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Swallowing therapy for dysphagia in acute and subacute stroke (Review)

Bath PM, Lee HS, Everton LF

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Swallowing therapy for dysphagia in acute and subacute stroke.
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[Intervention Review]

Swallowing therapy for dysphagia in acute and subacute stroke

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ABSTRACT

Background

Dysphagia (swallowing problems), which is common after stroke, is associated with increased risk of death or dependency, occurrence of pneumonia, poor quality of life, and longer hospital stay. Treatments provided to improve dysphagia are aimed at accelerating recovery of swallowing function and reducing these risks. This is an update of the review first published in 1999 and updated in 2012.

Objectives

To assess the effects of swallowing therapy on death or dependency among stroke survivors with dysphagia within six months of stroke onset.

Search methods

We searched the Cochrane Stroke Group Trials Register (26 June 2018), the Cochrane Central Register of Controlled Trials (CENTRAL; 2018, Issue 6) in the Cochrane Library (searched 26 June 2018), MEDLINE (26 June 2018), Embase (26 June 2018), the Cumulative Index to Nursing and Allied Health Literature (CINAHL) (26 June 2018), Web of Science Core Collection (26 June 2018), SpeechBITE (28 June 2016), ClinicalTrials.Gov (26 June 2018), and the World Health Organization International Clinical Trials Registry Platform (26 June 2018). We also searched Google Scholar (7 June 2018) and the reference lists of relevant trials and review articles.

Selection criteria

We sought to include randomised controlled trials (RCTs) of interventions for people with dysphagia and recent stroke (within six months).

Data collection and analysis

Two review authors independently applied the inclusion criteria, extracted data, assessed risk of bias, used the GRADE approach to assess the quality of evidence, and resolved disagreements through discussion with the third review author (PB). We used random-effects models to calculate odds ratios (ORs), mean differences (MDs), and standardised mean differences (SMDs), and provided 95% confidence intervals (CIs) for each.

The primary outcome was functional outcome, defined as death or dependency (or death or disability), at the end of the trial. Secondary outcomes were case fatality at the end of the trial, length of inpatient stay, proportion of participants with dysphagia at the end of the trial, swallowing ability, penetration aspiration score, or pneumonia, pharyngeal transit time, institutionalisation, and nutrition.

Main results

We added 27 new studies (1777 participants) to this update to include a total of 41 trials (2660 participants).

We assessed the efficacy of swallowing therapy overall and in subgroups by type of intervention: acupuncture (11 studies), behavioural interventions (nine studies), drug therapy (three studies), neuromuscular electrical stimulation (NMES; six studies), pharyngeal electrical stimulation (PES; four studies), physical stimulation (three studies), transcranial direct current stimulation (tDCS; two studies), and transcranial magnetic stimulation (TMS; nine studies).

Swallowing therapy had no effect on the primary outcome (death or dependency/disability at the end of the trial) based on data from one trial (two data sets) (OR 1.05, 95% CI 0.63 to 1.75; 306 participants; 2 studies; I^2 = 0%; P = 0.86; moderate-quality evidence). Swallowing therapy had no effect on case fatality at the end of the trial (OR 1.00, 95% CI 0.66 to 1.52; 766 participants; 14 studies; I^2 = 6%; P = 0.99; moderate-quality evidence). Swallowing therapy probably reduced length of inpatient stay (MD -2.9, 95% CI -5.65 to -0.15; 577 participants; 8 studies; I^2 = 11%; P = 0.04; moderate-quality evidence). Researchers found no evidence of a subgroup effect based on testing for subgroup differences (P = 0.54). Swallowing therapy may have reduced the proportion of participants with dysphagia at the end of the trial (OR 0.42, 95% CI 0.32 to 0.55; 1487 participants; 23 studies; I^2 = 0%; P = 0.00001; low-quality evidence). Trial results show no evidence of a subgroup effect based on testing for subgroup differences (P = 0.91). Swallowing therapy may improve swallowing ability (SMD -0.66, 95% CI -1.01 to -0.32; 1173 participants; 26 studies; I^2 = 86%; P = 0.0002; very low-quality evidence). We found no evidence of a subgroup effect based on testing for subgroup differences (P = 0.09). We noted moderate to substantial heterogeneity between trials for these interventions. Swallowing therapy did not reduce the penetration aspiration score (i.e. it did not reduce radiological aspiration) (SMD -0.37, 95% CI -0.74 to -0.00; 303 participants; 11 studies; I^2 = 46%; P = 0.05; low-quality evidence). Swallowing therapy may reduce the incidence of chest infection or pneumonia (OR 0.36, 95% CI 0.16 to 0.78; 618 participants; 9 studies; I^2 = 59%; P = 0.009; very low-quality evidence).

Authors' conclusions

Moderate- and low-quality evidence suggests that swallowing therapy did not have a significant effect on the outcomes of death or dependency/disability, case fatality at the end of the trial, or penetration aspiration score. However, swallowing therapy may have reduced length of hospital stay, dysphagia, and chest infections, and may have improved swallowing ability. However, these results are based on evidence of variable quality, involving a variety of interventions. Further high-quality trials are needed to test whether specific interventions are effective.

PLAIN LANGUAGE SUMMARY

Swallowing therapy for difficulties with swallowing in stroke survivors who have had a recent stroke

Question

We wanted to assess the effectiveness of swallowing therapy for stroke survivors with dysphagia (difficulty in swallowing). We looked at swallowing therapy in survivors up to six months after stroke.

Background

Stroke often results in difficulty swallowing. This can lead to choking, chest infections, poorer quality of life, longer hospital stay, and increased risk of death or discharge to a care home. Therapy to improve swallowing aims to speed up recovery of swallowing function and reduce these risks.

Study characteristics

This is an update of the review originally published in 1999 and previously updated in 2012. We have now included a total of 41 studies (2660 participants), and the evidence is current to June 2018. Swallowing therapy comprises several different treatment types, and we looked at eight of these: acupuncture (11 studies), behavioural interventions (nine studies), drug therapy (three studies), neuromuscular electrical stimulation (NMES; six studies), pharyngeal electrical stimulation (PES; four studies), physical stimulation (three studies), transcranial direct current stimulation (tDCS; two studies), and transcranial magnetic stimulation (TMS; nine studies).

Key results

Swallowing therapy did not result in less death or disability among stroke survivors, nor did it lead to a safer swallow after treatment. However, some individual swallowing therapies seemed to reduce hospital length of stay, lessen the chance of getting a chest infection

or pneumonia, or improve swallowing ability and recovery from swallowing problems. Many of the swallowing therapies involved different methods of delivery, so it is still not clear which approach is most effective for each type of therapy.

Quality of the evidence

The quality of the evidence was generally very low, low, or moderate. Additional high-quality studies are needed.

SUMMARY OF FINDINGS FOR THE MAIN COMPARISON [Explanation]

Swallowing therapy compared to placebo for dysphagia in acute and subacute stroke

Patient or population: dysphagia in acute and subacute stroke
Setting: in hospital
Intervention: swallowing therapy
Comparison: placebo

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No. of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with placebo	Risk with swallowing therapy				
Death or dependency at end of trial	Study population		OR 1.05 (0.63 to 1.75)	306 (2 RCTs)	⊕⊕⊕◯ Moderate	a
	693 per 1000	703 per 1000 (587 to 798)				
Case fatality at end of trial	Study population		OR 1.00 (0.66 to 1.52)	766 (14 RCTs)	⊕⊕⊕◯ Moderate	b
	197 per 1000	197 per 1000 (140 to 272)				
Length of inpatient stay (days)	Mean length of inpatient stay (days) ranged from 19 to 119	MD 2.9 lower (5.65 lower to 0.15 lower)	-	577 (8 RCTs)	⊕⊕⊕◯ Moderate	c
Proportion of participants with dysphagia at end of trial	Study population		OR 0.42 (0.32 to 0.55)	1487 (23 RCTs)	⊕⊕◯◯ Low	d
	570 per 1000	357 per 1000 (298 to 421)				
Swallowing ability	Mean swallowing ability was 0	SMD 0.66 lower (1.01 lower to 0.32 lower)	-	1173 (26 RCTs)	⊕◯◯◯ Very low	e

Penetration aspiration score	Mean penetration aspiration score was 0	SMD 0.37 lower (0.74 lower to 0)	-	303 (11 RCTs)	⊕⊕◯◯ Low	f
Adverse event: chest infection or pneumonia	Study population		OR 0.34 (0.17 to 0.71)	676 (10 RCTs)	⊕◯◯◯ Very low	g
	343 per 1000	151 per 100 (82 to 271)				

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

CI: confidence interval; OR: odds ratio; RCT: randomised controlled trial

GRADE Working Group grades of evidence.
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect

[a] Downgraded by one level due to lack of precision (one study split into two trials).
[b] Downgraded by one level for indirectness of the evidence (i.e. multiple different interventions).
[c] Downgraded by one level due to indirectness of the evidence (i.e. multiple different interventions). Note also that two studies had unclear blinding.
[d] Downgraded by two levels due to indirectness of the evidence and blinding - a large number of studies did not clarify blinding status.
[e] Downgraded by three levels due to indirectness of the evidence (i.e. multiple different interventions), considerable heterogeneity, and fair number of studies did not clarify blinding status.
[f] Downgraded by two levels due to indirectness of the evidence (i.e. multiple different interventions) and moderate heterogeneity.
[g] Downgraded by three levels due to indirectness of the evidence (i.e. multiple different interventions), substantial heterogeneity, and fair number of studies did not clarify blinding status.

BACKGROUND

Description of the condition

Dysphagia after stroke is common, affecting 27% to 64% of stroke survivors (Gordon 1987; Wolfe 1993; Odderson 1995; Smithard 1996; Mann 2000; Singh 2006a; Rofes 2013). Although dysphagia improves spontaneously in many people with stroke (by two weeks in about half), some will die and 15% of stroke survivors will still have swallowing problems at one month (Smithard 1993); many of these individuals require long-term feeding with significant impairment of function, recovery, and quality of life (Barer 1989; Smithard 1997; Mann 1999; Perry 2004). Complications of dysphagia include aspiration leading to chest infection and pneumonia, malnutrition, inability to rehabilitate, increased risk of infection, prolonged length of stay in hospital, and increased risk of death (Smithard 1993; Odderson 1995; Finestone 1996; Smithard 1996; Sharma 2001; Martino 2005; Arnold 2016). Early identification and management of dysphagia have been shown to reduce pneumonia rates (Odderson 1995; Ramsey 2003; Hinchey 2005; Lakshminarayan 2010). Cohen 2016 recently reviewed this topic.

Description of the intervention

Speech and language therapists (SLTs) often administer interventions for treating dysphagia. These interventions involve behavioural approaches that may be compensatory or rehabilitative in nature. Compensatory approaches include modification of fluid and food consistencies, postural techniques such as adopting a chin tuck position, and swallow strategies such as a supraglottic swallow. Rehabilitative methods include swallowing exercises that focus on muscle strength; resistance or skill training, or both, such as tongue exercises, effortful swallow, and Mendelsohn's manoeuvre (Mendelsohn 1987); and the Shaker exercise (Shaker 2002). Rehabilitative methods also include peripheral sensory stimulation, such as physical stimulation with tactile, thermal, or sour stimulation (Lazarra 1986; Logemann 1991; Logemann 1993; Rosenbek 1996; U1111-1188-0335); carbonation (Krival 2008); electrical stimulation (Power 2006); and air pulses (Theurer 2013). Researchers have also studied chemical and pharmacological agents, including capsaicin, black pepper oil, cabergoline, angiotensin-converting enzyme (ACE) inhibitors, and nifedipine (Arai 2003; Ebihira 2004; Ebihira 2005).

Practitioners in China routinely use acupuncture techniques to treat dysphagia (Wong 2012).

Several other stimulation methods to promote recovery from dysphagia post stroke have emerged in recent years, in particular peripheral and central stimulation methods. Peripheral methods include pharyngeal electrical stimulation (PES), as reported in Scutt 2015, and neuromuscular surface electrical stimulation (NMES), as described in Chen 2016. Central stimulation methods, also known as non-invasive brain stimulation, include transcranial magnetic stimulation (TMS) (Momosaki 2016; Pisegna 2016), as well as transcranial direct current stimulation (tDCS) (Momosaki 2016; Pisegna 2016).

How the intervention might work

The swallowing network is asymmetrically represented in both cerebral hemispheres, with one hemisphere showing dominance for swallowing (Hamdy 1998). Following unilateral stroke, TMS studies have demonstrated that recovery from dysphagia is associated with improved function of the non-lesioned hemisphere (Hamdy 1998). The aim of most of the interventions described in this review is to accelerate this process of plasticity in acute and sub-acute stroke patients with dysphagia. The exact process by which this is achieved is not fully understood, although it is thought that some interventions specifically aim to improve swallowing by enhancing sensory drive to the brain, causing increased activity in motor swallowing areas.

Why it is important to do this review

Dysphagia post stroke affects quality of life, carries increased risks of mortality and dependency (Smithard 1996; Arnold 2016), prolongs hospital stay (Smithard 1996; Smithard 1997; Arnold 2016), increases healthcare costs, and often leads to discharge from hospital to a care home (Smithard 1996; Arnold 2016). Despite all of this, the previous two versions of this review concluded in 1999 and 2012 that overall, current evidence for interventions was insufficient, and that no definitive treatments for dysphagia were available (Bath 1999; Geeganage 2012).

An updated version of this review is therefore needed to appraise current evidence regarding the effectiveness of interventions for dysphagia post stroke. This information will provide support for clinical practice; will inform stroke survivors, clinicians, and healthcare funders regarding which interventions are most effective; and may help guide policy and funding decisions. This review assesses the effectiveness of swallowing therapy for treatment of dysphagia in stroke survivors with acute or subacute stroke.

OBJECTIVES

To assess the effects of swallowing therapy on death or dependency among stroke survivors with dysphagia within six months of stroke onset.

METHODS

Criteria for considering studies for this review

Types of studies

We identified randomised controlled trials (RCTs) of swallowing therapy for stroke survivors with acute or subacute stroke and dysphagia.

We excluded trials if they compared two or more active treatments (i.e. treatment was confounded), recruited participants after six months following stroke onset, involved a large proportion of participants with non-stroke causes of dysphagia, or used a cross-over design by which we could not just use data from the first treatment phase.

For this third version of the review, we removed most trials examining postural studies and all trials examining modified fluids because they lacked a true control group. We also excluded trials of free water protocols, oral hygiene, cough reflex testing, and swallow screening, as we do not consider these to be interventions for dysphagia per se. We also excluded trials involving the use of antibiotics.

Types of participants

Definitions

Acute or subacute stroke

Participants recruited with a clinical diagnosis of stroke within six months of onset.

Stroke type

Ischaemic or haemorrhagic.

Dysphagia

Diagnosed clinically (water swallow tests, modified diet or fluid assessments, swallowing test scores) by a clinician (typically a nurse or SLT), or by a videofluoroscopy swallow study (VFSS) or fibreoptic endoscopic evaluation of swallowing (FEES).

