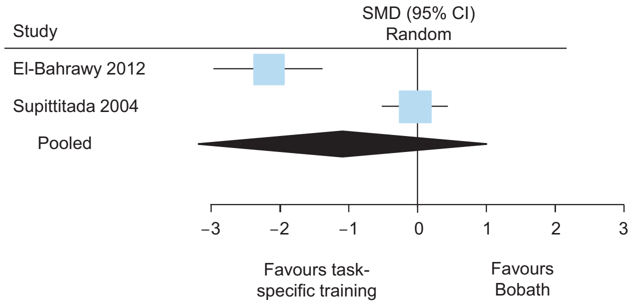

Figure 10. Standardised mean difference (95% CI) in the effect of Bobath therapy versus task-specific training on strength outcomes.

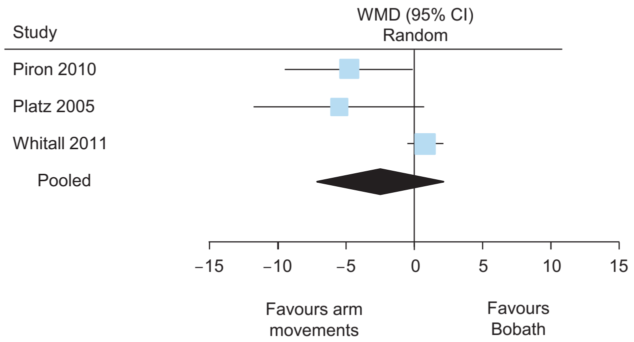

Figure 12. Weighted mean difference (95% CI) in the effect of Bobath therapy versus arm movements on Fugl-Meyer Assessment score.

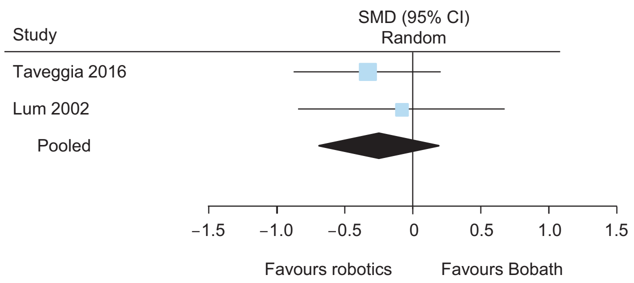

Figure 14. Standardised mean difference (95% CI) in the effect of Bobath therapy versus arm robotics on strength outcomes.

similar to or better than Bobath at improving arm activity after stroke. Bobath therapy and mental practice had similar efficacy for improving arm activity after stroke. Bobath therapy was less effective than task-specific training in improving arm strength after stroke measured with the Fugl-Meyer motor score but the difference between Bobath therapy and task-specific training in improving arm strength measured with specific strength measures remains very unclear. Robotics and arm movements were similar to or better than Bobath therapy for improving arm strength after stroke. The relative efficacy of Bobath therapy and mental practice for improving arm strength after stroke remains unclear.

There is a large body of evidence to guide rehabilitation interventions following stroke. Clinical guidelines for stroke rehabilitation universally recommend intensive task-specific training, with no clinical guidelines recommending Bobath therapy. Previous systematic reviews of rehabilitation for the arm after stroke generally conclude that other interventions are more effective than Bobath therapy, or that there is insufficient evidence to make conclusions about the relative effectiveness of different interventions and treatment approaches.[3–7] However, these previous reviews have included relatively low numbers of trials with small sample sizes. The current review was able to include 13 trials involving close to 600 participants. Findings from this comprehensive review, combined with conclusions from previous reviews, confirm that task-specific training and robotics result in improved arm outcomes for stroke survivors when compared with Bobath therapy.

The results of this systematic review show that task-specific training is superior to Bobath therapy for arm activity outcomes, with the 95% CI for the activity outcomes showing a moderate to large effect size (between 0.55 and 1.59) in favour of task-specific training for activity. Additionally, task-specific training is superior or equivalent to Bobath therapy for arm strength outcomes. Task-specific training involves intensive practice of the tasks a person is trying to improve. When motor impairments do not allow individuals to practise tasks in their entirety, there is evidence to support training of components of tasks without being passively moved or assisted. For example, 'shaping' strategies used in constraint-induced movement therapy involve the use of part-practice to target a person's specific activity limitations. This differs fundamentally from Bobath therapy, where therapists believe that facilitation of movement by passive (or active-assisted) guidance of movements in a specific way, focusing on postural control, will lead to improved outcomes for stroke survivors.[2] Bobath therapy is reliant on the therapist assisting the stroke survivor and hence requires more staff time and is more resource intensive. The use of therapies such as task-specific training, arm movements, robotics and mental practice provides stroke survivors with increased opportunity to independently and intensively practise the arm movements and tasks that they are aiming to improve. Even a finding of equivalent outcomes would indicate that therapists should prioritise these other therapies over Bobath therapy.