Types of interventions

- Acupuncture versus no acupuncture or routine acupuncture or sham acupuncture
- Behavioural interventions such as swallowing exercises, or positioning versus limited, usual, or no treatment
- Drug intervention versus none or placebo
- Neuromuscular electrical stimulation (NMES) versus none or sham stimulation
- Pharyngeal electrical stimulation (PES) versus none or sham stimulation
- Physical stimulation such as thermal or tactile versus limited, usual, or no treatment
- Transcranial direct current stimulation (tDCS) versus none or sham stimulation
- Transcranial magnetic stimulation (TMS) versus none or sham stimulation

We combined different interventions, collectively referred to as 'swallowing therapy', for the purpose of analysing their effects on the main outcomes. Given that the science of intervention development for dysphagia is at an early stage, it is reasonable to ask the question whether any intervention is better than no intervention, and to try to establish where the most positive effects are seen and for what topics more research is needed.

Types of outcome measures

We obtained information on the following outcome measures, as available, for each trial.

Primary outcomes

- Functional outcome assessed as death or dependency (modified Rankin Scale: mRS > 2), or death or disability (Barthel Index: BI < 60), at the end of the trial

We chose functional outcome (i.e. death or dependency/disability) as the primary outcome because dysphagia is associated with increased risk of death or dependency in acute and subacute stroke. Whilst swallowing therapy aims to reduce dysphagia, we needed to assess whether evidences shows that people receiving swallowing therapy are less likely to die or remain dependent. We listed other important outcomes relevant to swallowing function as secondary outcomes.

Secondary outcomes

- Case fatality at the end of the trial
- Length of inpatient stay
- Proportion of patients with dysphagia at the end of the trial
- Swallowing ability based on assessments of dysphagia impairment using the dysphagia severity rating scale (DSRS), the functional oral intake scale (FOIS), the dysphagia outcome and severity scale (DOSS), or water swallowing tests
- Penetration Aspiration score determined by VFSS and FEES and quantified on a scale such as the Penetration Aspiration Scale (PAS)
- Chest infection or pneumonia, determined clinically or radiologically
- Swallow timings from VFSS measurements (e.g. pharyngeal transit time (PTT))
- Nutritional measure based on blood albumin
- Institutionalisation with discharge to a residential, care, or nursing home, or to an extended care facility

- Neurological impairment within four weeks (e.g. using National Institutes of Health Stroke Scale (NIHSS) or Scandinavian Stroke Scale)
- Quality of life (e.g. using Short Form-36 (SF-36) or EuroQoL (measure of health-related quality of life))

Search methods for identification of studies

See the Cochrane Stroke Group search methods. We searched for trials in all languages and arranged translation of relevant articles published in languages other than English. We have listed publications requiring translation in the Characteristics of studies awaiting classification section.

Electronic searches

We searched the Cochrane Stroke Group Trials Register (last searched on 26 June 2018). In addition, we searched:

- Cochrane Central Register of Controlled Trials (CENTRAL; 2018, Issue 6) (Appendix 1) in the Cochrane Library (searched 26 June 2018);
- MEDLINE Ovid (1946 to 26 June 2018) (Appendix 2);
- Embase (1974 to 26 June 2018) (Appendix 3);
- Cumulative Index to Nursing and Allied Health Literature (CINAHL EBSCO) (1982 to 26 June 2018) (Appendix 4);
- Science Citation Index Expanded, Social Sciences Citation Index, Conference Proceedings Citation Index- Science (Web of Science Core Collection; 1900 to 26 June 2018) (Appendix 5); and
- SpeechBITE (searched 28 June 2018) (Appendix 6).

In an effort to identify further published, unpublished, and ongoing trials, we searched:

- US National Institutes of Health Ongoing Trials Register ClinicalTrials.gov (www.clinicaltrials.gov; searched 26 June 2018; Appendix 7);
- World Health Organization International Clinical Trials Registry Platform (apps.who.int/trialsearch; searched 26 June 2018; Appendix 8); and
- Google Scholar (searched 7 June 2018; Appendix 9).

Searching other resources

Additionally, we searched the reference lists of relevant trials and review articles and our own reference lists.
For a previous version of this review (Geeganage 2012), we contacted researchers and the UK Royal College of Speech and Language Therapists Special Interest Group for information on adult-acquired dysphagia trials.

Data collection and analysis

Selection of studies

For this update, two review authors (HSL, LE) scanned the titles and abstracts of records identified through searches of electronic bibliographic databases and excluded obviously irrelevant articles. We independently reviewed the full text of remaining studies and selected relevant trials according to the listed inclusion criteria; we resolved disagreements through discussion with the third review author (PB).

Data extraction and management

For this update, two review authors (HSL, LE) extracted data using a predefined proforma, and entered the data into RevMan 5 (RevMan 2014); we resolved disagreements through discussion and consultation with the third review author (PB). We assessed information on randomisation, blinding, numbers of participants randomised, timing of treatment from stroke, types of dysphagia therapy, participant withdrawals and losses to follow-up, and relevant outcomes (Types of outcome measures). We aggregated outcome data from dose escalation or dose comparison trials into one active treatment group.

Assessment of risk of bias in included studies

We assessed potential for bias using the 'Risk of bias' tool as recommended in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). This assessment includes sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective outcome reporting, and other issues.

Measures of treatment effect

We assessed weighted estimate of the typical treatment effect across trials using odds ratios (ORs) and 95% confidence intervals (CIs) for binary data, mean differences (MDs) and 95% CIs for continuous data, and standardised mean differences (SMDs) and 95% CIs for continuous data based on different scales. We performed analyses using RevMan 5 (RevMan 2014). We calculated OR using the Mantel-Haenszel method, and MDs using the inverse variance method.

Unit of analysis issues

When outcome measures included different scores, we converted these to grades in the same direction of mild to severe and analysed them using MDs. When studies compared graduations of therapy (high-medium-low intensity), we divided the middle-intensity group in two and analysed study data by comparing high intensity versus medium intensity, and medium intensity versus low intensity or no treatment. Similarly, if a trial compared high- versus low-

frequency stimulation or unilateral versus bilateral stimulation, we divided control group participants equally between treatment groups to prevent control participants from being counted more than once, and thereby artificially narrowing the CIs. We entered each set of data as a separate trial.

Dealing with missing data

If a trial publication did not provide relevant data or if data were missing but we felt it appropriate otherwise, we placed studies into Characteristics of studies awaiting classification.

Assessment of heterogeneity

We used the random-effects model to assess heterogeneity by looking at forest plots to see how CIs overlapped (non-overlapping studies are exhibiting statistical heterogeneity) along with the I^2 statistic (Higgins 2011). We defined thresholds for interpreting heterogeneity according to the *Cochrane Handbook for Systematic Reviews of Interventions*, whereby 0% to 40% might not be important; 30% to 60% may represent moderate heterogeneity; 50% to 90% may represent substantial heterogeneity, and 75% to 100% represents considerable heterogeneity (Higgins 2011).

Assessment of reporting biases

We assessed selective outcome reporting as reported in the 'Risk of bias' table (Characteristics of included studies).

Data synthesis

We performed meta-analysis using functionality within RevMan 5 (RevMan 2014): we used random-effects models (Mantel-Haenszel method) and presented data as number (%) or mean (standard deviation), with OR, MD, or SMD. We used random-effects models because we expected that trials would be heterogeneous in design and delivery, including different types of participants and interventions.

Grade and 'Summary of findings' table

We assessed the quality of the evidence using the five GRADE considerations (study limitations, consistency of effect, imprecision, indirectness, and publication bias), as described in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011), for the following main outcomes of analysis.

- Death or dependency/disability at the end of the trial.
- Case fatality at the end of the trial.
- Length of inpatient stay.
- Proportion of participants with dysphagia at the end of the trial.
- Swallowing ability.
- Penetration aspiration score.
- Adverse event: chest infection or pneumonia.

We have presented in Summary of findings for the main comparison key findings of the review, including a summary of the quantity of data, the magnitude of effect size, and the overall quality of evidence.

Subgroup analysis and investigation of heterogeneity

We performed subgroup analyses on the eight different types of swallowing therapy to provide more specific information pertaining to the different interventions. We assessed for significant subgroup interactions by testing for subgroup differences for each main outcome.

Sensitivity analysis

We did not perform sensitivity analyses due to the small number of studies.

RESULTS

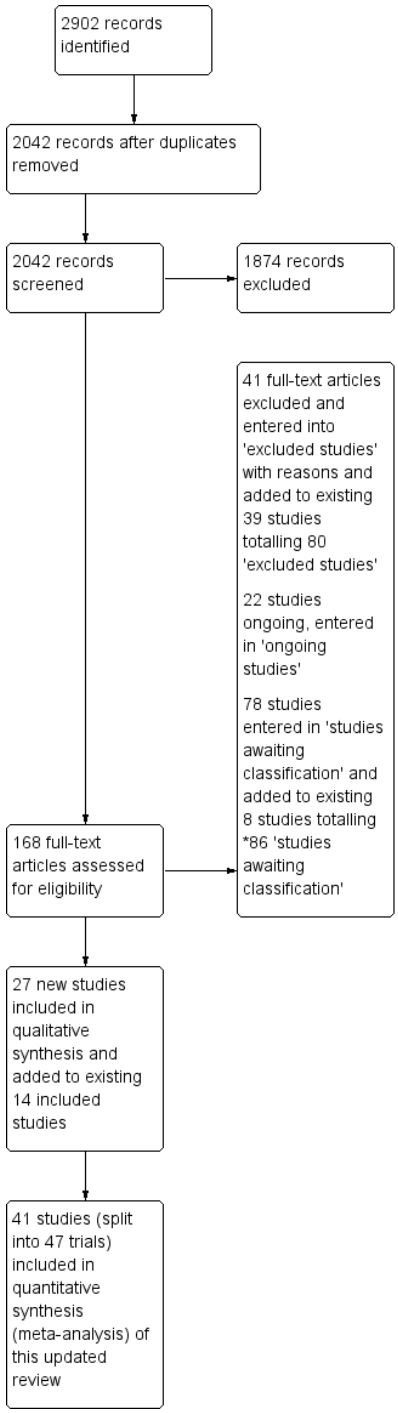
Description of studies

We identified 27 new RCTs involving a total of 1777 acute or subacute stroke survivors with dysphagia.

Results of the search

We have presented the PRISMA study flow diagram in Figure 1. In total, we identified 2902 references, removed 860 duplicates, and screened 2042 records. We excluded 1874 records, leaving a total of 168 records. After full-text review, we excluded 41 studies. We added these newly excluded studies to the existing list of 39 excluded studies, for a total of 80 (Excluded studies). We added 22 studies into the ongoing studies section (Ongoing studies). We also added 78 new studies to the eight existing studies awaiting classification, yielding a total of 86 (Studies awaiting classification); these studies have been completed and are awaiting publication or are awaiting translation, or we are seeking full-text articles. External assessment of this review led to a request to further update the searches; an updated search revealed further potentially relevant studies, and we have added these to the Studies awaiting classification section; we will assess these when we prepare the next update of this review. Finally, we added 27 new studies to the existing 14 studies, yielding a total of 41 included studies (47 data sets) (Included studies). This resulted in the addition of 1777 participants to the existing 883, for a total of 2660 participants.

Figure 1. Study Flow Diagram, *86 studies awaiting classification.



Included studies

We included 41 trials in this updated review (mean participant age 67.8 years). These trials looked at various forms of swallowing therapy after stroke.

When outcome measures included different scores, we converted these to grades in the same direction of mild to severe and analysed them using mean differences (MDs). Two studies compared graduations of therapy (high-medium-low intensity) (Yuan 2003i; Yuan 2003ii; Carnaby 2006i; Carnaby 2006ii;); here, we divided the middle-intensity group in two and analysed the study data by comparing high intensity versus medium intensity, and medium intensity versus low intensity or no treatment. Similarly, one trial of TMS compared high- versus low-frequency stimulation or unilateral versus bilateral stimulation (Kim 2012i; Kim 2012ii; Du 2016i; Du 2016ii; Park 2016 (a) i; Park 2016 (a) ii); here, we divided control group participants equally between treatment groups to prevent control participants from being counted more than once and thereby artificially narrowing the confidence intervals (CIs). We entered each set of data as a separate trial; hence, although the total number of included studies was 41, the total number of data sets entered for analysis was 47.

Acupuncture

Eleven studies tested acupuncture in 998 participants (Liu 2000; Han 2004; Liu 2004; Wei 2005; Jia 2006a; Bai 2007i; Bai 2007ii; Huang 2010; Chan 2012; Chen 2016a; Xia 2016a).

Behavioural interventions

Nine studies investigated behavioural interventions in 632 participants (Yuan 2003i; Yuan 2003ii; Song 2004; Carnaby 2006i; Carnaby 2006ii; Kang 2012; Zheng 2014; Heo 2015; Park 2016b). Behavioural interventions consisted of swallowing exercises, environmental modifications such as upright positioning for feeding, safe swallowing advice, dietary modifications, kinesiotaping, and expiratory muscle strength training.

Drug therapy

Three studies assessed several different drugs in 148 participants (Perez 1997; Lee 2015; Warusevitane 2015). Drug interventions included nifedipine in 17 participants (Perez 1997), lisinopril in 71 participants (Lee 2015), and metoclopramide in 60 participants (Warusevitane 2015).

Neuromuscular electrical stimulation (NMES)

Six studies tested NMES in 312 participants (Lim 2009; Xia 2011; Park 2012; Lee 2014; Li 2014; Terre 2015). Researchers most often compared NMES versus traditional dysphagia therapy. One study combined NMES and effortful swallow (Park 2012).

Pharyngeal electrical stimulation (PES)

Four studies involving 214 participants assessed PES (Jayasekeran 2010a; Jayasekeran 2010b; STEPS 2016; Vasant 2016).

Physical stimulation (thermal, tactile)

Three studies enrolled 155 participants. Types of stimulation included tactile stimulation (Bath 1997), electrical stimulation (Power 2006), and Tongyan spray (Feng 2012).

Transcranial direct current stimulation (tDCS)

Two studies assessed tDCS in 34 participants (Kumar 2011; Shigematsu 2013).

Transcranial magnetic stimulation (TMS)

Nine studies involving 167 participants investigated TMS (Khedr 2009; Khedr 2010; Kim 2012i; Kim 2012ii; Park 2013; Du 2016i; Du 2016ii; Park 2016a (i); Park 2016a (ii).