As found in a previous review of lower limb outcomes,[27] limitations included the lack of clarity in definitions provided about Bobath therapy. Bobath therapy is an approach rather than one discrete intervention; consequently, it is difficult to standardise the interventions between therapists or trial interventions. However, there is an underpinning belief of Bobath therapy that therapists need to facilitate movements that focus on postural control and the trunk, and this appears to be common to the interventions described in these trials. The publication dates and quality scores of the included trials could be considered as limitations, as the trials were published between 1987 and 2018 and there was variety in the methodological quality. However, eight of the 13 studies scored 7 or 8 on the PEDro scale and the lowest score was 5. A strength of this review was that the search was comprehensive, and it included a greater number of trials than previous reviews on this topic. Importantly, it only included trials where the dose of Bobath therapy targeting the affected arm and the comparison intervention were matched. Thus, differences in the dose of treatments cannot be considered a possible reason for the differences in measured outcomes.

In conclusion, Bobath therapy is less effective than task-specific training and robotics for improving arm activities after stroke. Bobath therapy is less effective than task-specific training for improving arm strength after stroke, as reflected in the Fugl-Meyer Assessment score. Use of Bobath therapy in preference to other interventions is not supported.

What is already known on this topic: Bobath therapy is widely used in stroke rehabilitation, despite a growing body of evidence challenging its efficacy and underlying beliefs.
What this study adds: This review shows that task-specific training and robotic training is more effective than Bobath therapy for improving upper limb activity outcomes after stroke. Task-specific training is also more effective than Bobath therapy for improving Fugl-Meyer Assessment score after stroke. It challenges the prioritisation of Bobath therapy in stroke rehabilitation.

eAddenda: Appendices 1 to 5 and Figures 3, 5, 6, 7, 9, 11, 13 and 15 can be found online at https://doi.org/10.1016/j.jphys.2022.11.008

Ethics approval: Nil.
Competing interests: Authors SD, KS, AM, KS are directors of StrokeEd and earn some income from workshops on evidence-based therapy in stroke rehabilitation.
Source(s) of support: Nil.
Acknowledgements: Izumi Ibayashi for reviewing non-English manuscripts.
Providence: Not invited. Peer reviewed.
Correspondence: Simone Dorsch, School of Allied Health, Australian Catholic University, Sydney, Australia. Email: simone.dorsch@acu.edu.au