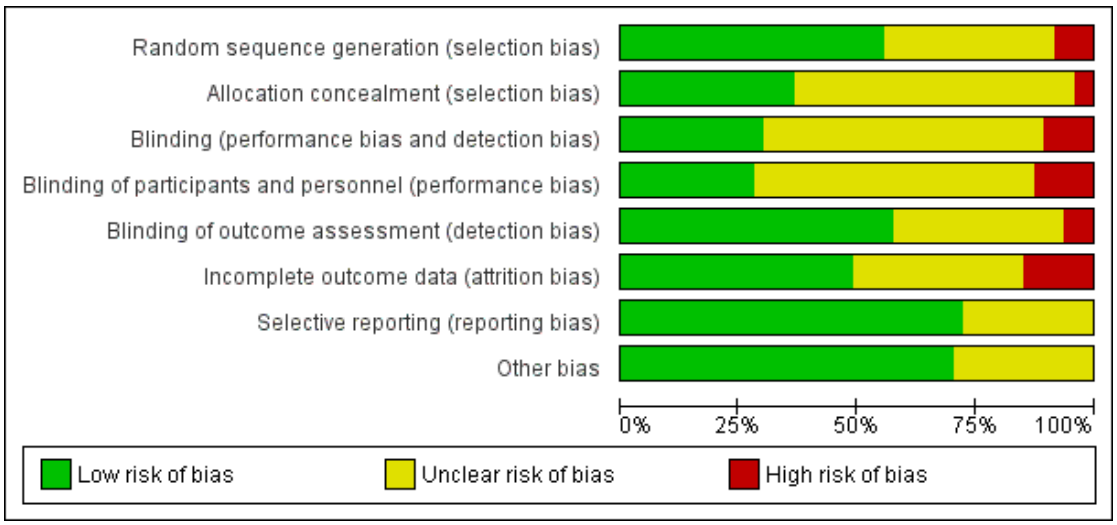
Excluded studies

We excluded 80 studies from this updated review, most commonly because investigators compared two active treatments (confounded) or because the trials were not RCTs. We excluded 10 studies as reported outcomes were not relevant to this review. We excluded 11 studies because of lack of outcome data; some of these might be relevant to this review should outcome data become available (Characteristics of excluded studies).

Risk of bias in included studies

Key sources of bias follow; we have summarised risk of bias in Figure 2.

Figure 2. 'Risk of bias' graph: review authors' judgements about each 'Risk of bias' item presented as percentages across all included studies.



Allocation

Random sequence generation

- Randomisation by computer occurred in 15 studies (low risk of bias) (Bath 1997; Perez 1997; Carnaby 2006i; Carnaby 2006ii; Jayasekeran 2010a; Jayasekeran 2010b; Park 2012; Park 2013; Lee 2014; Li 2014; Lee 2015; Terre 2015; Chen 2016a; STEPS 2016; Vasant 2016).
- Randomisation via random number tables occurred in 10 studies (low risk of bias) (Song 2004; Bai 2007i; Bai 2007ii; Chan 2012; Feng 2012; Shigematsu 2013; Warusevitane 2015; Du 2016i; Du 2016ii; Xia 2016a).
- Simple randomisation occurred in four studies (low risk of bias) (Han 2004; Kumar 2011; Heo 2015; Park 2016b).
- Method of randomisation was unclear in 16 studies (unclear risk of bias) (Liu 2000; Yuan 2003i; Yuan 2003ii; Liu 2004; Wei 2005; Power 2006; Khedr 2009; Huang 2010; Khedr 2010; Xia 2011; Kang 2012; Kim 2012i; Kim 2012ii; Zheng 2014; Park 2016a (i); Park 2016a (ii)).
- Two studies used non-randomised methods (high risk of bias) (Jia 2006a; Lim 2009).

Allocation concealment

- Researchers ensured allocation concealment in 17 studies (low risk of bias) (Han 2004; Carnaby 2006i; Carnaby 2006ii; Khedr 2009; Chan 2012; Feng 2012; Park 2012; Park 2013; Shigematsu 2013; Li 2014; Lee 2015; Warusevitane 2015; Chen 2016a; Du 2016i; Du 2016ii; Park 2016b; Vasant 2016).
- Allocation concealment was unclear in 28 studies (unclear risk of bias) (Bath 1997; Perez 1997; Liu 2000; Yuan 2003i; Yuan 2003ii; Liu 2004; Song 2004; Wei 2005; Power 2006; Bai 2007i; Bai 2007ii; Huang 2010; Jayasekeran 2010a; Jayasekeran 2010b; Khedr 2010; Kumar 2011; Xia 2011; Kang 2012; Kim 2012i; Kim 2012ii; Lee 2014; Zheng 2014; Heo 2015; Terre 2015; Park 2016a (i); Park 2016a (ii); STEPS 2016; Xia 2016a).
- Two studies did not ensure allocation concealment (high risk of bias) (Jia 2006a; Lim 2009).

Baseline prognostic factors matching between intervention and control groups

- Baseline factors were similar in 34 studies (low risk of bias) (Perez 1997; Song 2004; Carnaby 2006i; Carnaby 2006ii; Bai 2007i; Bai 2007ii; Khedr 2009; Jayasekeran 2010b; Khedr 2010; Xia 2011; Chan 2012; Feng 2012; Kang 2012; Kim 2012i; Kim 2012ii; Park 2012; Park 2013; Shigematsu 2013; Lee 2014; Li 2014; Zheng 2014; Heo 2015; Lee 2015; Terre 2015; Warusevitane 2015; Chen 2016a; Du 2016i; Du 2016ii; Park 2016a (i); Park 2016a (ii); Park 2016b; STEPS 2016; Vasant 2016; Xia 2016a).
- Baseline factor matching was unclear in 13 studies (unclear risk of bias) (Bath 1997; Liu 2000; Yuan 2003i; Yuan 2003ii; Han 2004; Liu 2004; Wei 2005; Jia 2006a; Power 2006; Lim 2009; Huang 2010; Jayasekeran 2010a; Kumar 2011).

Blinding

Performance bias

- Both participants and investigators were blinded in three studies (low risk of bias) (Perez 1997; Kumar 2011; Warusevitane 2015).
- Participants were blinded in nine studies (low risk of bias) (Khedr 2009; Chan 2012; Park 2012; Park 2013; Terre 2015; Du 2016i; Du 2016ii; STEPS 2016; Vasant 2016).
- Both participants and investigators were unblinded in five studies (high risk of bias) (Carnaby 2006i; Carnaby 2006ii; Chen 2016a; Park 2016a (i); Park 2016a (ii)).
- Blinding of participants and investigators was uncertain in 14 studies (unclear risk of bias) (Bath 1997; Han 2004; Bai 2007i; Bai 2007ii; Lim 2009; Jayasekeran 2010a; Jayasekeran 2010b; Khedr 2010; Xia 2011; Shigematsu 2013; Li 2014; Lee 2015; Park 2016b; Xia 2016a).

Detection bias

- Outcomes were blinded in 28 studies (low risk of bias) (Perez 1997; Han 2004; Wei 2005; Carnaby 2006i; Carnaby 2006ii; Khedr 2009; Lim 2009; Jayasekeran 2010a; Jayasekeran 2010b; Khedr 2010; Xia 2011; Chan 2012; Park 2012; Park 2013; Shigematsu 2013; Li 2014; Lee 2015; Terre 2015; Warusevitane 2015; Chen 2016a; Du 2016i; Du 2016ii; Park 2016a (i); Park 2016a (ii); Park 2016b; STEPS 2016; Vasant 2016; Xia 2016a).
- Outcomes were not blinded in three studies (high risk of bias) (Bath 1997; Bai 2007i; Bai 2007ii).

Overall, 16 studies did not report on any blinding procedures (i.e. for participants, investigators, or outcome assessors) (unclear risk of bias) (Liu 2000; Yuan 2003i; Yuan 2003ii; Liu 2004; Song 2004; Wei 2005; Jia 2006a; Power 2006; Huang 2010; Feng 2012; Kang 2012; Kim 2012i; Kim 2012ii; Lee 2014; Zheng 2014; Heo 2015).

Incomplete outcome data

- Ten studies reported no loss of participants during follow-up (low risk of bias) (Han 2004; Jayasekeran 2010a; Chan 2012; Kang 2012; Kim 2012i; Kim 2012ii; Park 2013; Shigematsu 2013; Lee 2014; Warusevitane 2015).
- Twelve studies reported loss of participants during follow-up, but we judged them to be at low risk of bias (Perez 1997; Carnaby 2006i; Carnaby 2006ii; Khedr 2009; Khedr 2010; Feng 2012; Park 2012; Du 2016i; Du 2016ii; Park 2016a (i); Park 2016a (ii); Vasant 2016).
- We judged seven studies to be at high risk of bias due to incomplete outcome data (Lim 2009; Jayasekeran 2010b; Li 2014; Lee 2015; Chen 2016a; Park 2016b; STEPS 2016).
- Loss of participants during follow-up was unclear in 18 studies (unclear risk of bias) (Bath 1997; Liu 2000; Yuan 2003i; Yuan 2003ii; Liu 2004; Song 2004; Wei 2005; Jia 2006a; Power 2006; Bai 2007i; Bai 2007ii; Huang 2010; Kumar 2011; Xia 2011; Zheng 2014; Heo 2015; Terre 2015; Xia 2016a).
- Data were not available for quality of life.

Selective reporting

- We judged 34 studies to be at low risk of reporting bias (Perez 1997; Carnaby 2006i; Carnaby 2006ii; Power 2006; Khedr 2009; Jayasekeran 2010a; Jayasekeran 2010b; Khedr 2010; Kumar 2011; Xia 2011; Chan 2012; Feng 2012; Kang 2012; Kim 2012i; Kim 2012ii; Park 2012; Park 2013; Shigematsu 2013; Lee 2014; Li 2014; Zheng 2014; Heo 2015; Lee 2015; Terre 2015; Warusevitane 2015; Chen 2016a; Du 2016i; Du 2016ii; Park 2016a (i); Park 2016a (ii); Park 2016b; STEPS 2016; Vasant 2016; Xia 2016a).
- In the remaining 13 studies, it was unclear if reported data were complete (unclear risk of bias) (Bath 1997; Liu 2000; Yuan 2003i; Yuan 2003ii; Han 2004; Liu 2004; Song 2004; Wei 2005; Jia 2006a; Bai 2007i; Bai 2007ii; Lim 2009; Huang 2010).

Other potential sources of bias

We assessed seven studies based on translations of the original text (Yuan 2003i; Yuan 2003ii; Song 2004; Wei 2005; Bai 2007i; Bai 2007ii; Huang 2010). Native Chinese speakers performed translations from Chinese to English.

We aggregated outcome data from dose escalation or comparison trials to form one active treatment group in one trial (Jayasekeran 2010b).

Effects of interventions

See: **Summary of findings for the main comparison** Swallowing therapy compared to placebo for dysphagia in acute and subacute stroke

Summary of findings for main outcomes of swallowing therapy in general

We entered the important outcomes in this review into Summary of findings for the main comparison, and we reported outcomes for 'swallowing therapy' versus 'no swallowing therapy'. This means that overall, for each outcome (e.g. length of inpatient stay), we combined several different interventions to test for efficacy. In this way, we have provided information on the effectiveness of swallowing therapy as a whole for each outcome. We assessed three additional outcomes (pharyngeal transit time, institutionalisation, and nutrition) but did not include them in Summary of findings for the main comparison (a maximum of seven outcomes are allowed); therefore, we did not assess the quality of studies for these outcomes using the GRADE approach, and we have not reported their outcomes in the main findings.

We also undertook subgroup analysis for each different type of intervention.

The number of outcomes reported varied considerably across studies.

- Primary outcome of death or dependency/disability at end of trial in one trial (split into two data sets).
- Case fatality at end of trial in 14 trials.
- Length of inpatient stay in eight trials.
- Proportion of patients with dysphagia at end of trial in 23 trials.
- Swallowing ability in 26 trials.
- Penetration aspiration score (PAS) in 11 trials.
- Chest infections or pneumonia in nine trials.
- Swallow timing in six trials.
- Nutrition in three trials.
- Institutionalisation in three trials.

Primary outcome

Functional outcome: death or dependency or death or disability at end of trial

Swallowing therapy had no effect on death or dependency, or death or disability, at end of trial (odds ratio (OR) 1.05, 95% confidence interval (CI) 0.63 to 1.75; 306 participants; 2 studies; I^2 = 0%; P = 0.86: moderate-quality evidence; Analysis 1.1). One trial (two data sets) of behavioural interventions reported on this outcome.

Secondary outcomes

Case fatality at end of trial

Swallowing therapy had no effect on case fatality at end of trial (OR 1.00, 95% CI 0.66 to 1.52; 766 participants; 14 studies; I^2 = 6%; P = 0.99: moderate-quality evidence; Analysis 1.2). Trials of behavioural interventions, drug therapy, pharyngeal electrical stimulation, physical stimulation, and transcranial magnetic stimulation reported on this outcome.

Length of inpatient stay

Swallowing therapy probably reduced length of inpatient stay (mean difference (MD) -2.90, 95% CI -5.65 to -0.15; 577 participants; 8 studies; I^2 = 11%; P = 0.04: moderate-quality evidence; Analysis 1.3). Trials of behavioural interventions and PES reported on this outcome. Subgroup analysis showed that the interventions did not differ (Analysis 1.3).

Proportion of participants with dysphagia at end of trial

Swallowing therapy probably reduced the proportion of participants with dysphagia at end of trial (OR 0.42, 95% CI 0.32 to 0.55; 1487 participants; 23 studies; I^2 = 0%; P = 0.00001: low-quality evidence; Analysis 1.4). Trials of acupuncture, behavioural interventions, drug therapy, NMES, PES, physical stimulation, and tDCS reported on this outcome. Subgroup analysis showed that acupuncture (OR 0.31, 95% CI 0.20 to 0.49; 676 participants; 8 studies; I^2 = 0%; P < 0.00001) and behavioural interventions (OR 0.45, 95% CI 0.28 to 0.74; 511 participants; 6 studies; I^2 = 28%; P = 0.001) each reduced dysphagia but did not differ from each other (P = 0.91; Analysis 1.4).

Swallowing ability

Swallowing therapy probably improved swallowing ability (standardised mean difference (SMD) -0.66, 95% CI -1.01 to -0.32; 1173 participants; 26 studies; I^2 = 86%; P = 0.0002: very low-quality evidence; Analysis 1.5). Trials of acupuncture, behavioural interventions, drug therapy, NMES, PES, physical stimulation, tCDS, and TMS reported on this outcome. Subgroup analysis showed that behavioural interventions (SMD -0.56, 95% CI -1.07 to -0.05; 121 participants; 3 studies; I^2 = 47%; P = 0.03) and TMS (SMD -1.29, 95% CI -2.37 to -0.21; 141 participants; 8 studies; I^2 = 85%; P = 0.02) each improved swallowing ability but did not differ from each other (P = 0.09; Analysis 1.5). Review authors noted moderate to substantial heterogeneity between trials (Analysis 1.5).

Penetration aspiration score

Swallowing therapy did not significantly reduce aspiration assessed as penetration aspiration score (SMD -0.37, 95% CI -0.74 to -0.00; 303 participants; 11 studies; I^2 = 46%; P = 0.05: low-quality evidence; Analysis 1.6). Trials of behavioural interventions, NMES, PES, and TMS reported on this outcome. However, given that results show no overall benefit, we have not commented on subgroup analysis (Analysis 1.6).

Chest infection or pneumonia

Swallowing therapy probably reduced the incidence of chest infection or pneumonia (OR 0.36, 95% CI 0.16 to 0.78; 618 participants; 9 studies; I^2 = 59%; P = 0.009: very low-quality evidence; Analysis 1.7). Trials of behavioural interventions, drug therapy, NMES, and PES reported on this outcome. Subgroup analysis showed that drug therapy (OR 0.06, 95% CI 0.01 to 0.21; 60 participants; 1 study; I^2 not applicable; P < 0.0001) significantly reduced the incidence of chest infection or pneumonia at end of trial - a result that differed significantly from other interventions (P = 0.008; Analysis 1.7).

Pharyngeal transit time (PTT)

Swallowing therapy may have reduced PTT (MD -0.23, 95% CI -0.32 to -0.15; 187 participants; 6 studies; I^2 = 29%; P < 0.00001; Analysis 1.8). Trials of drug therapy, NMES, PES, and physical stimulation reported on this outcome. Subgroup analysis showed that NMES (MD -0.23, 95% CI -0.39 to -0.08; 126 participants; 3 studies; I^2 = 63%; P = 0.003; Analysis 1.8) and physical stimulation in one small study (MD -0.19; 95% CI -0.34 to -0.04; 16 participants; 1 study; I^2 not applicable; P = 0.01) each reduced PTT but did not differ from each other, i.e. these findings are likely due to chance and not-significant. (P = 0.98; Analysis 1.8).

Institutionalisation

Swallowing therapy did not reduce the incidence of institutionalisation (OR 0.75, 95% CI 0.47 to 1.19; 447 participants; 3 studies; I^2 = 0%; P= 0.22; Analysis 1.9). Trials of behavioural interventions and pharyngeal electrical stimulation reported on this outcome.

Nutrition (albumin)

Swallowing therapy did not reduce nutrition (MD 0.37, 95% CI -1.5 to 2.24; 169 participants; 3 studies; I^2 = 0%; P = 0.70; Analysis 1.10). Trials of behavioural interventions and pharyngeal electrical stimulation reported on this outcome.

Detailed subgroup analysis: summary of findings per type of intervention

Not all interventions addressed all outcomes. We have reported available data.

Acupuncture

Acupuncture resulted in significant results (i.e. < 1.0) for reducing the proportion of participants with dysphagia at end of trial. However, these findings may be due to chance, given that testing for subgroup differences did not yield significant results. Acupuncture did not reduce swallowing ability. Data on the effects of acupuncture on other outcomes were not available.

- Proportion of participants with dysphagia at end of trial (OR 0.31, 95% CI 0.20 to 0.49; 676 participants; 8 studies; I^2 = 0%; P < 0.00001; Analysis 1.4).
- Swallowing ability (SMD -0.55, 95% CI -1.20 to 0.11; 496 participants; 6 studies; I^2 = 91%; P = 0.10). We noted significant heterogeneity (Analysis 1.5).

Behavioural interventions

Behavioural interventions produced significant results (i.e. < 1.0) for improving swallowing ability and reducing the proportion of participants with dysphagia at the end of the trial. However, both of these findings may be due to chance, given that testing for subgroup differences for each outcome did not yield significant results. Although behavioural interventions also reduced penetration aspiration score (i.e. < 1.0), results show no overall benefit for this outcome and this finding is likely due to chance. Behavioural interventions did not reduce length of inpatient stay, chest infection or pneumonia, case fatality at end of trial, functional outcome, institutionalisation, or nutrition. Behavioural interventions addressed more outcomes when compared with most interventions.

- Swallowing ability (SMD -0.56, 95% CI -1.07 to -0.05; 121 participants; 3 studies; I^2 = 47%; P = 0.03; Analysis 1.5).
- Proportion of participants with dysphagia at end of trial (OR 0.45, 95% CI 0.28 to 0.74; 511 participants; 6 studies; I^2 = 28%; P = 0.001; Analysis 1.4).
- Penetration aspiration score (SMD -0.88, 95% CI -1.68 to -0.08; 27 participants; 1 study; I^2 not applicable; P = 0.03; Analysis 1.6).
- Length of inpatient stay (MD -2.70, 95% CI -5.68 to 0.28; 370 participants; 4 studies; I^2 = 19%; P = 0.08; Analysis 1.3).
- Chest infection or pneumonia (OR 0.56, 95% CI 0.31 to 1.00; 473 participants; 6 studies; I^2 = 21%; P = 0.05; Analysis 1.7).
- Case fatality at end of trial (OR 0.83, 95% CI 0.46 to 1.51; 306 participants; 2 studies; I^2 = 0%; P = 0.54; Analysis 1.2).
- Functional outcome (OR 1.05, 95% CI 0.63 to 1.75; 306 participants; 2 studies; I^2 = 0%; P = 0.86; Analysis 1.1).
- Institutionalisation (OR 0.76, 95% CI 0.39 to 1.48; 306 participants; 2 studies; I^2 = 12%; P = 0.42; Analysis 1.9).
- Nutrition (albumin) (MD 0.20, 95% CI -4.77 to 5.17; 64 participants; 2 studies; I^2 = 0%; P = 0.94; Analysis 1.10).

Drug therapy

Drug therapy was probably effective for reducing chest infection or pneumonia in one study - a result that differed from those of other interventions. Drug therapy did not improve swallowing ability, nor did it reduce case fatality, proportion of participants with dysphagia at end of trial, or pharyngeal transit time. Data on effects of drug therapy on other outcomes were not available.

- Chest infection or pneumonia (OR 0.06, 95% CI 0.01 to 0.21; 60 participants; 1 study; I^2 not applicable; P < 0.0001; Analysis 1.7).
- Swallowing ability (SMD -0.46, 95% CI -0.93 to 0.01; 71 participants; 1 study; I^2 not applicable; P = 0.06; Analysis 1.5).
- Case fatality (OR 1.40, 95% CI 0.31 to 6.28; 148 participants; 3 studies; I^2 = 70%; P = 0.66; Analysis 1.2).
- Proportion of participants with dysphagia at end of trial (OR 0.48, 95% CI 0.07 to 3.35; 17 participants; 1 study; I^2 not applicable; P = 0.46; Analysis 1.4).
- Pharyngeal transit time (MD -0.21, 95% CI -0.91 to 0.49;

17 participants; 1 study; I^2 not applicable; P = 0.56; Analysis 1.8).

Neuromuscular electrical stimulation (NMES)

NMES was probably effective for reducing pharyngeal transit time (i.e. < 1.0). NMES did not reduce the proportion of participants with dysphagia at end of trial or penetration aspiration score, and did not improve swallowing ability.

- Pharyngeal transit time (MD -0.23, 95% CI -0.39 to -0.08; 126 participants; 3 studies; I^2 = 63%; P = 0.003; Analysis 1.8).
- Proportion of participants with dysphagia at end of trial (OR 0.51, 95% CI 0.18 to 1.49; 76 participants; 2 studies; I^2 = 7%; P = 0.22; Analysis 1.4).
- Penetration aspiration score (SMD 0.57, 95% CI -0.38 to 1.52; 18 participants; 1 study; I^2 not applicable; P = 0.24; Analysis 1.6).
- Swallowing ability (SMD -1.34, 95% CI -3.39 to 0.71; 100 participants; 2 studies; I^2 = 93%; P = 0.20; Analysis 1.5).

Pharyngeal electrical stimulation (PES)

PES studies addressed many outcomes but did not show an effect for case fatality, length of inpatient stay, proportion of participants with dysphagia at end of trial, swallowing ability, penetration aspiration score, chest infection or pneumonia, pharyngeal transit time, institutionalisation, or nutrition.

- Case fatality (OR 0.92, 95% CI 0.38 to 2.26; 215 participants; 4 studies; I^2 = 0%; P = 0.86; Analysis 1.2).
- Length of inpatient stay (MD -6.05, 95% CI -16.40 to 4.31; 207 participants; 4 studies; I^2 = 27%; P = 0.25; Analysis 1.3).
- Proportion of participants with dysphagia at end of trial (OR 0.55, 95% CI 0.15 to 2.11; 66 participants; 3 studies; I^2 = 0%; P = 0.39; Analysis 1.4).
- Swallowing ability (SMD 0.06, 95% CI -0.22 to 0.34; 194 participants; 3 studies; I^2 = 0%; P = 0.69; Analysis 1.5).
- Penetration aspiration score (SMD -0.17, 95% CI -0.53 to 0.19; 177 participants; 4 studies; I^2 = 12%; P = 0.35; Analysis 1.6).
- Chest infection (OR 0.43, 95% CI 0.06 to 3.09; 28 participants; 1 study; I^2 not applicable; P = 0.40; Analysis 1.7).
- Pharyngeal transit time (MD -0.15, 95% CI -0.67 to 0.37; 28 participants; 1 study; I^2 not applicable; P = 0.56; Analysis 1.8).
- Institutionalisation (OR 0.73, 95% CI 0.36 to 1.48; 141 participants; 1 study; I^2 not applicable; P = 0.38; Analysis 1.9).
- Nutrition (MD 0.40; 95% CI-1.62 to 2.42; 105 participants; 1 study; I^2 not applicable; P = 0.70; Analysis 1.10).

Physical stimulation (thermal, tactile)

Physical stimulation reduced pharyngeal transit time in one small study (i.e. < 1.0). However, these findings may be due to chance, given that testing for subgroup differences did not yield significant findings.

Physical stimulation had no effect on case fatality at end of trial nor on proportion of participants with dysphagia at end of trial and did not improve swallowing ability.

- Pharyngeal transit time (MD -0.19, 95% CI -0.34 to -0.04; 16 participants; 1 study; I^2 not applicable; P = 0.01; Analysis 1.8).
- Case fatality at end of trial (OR 1.05, 95% CI 0.16 to 6.92; 19 participants; 1 study; I^2 not applicable; P = 0.96; Analysis 1.2).
- Proportion of participants with dysphagia at end of trial (OR 0.65, 95% CI 0.07 to 5.85; 127 participants; 2 studies; I^2 = 0%; P = 0.70; Analysis 1.4).
- Swallowing ability (SMD -0.30, 95% CI -1.29 to 0.68; 16 participants; 1 study; I^2 not applicable; P = 0.55; Analysis 1.5).

Transcranial direct current stimulation (tDCS)

tDCS did not alter the proportion of participants with dysphagia at end of trial and did not improve swallowing ability. Data on other outcomes were not available.

- Proportion of participants with dysphagia at end of trial (OR 0.29, 95% CI 0.01 to 8.39; 14 participants; 1 study; I^2 not applicable; P = 0.47; Analysis 1.4).
- Swallowing ability (SMD -0.33, 95% CI -2.22 to 1.56; 34 participants; 2 studies; I^2 = 85%; P = 0.73; Analysis 1.5).

Transcranial magnetic stimulation (TMS)

TMS improved swallowing ability at end of trial (i.e. < 1.0), although this finding may be due to chance, given that testing for subgroup differences did not yield significant results. We also noted considerable heterogeneity. TMS did not alter case fatality at end of trial nor penetration aspiration score. Data on other outcomes were not available.

- Swallowing ability (SMD -1.29, 95% CI -2.37 to -0.21; 141 participants; 8 studies = 8; I^2 = 85%; P = 0.02; Analysis 1.5).
- Case fatality at end of trial (OR 0.28, 95% CI 0.03 to 2.93; 78 participants; 4 studies; I^2 = 0%; P = 0.29; Analysis 1.2).
- Penetration aspiration score (SMD -0.53, 95% CI -1.22 to 0.16; 81 participants; 5 studies; I^2 = 51%; P = 0.13; Analysis 1.6).

In summary, acupuncture, behavioural interventions, and TMS appeared to be individually effective for reducing some outcomes. However, as results of testing for subgroup differences were not significant, none of these interventions are convincingly different from the summary result. Drug therapy was the only intervention that was significantly less than 1.0, and findings were significantly different for testing of subgroup differences, although this result was based on very low-quality evidence.

DISCUSSION

Summary of main results

We included 41 studies in this updated review of swallowing therapy in people with stroke. We identified 22 additional studies that are ongoing (Characteristics of ongoing studies), along with 86 studies that are awaiting classification (Characteristics of studies awaiting classification).

Researchers assessed eight types of stimulatory techniques - acupuncture, behavioural therapy, drug therapy, neuromuscular electrical stimulation (NMES), pharyngeal electrical stimulation (PES), physical stimulation, transcranial direct current stimulation (tDCS), and transcranial magnetic stimulation (TMS). Swallowing therapy had no effect on functional outcomes (death or dependency, or death or disability), although only one trial reported this outcome (two data sets). Swallowing therapy also had no effect on case fatality at end of trial, nor on penetration aspiration score. However, swallowing therapy probably reduced length of inpatient stay, the proportion of participants with dysphagia at end of trial, and the incidence of chest infection or pneumonia (with one study reporting significant effects for drug therapy). Swallowing therapy also probably improved swallowing ability. In the absence of significant effects on the primary outcome, statistically significant findings in secondary and explanatory outcomes are hypothesis-generating and might reflect chance, for example, due to multiple-comparison testing. Hence, further trials are needed to test these observations.

Overall completeness and applicability of evidence

Results of this review are incomplete at this time because of the significant number of ongoing studies and those awaiting classification identified by review authors. Nevertheless, the addition of new studies to this version of the review has tightened confidence intervals, although the overall conclusion that dysphagia treatment does not alter functional outcome has not changed.

Quality of the evidence

The quality of evidence ranged from very low and low through moderate to high, as presented in Summary of findings for the main comparison. The most common reasons for reduced quality of evidence were lack of blinding, moderate to considerable heterogeneity between trials, and lack of precision (i.e. inclusion of multiple different interventions).

Potential biases in the review process

Results of the present analysis are subject to several caveats. First, we combined different interventions together for analysis, to assess whether trial results show any effect of swallowing therapy as a whole as opposed to no intervention or usual care. This means that decisions on which specific types of interventions are effective cannot be made upon analysis of these data. Future reviews will focus on assessing effects of specific interventions on main outcomes. Second, we excluded 80 studies from the analysis. One common reason for exclusion is that studies compared two active treatments without including a control or placebo group. We also excluded trials due to lack of uniformity in usage of outcome measures and lack of data on clinical outcomes, such as dependency, mortality, institutionalisation, and chest infection or pneumonia. Further, included trials used various swallowing assessment techniques, cortical excitability techniques, and videofluoroscopic measurements. So, trialists are encouraged to design future trials that include a control or placebo group, and to incorporate standard outcome measures. Third, a further 86 studies are awaiting assessment, subject to the availability of full-text articles; such omission of multiple studies will inevitably bias review results. Fourth, with regard to acupuncture, data from three studies may have been confounded due to use of 'routine' acupuncture or a different type of acupuncture as control, variation in delivery of therapy, and risk of language bias, in that some of the acupuncture literature is available in full only in Chinese language journals. Similarly, we included data from an NMES study (Park 2012), which considered sensory stimulation as a control; therefore we cannot be certain that this trial is not confounded. Last, the present analysis included only studies up to six months from stroke onset, and the effects of later treatments for post-stroke dysphagia remain unclear.