References

1. Michielsen M, Vaughan-Graham JA, Holland A, Magri A, Suzuki M. The Bobath concept - a model to illustrate clinical practice: responding to comments on Michielsen et al. *Disabil Rehabil*. 2019;41:2109–2110.
2. Vaughan-Graham J, Cheryl C, Holland A, Michielsen M, Magri A, Suzuki M, et al. Developing a revised definition of the Bobath concept: Phase three. *Physiother Res Int*. 2020;25:e1832.
3. Hiraoka K. Rehabilitation effort to improve upper extremity function in post-stroke patients: a meta-analysis. *J Phys Ther Sci*. 2001;13:5–9.
4. Wattchow KA, McDonnell MN, Hillier SL. Rehabilitation interventions for upper limb function in the first four weeks following stroke: a systematic review and meta-analysis of the evidence. *Arch Phys Med Rehabil*. 2018;99:367–382.
5. Kollen BJ, Lennon S, Lyons B, Wheatley-Smith L, Scheper M, Buurke JH, et al. The effectiveness of the Bobath concept in stroke rehabilitation what is the evidence? *Stroke*. 2009;40:e89–e97.
6. Luke C, Dodd KJ, Brock K. Outcomes of the Bobath concept on upper limb recovery following stroke. *Clin Rehabil*. 2004;18:888–898.
7. Díaz-Arribas MJ, Martín-Casas P, Cano-de-la-Cuerda R, Plaza-Manzano G. Effectiveness of the Bobath concept in the treatment of stroke: a systematic review. *Disabil Rehabil*. 2020;42:1636–1649.
8. Piron L, Turolla A, Agostini M, Zucconi CS, Ventura L, Tonin P, et al. Motor learning principles for rehabilitation: a pilot randomized controlled study in poststroke patients. *Neurorehabil Neural Repair*. 2010;24:501–508.
9. Lum PS, Burgar CG, Shor PC, Majmundar M, Van der Loos M. Robot-assisted movement training compared with conventional therapy techniques for the rehabilitation of upper-limb motor function after stroke. *Arch Phys Med Rehabil*. 2002;83:952–959.
10. Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (Eds). Cochrane Handbook for Systematic Reviews of Interventions version 6.3 (updated February 2022). Cochrane, 2022. Available from www.training.cochrane.org/handbook. Accessed November 12, 2022.
11. El-Bahrawy MNEA. Efficacy of motor relearning approach on hand function in chronic stroke patients. A controlled randomized study. *Ital J Physiother*. 2012;2:4.
12. Whitall J, Waller SM, Sorkin JD, Forrester LW, Macko RF, Hanley DF, et al. Bilateral and Unilateral Arm Training Improve Motor Function Through Differing Neuroplastic Mechanisms: A Single-Blinded Randomized Controlled Trial. *Neurorehabil Neural Repair*. 2011;25:118–129.
13. DerSimonian R, Laird N. Meta-analysis in clinical trials revisited. *Contemp Clin Trials*. 2015;45:139–145.
14. Hozo SP, Djulbegovic B, Hozo I. Estimating the mean and variance from the median, range, and the size of a sample. *BMC Med Res Methodol*. 2005;5:13.
15. Schwarzer G. meta: An R Package for Meta-Analysis. *R news*. 2007;7:40–45.
16. Taveggia G, Borboni A, Salvi L, Mulé C, Fogliaresi S, Villafañe JH, et al. Efficacy of robot-assisted rehabilitation for the functional recovery of the upper limb in post-stroke patients: a randomized controlled study. *Eur J Phys Rehabil Med*. 2016;52:767–773.
17. Platz T, Eickhof C, van Kaick S, Engel U, Pinkowski C, Kalok S, et al. Impairment-oriented training or Bobath therapy for severe arm paresis after stroke: a single-blind, multicentre randomized controlled trial. *Clin Rehabil*. 2005;19:714–724.
18. Basmajian JV, Gowland CA, Finlayson MA, Hall AL, Swanson LR, Stratford PW, et al. Stroke treatment: comparison of integrated behavioral-physical therapy vs traditional physical therapy programs. *Arch Phys Med Rehabil*. 1987;68:267–272.
19. Arya KN, Verma R, Garg RK, Sharma VP, Agarwal M, Aggarwal GG. Meaningful task-specific training (MTST) for stroke rehabilitation: a randomized controlled trial. *Top Stroke Rehabil*. 2012;19:193–211.
20. Suputtitada A, Suwanwela NC, Tumvitee S. Effectiveness of constraint-induced movement therapy in chronic stroke patients. *J Med Assoc Thai*. 2004;87:1482–1490.
21. Tariah HA, Almalty A-M, Sbeih Z, Al-Oraibi S. Constraint induced movement therapy for stroke survivors in Jordon: a home-based model. *Int J Ther Rehabil*. 2010;17:638–646.
22. Schuster-Amft C, Eng K, Suica Z, Thaler I, Signer S, Lehmann I, et al. Effect of a four-week virtual reality-based training versus conventional therapy on upper limb motor function after stroke: A multicenter parallel group randomized trial. *PloS one*. 2018;13:e0204455.
23. Timmermans AAAP, Verbunt JAMDP, van Woerden RM, Moennekens MMD, Pernot DHMD, Seelen HAMP. Effect of mental practice on the improvement of function and daily activity performance of the upper extremity in patients with subacute stroke: a randomized clinical trial. *J Am Med Dir Assoc*. 2013;14:204–212.
24. Moon JH, Park KY, Kim HJ, Na CH. The effects of task-oriented circuit training using rehabilitation tools on the upper-extremity functions and daily activities of patients with acute stroke: a randomized controlled pilot trial. *Osong Public Health Res Perspect*. 2018;9:225–230.
25. Luo D, Wan X, Liu J, Tong T. Optimally estimating the sample mean from the sample size, median, mid-range and/or mid-quartile range. *Stat Methods Med Res*. 2018;27:1785–1805.
26. Wan X, Wang W, Liu J, Tong T. Estimating the sample mean and standard deviation from the sample size, median, range and/or interquartile range. *BMC Med Res Methodol*. 2014;14:135.
27. Scrivener K, Dorsch S, McCluskey A, Schurr K, Graham PL, Cao Z, et al. Bobath therapy is inferior to task-specific training and not superior to other interventions in improving lower limb activities after stroke: a systematic review. *J Physiother*. 2020;66:225–235.