It is important to note that many trials are ongoing and should add substantially to the existing data once complete.

Agreements and disagreements with other studies or reviews

This is the largest, most inclusive, and most up-to-date review on this topic. It combines all current interventions for dysphagia in the acute and subacute phases of stroke. A number of separate systematic reviews exploring individual interventions for stroke survivors have been published, including some examining acupuncture in stroke (Xie 2008; Long 2012; Wong 2012), behavioural interventions in neurogenic dysphagia (Ashford 2009), TMS in stroke and acquired brain injury (Yang 2015; Liao 2016; Momosaki 2016; Pisegna 2016), tDCS in stroke and acquired brain injury (Yang 2015; Momosaki 2016; Pisegna 2016), NMES in stroke and neurological impairment (Chen 2016; Ding 2016), and PES in stroke (Scutt 2015). However, these reviews have examined the efficacy of individual interventions, whereas the current review has examined the efficacy of swallowing therapy overall; hence direct com-

parisons are difficult to make.

AUTHORS' CONCLUSIONS

Implications for practice

Information on effects of swallowing therapy on the primary outcome of death or dependency/disability continues to be insufficient. Although some swallowing therapies appear to have a beneficial effect on some outcomes, these results are based on lower-quality evidence. At present, clinical decisions cannot be based on reliable evidence from clinical trials.

Implications for research

On the basis of existing studies and the need to exclude many others, future trials should consider the following design issues.

- Patients: include only those who have post-stroke dysphagia, and limit recruitment to a particular temporal phase after stroke. Researchers must specify clearly the time from stroke onset to randomisation when reporting trials. Trialists should aim for larger numbers of participants, ideally from multiple centres.

- Comparator: in the absence of any proven treatment, the control group should receive only standard care, with the treatment group receiving standard care plus the intervention being tested.

- Outcomes: studies need to ensure that standardised outcome measures are used to allow comparison of trials. Functional outcome (death or dependency) should be included in future trials, as should the number of participants who develop chest infection or pneumonia, or who have signs of aspiration. Trials should include outcomes of relevance to health economics, such as length of inpatient stay and discharge to an institution, as well as quality of life outcomes (e.g. EuroQoL Group Quality of Life Questionnaire based on five dimensions (EuroQoL-5D), Swallowing Quality of Life Questionnaire (SWAL-QOL)).

- Methods: researchers should endeavour to examine common parameters (i.e. use similar methods), so that results can be compared more readily across different studies.

- Quality of research: trialists must report full information on randomisation, allocation concealment, blinding of treatment and outcome assessment, and attrition.

- Future research: further research is needed to discover which components of swallowing therapy are beneficial. A number of studies assessing interventions for dysphagia are ongoing (22 studies), and findings of these studies will add further information on this topic (Characteristics of ongoing studies). Several studies of mixed groups of chronic dysphagia have been done or are ongoing: a systematic review of these studies may further inform the management of acute and subacute dysphagia post stroke.

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REFERENCES

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Bai 2007i

Methods	Random numbers table Outcomes not blinded (medium-intensity vs low-intensity data set)
Participants	1 centre in China 111 participants within 2 weeks of stroke Baseline characteristics similar No cross-overs or dropouts identified Dysphagia defined by Watian swallow test
Interventions	A1: shallow needling (control) (n = 35) = low intensity A2: single deep needling (n = 18) = medium intensity B: deep multi-needling
Outcomes	Watian drinking test grade Return to normal diet
Notes	Exclusions: needle phobia, infection risk, dementia, inability to co-operate with treatment

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Randomisation via a random numbers table
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	High risk	Outcomes not blinded
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear

Bai 2007i (*Continued*)

Selective reporting (reporting bias)	Unclear risk	Unclear
Other bias	Unclear risk	Translated from Chinese language

Bai 2007ii

Methods	(High vs medium data set)
Participants	As data set 1
Interventions	A1: shallow needling (control) A2: single deep needling (n = 17) = medium intensity B: deep multi-needling (n = 40) = high intensity
Outcomes	As data set 1
Notes	-

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	High risk	Randomisation via a random numbers table
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	High risk	Outcomes not blinded
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear
Selective reporting (reporting bias)	Unclear risk	Unclear
Other bias	Unclear risk	Translated from Chinese

Bath 1997

Methods	Computerised randomisation by minimisation Unblinded outcome assessment Analysis by ITT Cross-overs: 3 NGT to PEG, 0 PEG to NGT Balancing of baseline prognostic factors between treatment groups unclear
Participants	1 centre in UK 19 participants: 8 male Mean age 77 (SD 11) years 13 ischaemic stroke, 6 haemorrhagic stroke 100% CT Enrolment within 2 weeks of stroke onset
Interventions	Factorial trial: PEG vs NGT; intensive vs conservative swallowing therapy PEG: NGT: up to 3 NGTs Intensive swallowing therapy: as for conservative, plus voluntary control (tongue-holding), sensory stimulation (tactile, oromotor exercises, swallow practice) Conservative swallowing therapy: review, advice regarding feeding route, postural/dietary modification, safe swallowing methods
Outcomes	Primary outcomes: resumption of safe feeding at 12 weeks, weight loss < 5% at 6 weeks, discharge by 6 weeks Secondary outcomes: impairment, disability, handicap, quality of life, tube failures, chest infection, oropharyngeal delay time (by videofluoroscopy) at 4 weeks
Notes	Exclusions: oro-gastrointestinal disease, concurrent severe illness, coagulopathy, premorbid dependency, severe dementia, psychiatric illness Follow-up: 3 months

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computerised randomisation by minimisation
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	High risk	Unblinded outcome assessment

Bath 1997 (*Continued*)

Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear
Selective reporting (reporting bias)	Unclear risk	Unclear
Other bias	Low risk	None identified

Carnaby 2006i

Methods	Computerised randomisation Blinded outcome assessments by SLT ITT (Control vs low-intensity data set) Baseline prognostic factors balanced between treatment groups
Participants	1 centre in Australia 306 participants; baseline characteristics similar Enrolment within 2 weeks of stroke onset: mean/median 2 days, range 0 to 12 days Clinical and videofluoroscopic evidence of dysphagia
Interventions	Rx 1: standardised high-intensity swallowing therapy (n = 102) Rx 2: standardised low-intensity swallowing therapy (n = 102); split into (n = 51) for each data set C: usual care (n = 102) Treatment for up to 1 month
Outcomes	Outcomes: time to return to normal diet; aspiration pneumonia; dysphagia (PHAD score < 85)
Notes	Trial completed and published 2006 Exclusions: previous swallowing therapy, head and neck surgery, inability to consent Follow-up: 6 months

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Treatment allocation based on a computer-generated random numbers list generated via the SPSS statistical package
Allocation concealment (selection bias)	Low risk	Randomisation schedule held at the trial office, remote from the study environment; assignment to 1 of 3 treatment options by a telephone call to the trial office made by the study speech pathologist

Carnaby 2006i (*Continued*)

Blinding (performance bias and detection bias) All outcomes	High risk	All people involved in the study unaware of treatment allocation, apart from participants and the study speech pathologist who treated participants Assigned to high-intensity and low-intensity groups
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and speech pathologist aware of treatment allocation
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome assessed by an independent speech pathologist, who was unaware of treatment allocation, every month for 6 months after randomisation
Incomplete outcome data (attrition bias) All outcomes	Low risk	3 participants lost to follow-up before 6-month analysis
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Carnaby 2006ii

Methods	(High-intensity vs low-intensity data set)
Participants	As data set 1
Interventions	High intensity (n = 102) Low intensity (n = 51)
Outcomes	As data set 1
Notes	-

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Treatment allocation based on a computer-generated random numbers list obtained via the SPSS statistical package
Allocation concealment (selection bias)	Low risk	Randomisation schedule held at trial office, remote from the study environment; assignment to 1 of 3 treatment options by a telephone call to the trial office made by the

Carnaby 2006ii (*Continued*)

		study speech pathologist
Blinding (performance bias and detection bias) All outcomes	High risk	All people involved in the study unaware of treatment allocation, apart from participants and the study speech pathologist who treated participants Assigned to high-intensity and low-intensity groups
Blinding of participants and personnel (performance bias) All outcomes	High risk	As above
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome assessed by an independent speech pathologist, who was unaware of treatment allocation, every month for 6 months after randomisation
Incomplete outcome data (attrition bias) All outcomes	Low risk	3 participants lost to follow-up before 6-month analysis
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Unclear risk	None identified

Chan 2012

Methods	Randomisation by random sequences on black paper Single-blind (participants blinded): outcome assessors blinded
Participants	1 centre in Hong Kong 87 participants with neurogenic dysphagia with similar baseline characteristics 60 (69%) participants with dysphagia due to cerebral infarct < 6 months; other causes of neurogenic dysphagia include intracranial haemorrhage, vascular dementia, Parkinson's disease Clinical evidence of dysphagia
Interventions	All groups given routine swallowing therapy Rx 1: true acupuncture (n = 20) Rx 2: sham acupuncture that did not puncture true acupoints lying on a meridian (n = 19) C: routine swallowing therapy only (n = 48) Treatment for up to 4 weeks
Outcomes	Outcomes: Royal Brisbane Hospital Outcome Measure Scale (RBHOMS), swallow function by consistencies of ingested food and fluid

Chan 2012 (*Continued*)

Notes	Exclusions: structural oral, pharyngeal, or oesophageal disease; severe primary disease of the liver, kidneys, hematopoietic system, or endocrine system; malignant tumour or infectious disease; inability to follow commands Follow-up: 3 months

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation by random sequences
Allocation concealment (selection bias)	Low risk	Allocation concealed in opaque envelopes
Blinding (performance bias and detection bias) All outcomes	Low risk	Single (participants) blinded
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Single (participants) blinded
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome assessors blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up reported
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Chen 2016a

Methods	Computer-generated random numbers by independent research staff Assessors blinded
Participants	Multi-centre trial in China 250 participants; 148 male 100% stroke within 2 to 7 days Dysphagia identified by bedside swallowing assessment and videofluoroscopic swallowing study Baseline characteristics and prognostic values similar between both groups
Interventions	Rx: acupuncture and conventional stroke rehabilitation care C: conventional stroke rehabilitation care only Duration: 3 weeks

Chen 2016a (*Continued*)

	Follow-up: 7 weeks
Outcomes	Primary outcome: NIHSS index Secondary outcomes: FMA for motor function, rate of recovery based on BSA, VFSS, MMSE, and MoCA
Notes	Exclusions: serious heart, liver, and kidney-related diseases; blood coagulation dysfunction; inability to complete the MMSE test or bedside swallowing assessment; congenital disabilities; posterior circulation infarcts; receiving thrombolytic; participated in other clinical trials within previous 3 months; pregnant or breastfeeding

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer-generated random numbers provided by independent research staff
Allocation concealment (selection bias)	Low risk	Random numbers placed into sequentially numbered, opaque, sealed envelopes
Blinding (performance bias and detection bias) All outcomes	High risk	Participants and acupuncturist aware of treatment allocations. All allopathic medical staff and rehabilitation therapists blinded
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and acupuncturist not blinded
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome assessors blinded
Incomplete outcome data (attrition bias) All outcomes	High risk	5 participants lost to follow-up; 4 discontinued intervention. Not all participants given VFSS examination
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Du 2016i

Methods	Randomisation by sequentially numbered sealed envelopes Blinded outcome assessments by trained neurologist (Sham vs low-frequency (1 Hz) data set) Baseline prognostic factors balanced between treatment groups
Participants	1 centre in China 40 participants; baseline characteristics similar Enrolment within 2 months of stroke onset confirmed by CT or MRI scan Clinical evidence of dysphagia
Interventions	Rx 1: 1 Hz rTMS to unaffected hemisphere (n = 13) Rx 2: 3 Hz rTMS to affected hemisphere (n = 13) C: sham rTMS (n = 12), split into n = 6 for each data set Treatment for up to 5 days
Outcomes	Outcomes: swallow score using Standardised Swallow Assessment (SSA), BI, mRS, and measures of mylohyoid MEPs
Notes	Exclusions: other concomitant neurological diseases, fever, infection, prior administration of tranquilliser, severe aphasia or cognitive impairment, inability to complete the follow-up, and other contraindications for rTMS Follow-up: up to 3 months

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Randomisation by sequentially numbered sealed envelopes
Allocation concealment (selection bias)	Low risk	Allocation concealed by sealed envelopes
Blinding (performance bias and detection bias) All outcomes	Low risk	Participant blinded; outcome assessor blinded
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Participant blinded
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome assessor blinded - measures evaluated by a trained neurologist who was blinded to participants' group allocation throughout
Incomplete outcome data (attrition bias) All outcomes	Low risk	2 participants lost to follow-up

Du 2016i (*Continued*)

Selective reporting (reporting bias)	Low risk	Only NIHSS not recorded at the end; all other measures reported on for all 3 time points
Other bias	Low risk	None identified

Du 2016ii

Methods	(High-frequency vs sham data set)	
Participants	As data set 1	
Interventions	High = 102 (high intensity) Sham = 51 (low intensity)	
Outcomes	As data set 1	
Notes	-	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Randomisation by sequentially numbered sealed envelopes
Allocation concealment (selection bias)	Low risk	Allocation concealed by sealed envelopes
Blinding (performance bias and detection bias) All outcomes	Low risk	Participant blinded; outcome assessor blinded
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Participant blinded
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome assessor blinded - measures evaluated by a trained neurologist who was blinded to participants' group allocation throughout
Incomplete outcome data (attrition bias) All outcomes	Low risk	2 participants lost to follow-up
Selective reporting (reporting bias)	Low risk	Only NIHSS not recorded at the end; all other measures reported on for all 3 time points
Other bias	Low risk	None identified

Feng 2012

Methods	Randomisation by random numbers table Blinding unclear Baseline prognostic factors balanced between treatment groups
Participants	1 centre in China 122 participants; baseline characteristics similar Enrolment within 2 weeks to 6 months of stroke onset Clinical evidence of dysphagia 2 participants lost to follow-up
Interventions	Rx: tongyan spray (n = 60) C: placebo (n = 60) Treatment for up to 28 days
Outcomes	Outcomes: swallow safety and function using the SSA
Notes	Exclusions: consciousness disorder; unstable life sign and accompanied by serious diseases (heart, kidney, etc.), non-compliance with examination and treatment

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Random numbers table
Allocation concealment (selection bias)	Low risk	Concealed via sealed envelopes
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Blinding unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Blinding unclear
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Blinding unclear
Incomplete outcome data (attrition bias) All outcomes	Low risk	2 participant dropouts (1 from each group)
Selective reporting (reporting bias)	Low risk	All outcomes listed reported
Other bias	Low risk	None identified

Han 2004

Methods	Randomisation by sealed opaque envelope. Assessors blinded	
Participants	People with acute stroke, dysphagia, and dysarthria 1 centre in China 66 participants 100% with stroke within 30 days of onset. Degrees of dysphagia not stated	
Interventions	Rx: scalp and neck acupuncture with electroacupuncture with standard Western medical treatment C: standard Western medical treatment only	
Outcomes	Dysphagia at end of trial after 3 treatment sessions	
Notes	Exclusions: reduced consciousness, poor compliance, infections at acupoints	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Randomisation by sealed opaque envelopes
Allocation concealment (selection bias)	Low risk	Allocations concealed by opaque envelopes
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Assessors blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	None lost to follow-up
Selective reporting (reporting bias)	Unclear risk	Unclear
Other bias	Low risk	None identified

Heo 2015

Methods	Participants were randomly allocated for radiographic inspection and treatment with or without kinesiotaping by drawing lots Blinding unknown
Participants	1 centre in Republic of Korea 44 participants 100% with dysphagia and stroke within 3 months of diagnosis Baseline characteristics similar
Interventions	Rx: kinesiotaping C: no kinesiotaping
Outcomes	Kinematic analysis of movement of the hyoid bone (movements measured in both horizontal and vertical sections) Angular variation of the epiglottis using human anatomy-based co-ordinates Swallow score: FDS
Notes	Exclusions: none

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Participants randomly allocated by drawing lots
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Blinding unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unclear
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Huang 2010

Methods	Method of randomisation unknown Blinding unknown Only data for groups 2 and 3 included	
Participants	1 centre in China 97 participants with post-stroke dysphagia	
Interventions	Group 1: electrical stimulation (n = 35) Group 2: rehabilitation training (n = 30) Group 3: acupuncture (n = 32)	
Outcomes	Swallowing function	
Notes	-	
Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Method of randomisation unknown
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Blinding unknown
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unclear
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear
Selective reporting (reporting bias)	Unclear risk	Unclear
Other bias	Unclear risk	Translated from Chinese language

Jayasekeran 2010a

Methods	Dose comparison protocol (only data from the group that were stimulated once a day over 3 days were included) Computerised randomisation by minimisation Blinded outcome measures Balancing of prognostic baseline factors between treatment groups unclear
Participants	1 centre in UK 10 participants with acute anterior circulation cerebral infarct (< 3 weeks) Mean age 73 years
Interventions	Rx: bedside pharyngeal electrical stimulation C: sham stimulation Duration: once daily for 3 consecutive days
Outcomes	Airway aspiration at 2 weeks' post intervention
Notes	Exclusion: dementia, pacemaker or implantable cardiac defibrillator, severe receptive aphasia, unstable cardiopulmonary status, distorted oropharyngeal anatomy (e.g. pharyngeal pouch), brainstem stroke, dysphagia resulting from conditions other than hemispheric stroke

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computerised randomisation by minimisation
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Blinded outcome measures
Incomplete outcome data (attrition bias) All outcomes	Low risk	None lost to follow-up
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Jayasekeran 2010b

Methods	Parallel-group design protocol Computerised randomisation by minimisation Blinded outcome measures Prognostic baseline factors between treatment groups similar
Participants	2 centres in UK 28 participants with acute anterior circulation cerebral infarct or haemorrhage (< 3 weeks) Mean age 75 years
Interventions	Rx: bedside pharyngeal electrical stimulation C: sham stimulation Duration: once daily for 3 consecutive days
Outcomes	Airway aspiration at 2 weeks post intervention
Notes	Exclusion: dementia, pacemaker or implantable cardiac defibrillator, severe receptive aphasia, unstable cardiopulmonary status, distorted oropharyngeal anatomy (e.g. pharyngeal pouch), brainstem stroke, dysphagia resulting from conditions other than hemispheric stroke

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computerised randomisation by minimisation
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Blinded outcome measures
Incomplete outcome data (attrition bias) All outcomes	High risk	3 participants lost to follow-up
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Jia 2006a

Methods	Randomisation: participants randomised in visiting sequence Blinding: unclear ITT: unclear Balancing of all prognostic factors not reported; only for age, gender, and stroke duration
Participants	1 centre in China 72 inpatients, stroke confirmed by CT or MRI scan but unclear patient inclusion criteria - 2 out of 5 symptoms as hemiplegia, coma, slurred speech, unilateral sensory disturbance, wry mouth and tongue; difficulty in swallowing Mean age: treatment group = 55.4 years, control = 54.8 years
Interventions	Group 1: acupuncture + rehabilitation training Group 2: rehabilitation training only
Outcomes	Primary outcomes: therapeutic assessment of swallowing function using 1 to 10 point scale with categories basic cure; marked improvement; improvement and failure
Notes	Not having above symptoms; cannot co-operate to do chemical examination and treatment; severe primary disease in the liver, kidneys, hematopoietic system, and endocrine system

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	High risk	Participants randomised in visiting sequence
Allocation concealment (selection bias)	High risk	Allocation not concealed
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Blinding unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unclear
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear
Selective reporting (reporting bias)	Unclear risk	Only 1 outcome chosen and reported - improvement in swallowing at end of trial
Other bias	Unclear risk	Unclear

Kang 2012

Methods	Method of randomisation unclear Baseline prognostic factors balanced between treatment groups
Participants	1 centre in Korea 25 participants; baseline characteristics similar Enrolment within 6 weeks of stroke onset Clinical and videofluoroscopic evidence of dysphagia
Interventions	Rx: additional exercise programme for dysphagia with thermal-tactile stimulation C: thermal-tactile stimulation only Treatment for up to 2 months
Outcomes	Videofluoroscopy, Functional Oral Intake Scale, transition from tube to oral feeding, incidence of aspiration pneumonia
Notes	Exclusions: previous history of other diseases, which may have caused dysphagia; severe cognitive disorder, such as dementia; inability to carry out videofluoroscopy due to incapability of sitting posture; inability to follow study instructions

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Randomisation unclear
Allocation concealment (selection bias)	Unclear risk	Blinding unclear
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unclear
Incomplete outcome data (attrition bias) All outcomes	Low risk	None reported
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Unclear risk	Unclear

Khedr 2009

Methods	Method of randomisation unclear: participants were assigned randomly to receive real or sham rTMS using closed envelopes Blinded outcome assessment Allocation sequence concealed from participants Baseline prognostic factors balanced between treatment groups
Participants	1 centre in Egypt 26 participants between 5th and 10th days post stroke (monohemispheric) Mean age 56 years
Interventions	Rx: repetitive transcranial magnetic stimulation of the affected motor cortex (n = 14) C: sham stimulation (n = 12)
Outcomes	Primary outcome: score on the dysphagia rating scale Secondary outcomes: motor power of hand grip, BI, measures of oesophageal motor evoked potentials from both hemispheres before and 1 month after sessions
Notes	Exclusion: head injury or neurological disease other than stroke, unstable cardiac dysrhythmia, fever, infection, hyperglycaemia, prior administration of tranquilliser

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Method of randomisation unclear
Allocation concealment (selection bias)	Low risk	Allocation sequence concealed from participants
Blinding (performance bias and detection bias) All outcomes	Low risk	Participants and outcome assessors not aware of allocation
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Participants informed of which group they had been allocated to at the end of the last assessment
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Blinded outcome assessment
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants apart from 1 in the sham treatment group who died completed the trial and follow-up periods
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Khedr 2010

Methods	Method of randomisation unclear: participants from both the lateral medullary infarction (LMI) group and the other brainstem infarction group were each randomly classified into 2 groups - to receive real or sham repetitive transcranial magnetic stimulation Blinded primary outcome assessment Baseline prognostic factors balanced between treatment groups
Participants	1 centre in Egypt Total of 22 participants with hemispheric stroke split into having lateral medullary infarction or other brainstem infarction Mean age 58 years
Interventions	Rx: repetitive transcranial magnetic stimulation of the affected motor cortex (n = 11) C: sham stimulation (n = 11)
Outcomes	Primary outcome: score on the dysphagia rating scale Secondary outcomes: motor power of hand grip, BI, NIHSS
Notes	Exclusion: head injury or neurological disease other than stroke, unstable cardiac dysrhythmia, fever, infection, hyperglycaemia, epilepsy, prior administration of tranquilliser

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Method of randomisation unclear
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Blinded outcome assessment
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants apart from 2 in the sham treatment group who died completed the trial and follow-up periods
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Kim 2012i

Methods	Method of randomisation unclear Blinding unclear (High frequency data set vs control)
Participants	1 centre in Korea 30 participants with acute brain injury; baseline characteristics similar Clinical and videofluoroscopic evidence of dysphagia
Interventions	Rx 1: high-frequency (5 Hz) rTMS (n = 10) Rx 2: low-frequency (1 Hz) rTMS (n = 10) (Using high frequency data set) C: sham stimulation. (n = 10); control = 5 Treatment for 2 weeks
Outcomes	Functional Dysphagia Scale and Penetration Aspiration Scale
Notes	Exclusions: prior diagnosis of another neurological disease, unstable medical condition, severe cognitive impairment, severe aphasia, history of seizure

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Method of randomisation unclear
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unclear
Incomplete outcome data (attrition bias) All outcomes	Low risk	None lost to follow-up
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Kim 2012ii

Methods	(Low-frequency data set vs control)
Participants	As data set 1
Interventions	Low-frequency rTMS = 10 Control (sham stimulation) = 5
Outcomes	As data set 1
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Method of randomisation unclear
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unclear
Incomplete outcome data (attrition bias) All outcomes	Low risk	None lost to follow-up
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Kumar 2011

Methods	Randomisation via simple randomisation Double-blind Analysis by ITT unclear Balancing of prognostic baseline factors between treatment groups unclear
Participants	1 centre in USA 14 participants with subacute (24 to 168 hours) unilateral hemispheric infarction Mean age 75 years

Kumar 2011 (*Continued*)

Interventions	Rx: anodal transcranial direct current stimulation C: sham stimulation For 5 consecutive days
Outcomes	Swallowing impairment using dysphagia outcome and severity scale
Notes	Exclusions: difficulty following instructions because of obtundation or cognitive impairment, pre-existing swallowing problems; other contraindications to transcranial direct current stimulation

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Randomisation via simple randomisation
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Low risk	Double-blind
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Double-blind
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unclear
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear
Selective reporting (reporting bias)	Low risk	All outcomes reported and explained
Other bias	Low risk	None identified

Lee 2014

Methods	Randomisation via computer-generated block randomisation Blinding unclear Analysis by ITT unclear Prognostic baseline factors between treatment groups similar
Participants	1 centre in Korea 57 participants with dysphagic stroke within 10 days of onset (men 42, women 15) Mean age 65 years

Lee 2014 (*Continued*)

Interventions	Rx: NMES combined with traditional dysphagia therapy (n = 31) C: traditional dysphagia therapy only (n = 26) 5 days per week for 3 weeks
Outcomes	Swallowing function, Functional Oral Intake Scale
Notes	Exclusion: presence of dysphagia before stroke, previous history, unstable cardiopulmonary status, serious psychological disorder or epilepsy, tumour or radiotherapy of the head and neck region, swallowing therapy before participation in the present study, unstable medical conditions that may interfere with VFSS

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer-generated block randomisation
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unclear
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants appeared to have been followed up at 12 weeks
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Lee 2015

Methods	Randomisation by computer-generated random sequence Outcome assessors blinded
Participants	Multi-centre trial in Hong Kong 93 participants with cerebrovascular disease; onset unclear although study states recent hospitalisation in the previous 3 months Baseline characteristics and prognostic factors similar

Lee 2015 (*Continued*)

Interventions	Rx: lisinopril 2.5 mg once daily at bedtime C: placebo
Outcomes	Incidence of pneumonia, mortality, and Royal Brisbane Hospital Outcome Measure Scale score
Notes	Exclusion: life expectancy < 6 months, baseline systolic blood pressure less than 100 mm Hg, known intolerance to ACE inhibitors, current use of ACE inhibitor or angiotensin receptor blockers, symptomatic chronic lung disease or cardiac failure, frequent withdrawal of enteral tube by patients, serum creatinine > 150 mmol/L, serum potassium > 5.1 mmol/L

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer-generated random sequence
Allocation concealment (selection bias)	Low risk	Allocations concealed by coding files kept confidential to all parties involved until the end of the trial
Blinding (performance bias and detection bias) All outcomes	Low risk	All parties involved not aware of allocation
Blinding of participants and personnel (performance bias) All outcomes	Low risk	All parties involved not aware of allocation
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome assessor blinded
Incomplete outcome data (attrition bias) All outcomes	High risk	22 participants did not complete trial
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Li 2014

Methods	Randomisation via minimisation software Single-blind - assessors blinded No significant differences in baseline comparability tests in all groups of participants
Participants	Recruitment through newspaper advertisements and flyers in China 118 participants with dysphagia and hemispheric stroke
Interventions	Rx 1: neuromuscular electrical stimulation (VitalStim) Rx 2: combined NMES and traditional swallowing therapy C: traditional swallowing therapy (Data from Rx 2 vs control used in this review)
Outcomes	Swallow score, oral transit time, pharyngeal transit time, laryngeal closure duration, PAS
Notes	Exclusion: progressive stroke, other neurological disease, neoplastic disease, previous surgery to swallowing apparatus, nasogastric tube

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer randomisation via minimisation software
Allocation concealment (selection bias)	Low risk	Allocation concealed by sealed envelope
Blinding (performance bias and detection bias) All outcomes	Low risk	Outcome assessor blinded
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and technicians not blinded
Blinding of outcome assessment (detection bias) All outcomes	Low risk	As above
Incomplete outcome data (attrition bias) All outcomes	High risk	17 participant dropouts
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Lim 2009

Methods	Method of randomisation unclear: participants divided into 2 groups according to order of enrolment Blinding of outcomes unclear Analysis by ITT unclear Balancing of prognostic baseline factors between treatment groups - not reported for dysphagia severity, only for previous treatment of pneumonia
Participants	1 centre in Korea 22 participants with CT or MRI confirmed stroke < 6 months from onset Mean age 64 years
Interventions	Rx: neuromuscular electrical stimulation + thermal-tactile stimulation (n = 13) C: thermal-tactile stimulation (n = 9)
Outcomes	Swallow function scoring system, PAS and PTT
Notes	Exclusions: inability to receive treatment for 1 hour, neurological disease other than stroke, combined behavioural disorder that interfered with administration of therapy, current illness or upper gastrointestinal disease, inability to give informed consent because of cognitive impairment or receptive aphasia

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	High risk	Participants divided into 2 groups according to order of enrolment
Allocation concealment (selection bias)	High risk	Not concealed
Blinding (performance bias and detection bias) All outcomes	Unclear risk	No details available
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	No details available
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Doctor blinded to groups performed videofluoroscopic examination; measured PTT as well as swallow function scoring system and Rosenbek penetration aspiration scale
Incomplete outcome data (attrition bias) All outcomes	High risk	36 enrolled to the study. Only 28 participants completed the study (16 in the experimental group and 12 in the control group)
Selective reporting (reporting bias)	Unclear risk	Swallow scores not fully reported (unclear on the range of median values)

Lim 2009 (*Continued*)

Other bias	Low risk	None identified

Liu 2000

Methods	Method of randomisation unclear Blinding of outcomes unclear Analysis by ITT unclear Balancing of prognostic baseline factors between treatment groups unclear
Participants	1 centre in China 84 participants with bulbar palsy and CT/MRI-documented stroke: 54 men, 30 women Age 50 to 78 years Infarct 56, haemorrhage 28 Enrolment within 2 months of stroke onset
Interventions	Rx: acupuncture - Tiantu (CV 22), Lieque (LU 7), Zhaohai (KI 6) - once daily for 10 days (n = 54) C: (n = 30)
Outcomes	Outcome: bulbar function (phonation, swallowing, cough reflex) Timing unclear
Notes	Exclusions: not given

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Method of randomisation unclear
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Blinding unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Blinding unclear
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Blinding unclear
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear

Liu 2000 (*Continued*)

Selective reporting (reporting bias)	Unclear risk	Unclear - no clear aim of study
Other bias	Unclear risk	Unclear

Liu 2004

Methods	RCT
Participants	1 centre in China 82 participants with cerebral infarction or haemorrhage and CT/MRI-documented stroke: 49 men, 33 women Age 40 to 80 years Infarct 72, haemorrhage 10 Enrolment within 6 months of stroke onset
Interventions	Rx: scalp acupuncture + sublingual needling (n = 44) C: scalp acupuncture + control needling (n = 38)
Outcomes	Recovery of function (swallowing food and water, movement of the tongue, disappearance of dyslalia and hoarseness)
Notes	Exclusion: severe arrhythmia, coma, asthma, dilating myocardiopathy

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Method of randomisation unclear
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Blinding unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Blinding unclear
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Blinding unclear
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear
Selective reporting (reporting bias)	Unclear risk	Unclear aim of study - only 1 outcome reported

Liu 2004 (*Continued*)

Other bias	Unclear risk	Unclear

Park 2012

Methods	Computer-generated randomisation sequence Outcomes and participants blinded
Participants	Study in Korea 20 participants with stroke > 1 month Baseline characteristics similar, except stimulation intensities. Unclear baseline degree of dysphagia between groups Dysphagia defined by videofluoroscopy
Interventions	Rx: effortful swallow with infrahyoid motor electrical stimulation C: effortful swallow with infrahyoid sensory electrical stimulation (placebo stimulation)
Outcomes	Vertical laryngeal and hyoid movements, maximum width of UES opening, PAS
Notes	Exclusions: subarachnoid haemorrhage, carotid stenosis, inability to overcome stimulation, which was determined by observation and palpation

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation sequence
Allocation concealment (selection bias)	Low risk	Automated assignment system
Blinding (performance bias and detection bias) All outcomes	Low risk	Participants and outcome assessors blinded
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Participants blinded
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome assessors blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	2 participant dropouts (1 from each group)
Selective reporting (reporting bias)	Low risk	All outcomes reported

Park 2012 (*Continued*)

Other bias	Low risk	None identified

Park 2013

Methods	Computer-generated randomisation sequence Outcomes and participants blinded
Participants	Study in Korea 18 participants with stroke > 1 month Baseline characteristics similar Dysphagia confirmed by videofluoroscopy
Interventions	Rx: active high-frequency rTMS (5 Hz) at the contralesional intact cortex C: sham rTMS
Outcomes	VDS, PAS
Notes	Exclusions: metal implants or a pacemaker in the body, history of seizures

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation sequence
Allocation concealment (selection bias)	Low risk	Automated assignment system
Blinding (performance bias and detection bias) All outcomes	Low risk	Participants and outcome assessors blinded
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Participants blinded
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome assessors blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	None lost to follow-up
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Park 2016a (i)

Methods	Randomisation unclear Outcome assessor blinded (unilateral stimulation vs sham data set)
Participants	1 centre in Korea 35 participants with subacute stroke defined as onset < 3 months Swallowing dysfunction confirmed by videofluoroscopy Baseline characteristics similar 2 participants lost to follow-up
Interventions	Rx 1: unilateral stimulation group with (10 Hz) rTMS on ipsilesional cortex and sham on contralesional cortex (n = 11) Rx 2: bilateral stimulation group with (10 Hz) rTMS on ipsilesional and contralesional cortex (n = 11) C: sham rTMS over bilateral hemispheres (n = 11) Control group split into n = 5 for data set 1 and n = 6 for data set 2 Therefore for this data set, unilateral stimulation (n = 11) vs sham stimulation (n = 5)
Outcomes	Clinical Dysphagia Scale, Dysphagia Outcome and Severity Scale, PAS, VDS
Notes	Exclusion: history of swallowing problems caused by other underlying neurological diseases, such as Parkinson's disease, dementia, or motor neuron disease; history of intractable seizure; metallic implants in the brain

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Blinding unclear
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	High risk	Single-blinded (assessors only)
Blinding of participants and personnel (performance bias) All outcomes	High risk	Reported only as single-blinded (assessors only)
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome assessors blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	2 lost to follow-up
Selective reporting (reporting bias)	Low risk	All outcomes reported

Park 2016a (i) (*Continued*)

Other bias	Low risk	None identified

Park 2016a (ii)

Methods	As per Park 2016a (bilateral stimulation vs sham data set)	
Participants	As data set 1	
Interventions	Bilateral stimulation (n = 11) vs sham stimulation (n = 6)	
Outcomes	As data set 1	
Notes	As data set 1	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Blinding unclear
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	High risk	Single-blinded (assessors only)
Blinding of participants and personnel (performance bias) All outcomes	High risk	Reported only as single-blinded (assessors only)
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome assessors blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	2 lost to follow-up
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Park 2016b

Methods	Randomisation by randomly selected envelopes containing a code specifying the group Outcomes partially blinded (for VFSS only but not for sEMG evaluation)
Participants	1 centre in Korea 33 participants with dysphagia (inclusion criteria states stroke onset within 6 months) Dysphagia confirmed by videofluoroscopy Baseline demographics and prognostic factors balanced
Interventions	Rx: EMST with a 70% threshold value of maximal expiratory pressure, using an EMST device C: training with sham device Treatment for 4 weeks
Outcomes	Swallow function using VFSS, PAS, Functional Oral Intake Scale
Notes	Exclusion: stroke before that resulting in dysphagia; severe oro-facial pain including trigeminal neuropathy; significant malocclusion or facial asymmetry; unstable breathing and pulse; tracheostomy; severe communication disorder such as severe aphasia; inadequate lip closure

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Randomisation by randomly selected envelopes containing a code specifying the group
Allocation concealment (selection bias)	Low risk	Concealed by coded envelopes
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Participant blinding unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcomes partially blinded (surface EMG evaluation not blinded; however this outcome not relevant in this review)
Incomplete outcome data (attrition bias) All outcomes	High risk	6 participants lost to follow-up
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Perez 1997

Methods	Computerised randomisation Triple-blind trial; outcomes assessed by blinded therapist Analysis by ITT No cross-overs or losses to follow-up 1 participant withdrawn with heart failure (nifedipine group) Baseline prognostic factors balanced between treatment groups
Participants	1 centre in UK 17 participants; 8 men Mean age 77 (SD 7) years All first ischaemic stroke 100% CT Enrolment 2 weeks after stroke
Interventions	Rx: nifedipine (30 mg orally daily, Bayer, UK) (n = 8) Pl: matching tablet; treatment for 4 weeks (n = 9)
Outcomes	Primary outcome: clinical improvement in swallowing Other outcomes: incidence of silent aspiration, pharyngeal transit time and response duration, swallowing delay (all assessed by videofluoroscopy), death
Notes	Exclusions: inability to sit, high clinical risk of aspiration, receptive dysphasia, cognitive impairment, pre-stroke dysphagia, existing neurological or psychiatric disease, current treatment with calcium channel blockers or aminophylline Follow-up: 4 weeks. 1 participant withdrawn with heart failure

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computerised randomisation
Allocation concealment (selection bias)	Unclear risk	Not stated
Blinding (performance bias and detection bias) All outcomes	Low risk	Triple-blind trial
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Triple-blind trial
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcomes assessed by blinded therapist
Incomplete outcome data (attrition bias) All outcomes	Low risk	1 participant withdrawn with heart failure (nifedipine group)

Perez 1997 (*Continued*)

		No cross-overs
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Power 2006

Methods	Method of randomisation unclear CT scans analysed by a neuroradiologist who was blinded to patients' clinical presentation and videofluoroscopic swallowing status Baseline data not including dysphagia severity of baseline groups
Participants	1 centre in UK 16 participants
Interventions	Rx: actual electrical stimulation following threshold setting exercise to faucial pillars C: single episode of sham electrical stimulation following threshold setting exercise
Outcomes	Changes on videofluoroscopy 60 minutes post intervention
Notes	Exclusions: prior dysphagia, intercurrent illness, other neurological disease

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Method of randomisation unclear
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unclear
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear
Selective reporting (reporting bias)	Low risk	All outcomes reported

Power 2006 (*Continued*)

Other bias	Low risk	None identified

Shigematsu 2013

Methods	Participants randomised using code numbers issued by coauthor Outcomes blinded
Participants	1 centre in Japan 20 participants with stroke > 4 weeks Baseline characteristics similar Clinical, video endoscopic, and videofluoroscopic evidence of dysphagia
Interventions	Rx: 1-mA anodal tDCS C: sham tDCS (n = 10) Treatment for 10 days
Outcomes	Dysphagia Outcome and Severity Scale, PAS, VFSS, video endoscopic evaluation of dysphagia
Notes	Exclusions: subarachnoid haemorrhage, history of epileptic seizures, severe consciousness disturbance, organic neck disease, history of surgery except for tracheotomy

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Randomised via code numbers issued by coauthor
Allocation concealment (selection bias)	Low risk	Allocation concealed by code numbers
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Participant blinding unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcomes blinded (rehabilitation doctor and speech-language hearing therapists did not know participants' group allocation)
Incomplete outcome data (attrition bias) All outcomes	Low risk	None lost to follow-up

Shigematsu 2013 (*Continued*)

Selective reporting (reporting bias)	Low risk	Results of the Dysphagia Outcome and Severity Scale reported pre-, post-, and at 1-month follow-up
Other bias	Low risk	None identified

Song 2004

Methods	Method of randomisation: random numbers table Allocation method and concealment unclear
Participants	1 centre in China 53 participants; 46 men All dysphagia identified by water swallow test Baseline characteristics reported as similar
Interventions	Rx: nurse-led swallowing exercises, oral stimulation and oral care (n = 29) C (n = 24) Follow-up: 1 month
Outcomes	Primary and secondary outcomes not defined Resolution of dysphagia by water swallow test and dietary ability, pneumonia rates
Notes	Exclusions and whether ITT not stated

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Method of randomisation: random numbers table
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unclear
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear

Song 2004 (*Continued*)

Selective reporting (reporting bias)	Unclear risk	Unclear
Other bias	Unclear risk	Translated from Chinese language

STEPS 2016

Methods	Computerised randomisation Single-blind; outcome assessor blinded Analysis by ITT Baseline characteristics balanced
Participants	International, multi-centre trial 162 participants; 94 men Mean age 74.4 years Dysphagia identified clinically and by videofluoroscopy
Interventions	Rx: active pharyngeal electrical stimulation C: sham pharyngeal electrical stimulation Follow-up: up to 12 weeks
Outcomes	Primary: change in PAS at 2 weeks from baseline Secondary: safety outcomes, clinical dysphagia (Dysphagia Severity Rating Scale, PAS at 12 weeks), dependency (mRS), activities of daily living/disability (BI), impairment (NIHSS), health-related quality of life (European Quality of Life-5 Dimensions (EQ-5D), nutritional measures (weight, mid-arm circumference, and blood albumin))
Notes	Exclusions: history of dysphagia, dysphagia from a condition other than stroke, advanced dementia, implanted pacemaker or cardiac defibrillator in situ, unstable cardiopulmonary status or a condition that compromised cardiac or respiratory status, distorted oropharyngeal anatomy, additional diagnosis of progressive neurological disorder, receiving continuous oxygen treatment, pregnant or nursing mother

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Randomisation by computer-generated permuted blocks
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding (performance bias and detection bias) All outcomes	Low risk	Researcher delivering the intervention not blinded
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Assessor and participant blinded

STEPS 2016 (*Continued*)

Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome assessors blinded
Incomplete outcome data (attrition bias) All outcomes	High risk	181 participants randomised; only 123 participants completed all 3 treatments
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Terre 2015

Methods	Computerised randomisation Double-blinded study Outcome assessors blinded
Participants	Study completed in Spain 20 participants with neurological oropharyngeal dysphagia (14 stroke participants in the posterior circulation; 6 with traumatic brain injury) Baseline characteristics similar between groups All within 5 months of diagnosis Dysphagia identified by videofluoroscopy and Functional Oral Intake Scale
Interventions	Rx: active NMES with conventional therapy C: sham NMES with conventional therapy
Outcomes	Clinical, videofluoroscopic, and oesophageal manometric analyses of swallow; Functional Oral Intake Scale
Notes	Exclusion: previous stroke or traumatic brain injury, previous dysphagia secondary to any other etiology, other metabolic or neurological disease

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computerised randomisation
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Low risk	Double-blinded

Terre 2015 (*Continued*)

Blinding of participants and personnel (performance bias) All outcomes	Low risk	Participants and assessors blinded
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Assessors blinded
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Vasant 2016

Methods	Computerised randomisation Single-blind trial; outcomes assessed by blinded therapist Analysis by ITT
Participants	3 centres in UK 36 participants; 22 men All dysphagia identified by bedside screening swallow test and videofluoroscopy Baseline characteristics reported as similar 1 participant withdrawn and lost to follow-up Baseline prognostic factors similar between groups
Interventions	Rx: pharyngeal electrical stimulation n = 18 C: sham n = 18 Duration: 3 days Follow-up: 3 months
Outcomes	Death, swallow function, dysphagia
Notes	Exclusions: advanced dementia, other neurological conditions that may explain dysphagia, previous history of dysphagia, presence of cardiac pacemaker or implanted cardiac defibrillator, diagnosis other than stroke (e.g. brain tumour), significant structural abnormalities of the mouth or throat and requiring continuous oxygen treatment

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Randomisation through a concealed computer programme
Allocation concealment (selection bias)	Low risk	Concealed via a computerised programme

Vasant 2016 (*Continued*)

Blinding (performance bias and detection bias) All outcomes	Low risk	Researcher delivering the intervention not blinded
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Participants and assessors blinded to group allocation
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome assessors blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	1 participant lost to follow-up (withdrawn) , 2 participants (1 from each group) died before follow-up at 3 months
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Warusevitane 2015

Methods	Randomisation via a random numbers list generated by an independent statistician Double-blind Analysis by ITT unclear
Participants	1 centre in UK 60 participants within 7 days of acute ischaemic or haemorrhagic stroke confirmed by CT scan of the brain who required nasogastric feeds for > 24 hours Mean age: 78 No significant differences between baseline characteristics
Interventions	Rx: 10 mg metoclopramide (10 mL) C: 10 mL normal saline Treatment duration: 21 days or until NGT no longer needed
Outcomes	Swallowing impairment using dysphagia outcome and severity scale
Notes	Exclusions: signs and symptoms of pneumonia after stroke onset, history of chronic neurodegenerative disease that could affect swallowing (e.g. Parkinson disease, motor neuron disease), oesophageal disorders, contraindications to metoclopramide

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Randomisation by numbers list generated by an independent statistician

Warusevitane 2015 (*Continued*)

Allocation concealment (selection bias)	Low risk	Allocation sequence concealed from participants
Blinding (performance bias and detection bias) All outcomes	Low risk	Double-blind trial
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Double-blind trial
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Researcher and medical team involved in participants' care blinded to treatment allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	All 60 participants analysed at end of trials (none excluded)
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Wei 2005

Methods	Method of randomisation unclear Outcomes blinded
Participants	1 centre in China 68 participants; timing post stroke unclear but suggests acute Dysphagia defined by water swallow test
Interventions	Rx: Shuiti acupoint injection with stellate ganglion block for 40 days of treatment (n = 32) C: standard medical care, which included some acupuncture (n = 33)
Outcomes	Resolution of dysphagia: water swallow test score BI Chinese Neurological Score Fugl-Meyer Assessment
Notes	Exclusions: needle phobia, organ failure, head and neck tumours Exclusions and dropouts accounted for but not analysed by ITT

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**

Wei 2005 (*Continued*)

Random sequence generation (selection bias)	Unclear risk	Unclear
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcomes blinded
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear
Selective reporting (reporting bias)	Unclear risk	Unclear
Other bias	Unclear risk	Translated from Chinese language

Xia 2011

Methods	Method of randomisation unclear Outcomes blinded
Participants	1 centre in China 120 participants, timing post stroke unclear but suggests acute Dysphagia defined by water swallow test Baseline characteristics similar
Interventions	Rx 1: combined VitalStim therapy + conventional swallowing training (n = 40) Rx 2: VitalStim therapy (n = 40) C: conventional swallowing training (n = 40) For the purpose of this review, treatment group Rx 1 used as the treatment arm only
Outcomes	VFSS, Standardised Swallowing Assessment (SSA), surface EMG, Swallowing Quality of Life (SWAL-QOL)
Notes	Exclusion criteria not specified

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**

Xia 2011 (*Continued*)

Random sequence generation (selection bias)	Unclear risk	Randomisation unclear
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Blinding unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Outcomes blinded
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Unclear risk	Unclear

Xia 2016a

Methods	Randomisation by random numbered tables Outcomes blinded
Participants	1 centre in China 124 participants, timing post stroke unclear but suggests acute based on mean days from onset of stroke Dysphagia identified by videofluoroscopy and Dysphagia Outcome Severity Scale No significant differences in baseline characteristics between groups
Interventions	Rx: combined acupuncture with standard swallowing training (n = 62) C: standard swallowing training only (n = 62) Treatment for 4 weeks
Outcomes	Primary: Standardized Swallowing Assessment, Dysphagia Outcome Severity Scale Secondary: Modified BI, Swallowing Quality of Life (SWAL-QOL)
Notes	Exclusion: presence of serious diseases of the liver, kidney, hematological system, or endocrine system; psychiatric disorders; severe cognitive impairment; severe aphasia; other diseases that potentially impaired swallowing function, such as head and neck tumours, oesophageal neoplasms, craniocerebral injury, myasthenia gravis, and Guillain-Barre syndrome

Xia 2016a (*Continued*)

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Randomisation by random numbers table
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Blinding unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome assessors blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	4 participant dropouts from study in total
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Low risk	None identified

Yuan 2003i

Methods	Method of randomisation unclear Blinding unclear (traditional liquid diet with swallowing therapy vs control)
Participants	1 centre in China 64 participants; timing unclear All dysphagia as defined by Watian Swallow Test
Interventions	R1: enteral nutrition agent with thickener and swallowing therapy (n = 18) R2: traditional liquid diet and swallowing therapy (n = 22). This data set was split (n= 11)* C: liquid diet only and no swallowing therapy (n = 24) (R1 and R2 had NGTs for an uncertain amount of time) *Compared in data set 1
Outcomes	Length of stay, pneumonia rates, nutritional measures, resolution of dysphagia (swallow test grade)

Yuan 2003i (*Continued*)

Notes	Exclusions: terminal illness, organ failure Unclear if any blinding of interventions or outcomes occurred

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Unclear
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unclear
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear
Selective reporting (reporting bias)	Unclear risk	Unclear
Other bias	Unclear risk	Translated from Chinese language

Yuan 2003ii

Methods	(Enteral nutrition agent with thickener and swallowing therapy vs traditional liquid diet and swallowing therapy data set)
Participants	As data set 1
Interventions	R1: enteral nutrition agent with thickener and swallowing therapy (n = 18) R2: traditional liquid diet and swallowing therapy (n = 22). This data set was split (n = 11)
Outcomes	As data set 1
Notes	-

Risk of bias

Yuan 2003ii (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Unclear
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unclear
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear
Selective reporting (reporting bias)	Unclear risk	Unclear
Other bias	Unclear risk	Unclear

Zheng 2014

Methods	Randomisation unclear Blinding unclear
Participants	1 centre in China 88 participants; onset of stroke within 2 weeks Dysphagia identified by water swallow test Baseline characteristics similar
Interventions	Rx: individualised multi-disciplinary rehabilitation programme (n = 44) C: conventional rehabilitation programme (n = 44) Treatment for 4 weeks
Outcomes	Swallowing function by the water swallow test
Notes	Exclusion: comprehension difficulty, such as Wernicke aphasia

Risk of bias

Bias	Authors' judgement	Support for judgement

Zheng 2014 (*Continued*)

Random sequence generation (selection bias)	Unclear risk	Unclear
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Unclear
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Unclear
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Unclear
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unclear
Selective reporting (reporting bias)	Low risk	All outcomes reported
Other bias	Unclear risk	Unclear

ACE: angiotensin-converting enzyme
BI: Barthel Index
BSA: body surface area
C: control group
CT: computed tomography
EMG: electromyography
EMST: expiratory muscle strength training
EQ-5D: EuroQoL Group Quality of Life Questionnaire based on five dimensions
FDS: Functional Dysphagia Scale
FMA: Fugl-Meyer Assessment
Hz: Hertz
ITT: intention-to-treat analysis
LMI: lateral medullary infarction
MD: mean difference
MEPs: motor evoked potentials
MMSE: Mini Mental State Examination
MoCA: Montreal Cognitive Assessment
MRI: magnetic resonance imaging
mRS: modified Rankin Scale
NGT: nasogastric tube
NIHSS: National Institutes of Health Stroke Scale
NMES: neuromuscular electrical stimulation
OR: odds ratio
PAS: Penetration Aspiration Scale

PEG: percutaneous endoscopic gastrostomy
PHAD: Paramatta Hospital's Assessment for Dysphagia score
Pl: placebo group
PTT: pharyngeal transit time
RBHOMS: Royal Brisbane Hospital Outcome Measure Scale
rTMS: repetitive transcranial magnetic stimulation
Rx: treatment group
SD: standard deviation
sEMG: surface electromyography
SLT: speech and language therapy
SPSS: Statistical Package for the Social Sciences
SSA: Standardised Swallow Assessment
SWAL-QOL: Swallowing Quality of Life Questionnaire
tDCS: transcranial direct current stimulation
UES: upper oesophageal sphincter
VDS: videofluoroscopic dysphagia scale
VFSS: videofluoroscopy swallow study

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Akamatsu 2009	RCT assessing transcutaneous electrical stimulation vs control 12 participants with chronic stroke and episodes of choking while eating or drinking Outcome: latency time in swallowing reflex Excluded: no relevant outcome data
Aoki 2016	Study looking at effect of implementing multi-disciplinary swallowing team approach in lowering the rate of pneumonia (between-team organisation vs after-team organisation) Outcomes: rates of pneumonia Excluded: not a true RCT
Arai 2003	RCT Group 1: cabergoline (n = 13) Group 2: amantadine (n = 14) Group 3 : ACE inhibitor (n = 12) Group 4: control Excluded: (1) > 3 months post stroke; (2) definition of aspiration non-standard; (3) randomisation unclear; (4) insufficient information
Beom 2011	Study comparing conventional dysphagia management (CDM) vs CDM with repetitive electrical stimulation of the suprahyoid muscles Outcomes: swallow score Excluded: not true RCT - non-concurrent comparative design
Beom 2015	Randomised trial in dysphagic participants with stroke, traumatic brain injury, or brain tumour NMES on suprahyoid (Stimplus) vs NMES on suprahyoid and infrahyoid (VitalStim) Outcomes: swallow scores Excluded: confounded - comparison between 2 treatment groups

(*Continued*)

Byeon 2016	Randomised trial comparing neuromuscular electrical stimulation vs thermal-tactile stimulation in subacute stroke patients with dysphagia Outcomes: swallow scores (Functional Dysphagia Scale using VFSS) Excluded: confounded - comparing 2 active treatments
Bülow 2008	RCT assessing neuromuscular electrical stimulation vs traditional swallowing therapy in 25 stroke patients with dysphagia Outcomes: video radiographic swallowing evaluation, nutritional status, oral motor function test, visual analogue scale for self-evaluation of complaints Excluded: (1) no available outcome data, (2) confounded, comparing 2 direct treatments
Cai 2015	Randomised trial comparing tongue acupuncture vs conventional (neck and wrist) acupuncture in post-stroke dysphagia patients Outcomes: dysphagia at end of trial, NIHSS, pneumonia Excluded: (1) confounded - both groups received active treatment
Chaudhuri 2006	RCT assessing effectiveness of electric stimulation vs traditional dysphagia therapy in participants with acute stroke (< 6 weeks) Outcomes: American Speech Language Hearing Association National outcome measurement system swallowing level Excluded: no available outcome data
Chen 2002	RCT assessing tongue acupuncture + ice massage + general medical treatment (n = 50) vs general medical treatment (n = 46) in acute dysphagic stroke patients Outcome: dysphagia recovery assessed by videofluoroscopy Excluded: no available outcome data
Chen 2003	RCT assessing electroacupuncture + rehabilitation (n = 34) vs rehabilitation alone (n = 34) in dysphagia patients with pseudobulbar palsy including stroke Treated for 10 days Outcome: dysphagia recovery after stroke Excluded: no available outcome data
ChiCTR-ONC-17012326	RCT examining effects of acupuncture and rTMS for acute patients - duration of stroke and dysphagia between 1 and 6 months Outcomes: VFSS score Excluded: confounded - comparing acupuncture and rTMS
ChiCTR-TRC-14005233	RCT comparing validity and safety of telerehabilitation (exercise rehabilitation and myoelectrical feedback) vs conventional rehabilitation in dysphagic patients with ischaemic cerebral stroke Outcomes: Barthel Index assessment; NIHSS assessment; water drinking test assessment; surface electromyography Excluded: confounded - comparing 2 active treatment groups
DePippo 1994	RCT comparing 3 active interventions in 115 dysphagic stroke patients taught compensatory swallowing techniques Group 1: patient/family choice of diet and food consistency (n = 38) Group 2: therapist-prescribed diet and food consistency (n = 38) Group 3: therapist-prescribed diet and food consistency, with daily reinforcement of compensatory

(*Continued*)

	swallowing techniques (n = 39) Outcomes: pneumonia, dehydration, caloric-nitrogen deficit, death Excluded: 3 active treatment groups with no control group (confounded)
Dou 2012	Randomised trial comparing effects of active vs passive balloon dilatation therapy on swallowing function in participants with cricopharyngeal dysfunction due to neurological disorders Outcomes: swallow score, changes in upper oesophageal sphincter opening Excluded: confounded - comparison between 2 active treatments
Ebihira 2004	RCT Group 1: theophylline 200 mg once daily Group 2: placebo N = 85 with 'mild to moderate' dysphagia (definition unclear) Outcome: latency of swallow Excluded: (1) nursing home residents (not acute), proportion of stroke patients not stated; (2) > 3 months post stroke
Ebihira 2005	RCT Group1: capsaicin troche 1.5 mcg (n = 34) Group 2: placebo (blinded) (n = 33) for 4 weeks Excluded: (1) 'predominantly' stroke (% not stated) nursing home-dependent residents; (2) definition of dysphagia unclear; (3) > 3 months post stroke; (4) outcomes: latency of swallow not relevant to review
El-Tamawy 2015	RCT evaluating effects of a designed physical therapy programme that consists of therapeutic physical exercises in addition to neuromuscular electrical stimulation on severe swallowing disorders (oropharyngeal dysphagia) in people with acute ischaemic cerebrovascular stroke Outcomes: oral transit time, hyoid/laryngeal elevation, oesophageal sphincter opening, incidence of penetration and aspiration Excluded: no available outcome data
Fraser 2002	RCT including 16 acute stroke (< 4 days from ictus) participants with dysphagia TMS vs none Outcome: pharyngeal electromyographic responses Excluded: no relevant outcome data
Freed 1996	Controlled clinical trial comparing 3 active interventions in 112 participants with aspiration Group 1: electrical stimulation Group 2: thermal stimulation Group 3: both - failed thermal stimulation followed by electrical stimulation Outcome: regain oral intake Excluded: (1) dysphagia of mixed aetiology (stroke ?%); (2) not an RCT; (3) 2 active treatment groups with no control group (confounded)
Freed 2001	Quasi-RCT (alternate assignment) comparing electrical stimulation vs thermal-tactile stimulation in 110 dysphagic stroke patients Outcome: swallow score Excluded: (1) 2 active treatment groups with no control group (confounded)

(*Continued*)

Hagg 2015	Prospective comparative study of 2 groups of post-stroke 4-quadrant facial dysfunction and dysphagic patients - palatal plate training (2005-2008) vs training with oral IQoro® (2009-2012) Outcome: facial activity, swallow function Excluded: (1) not a true RCT, (2) confounded - comparing 2 active treatment protocols
Inui 2017	Quasi-experimental study to compare the incidence of pneumonia as a dependent variable between before (control) and after (intervention group) intervention with pyriform sinus suctioning as an independent variable Outcomes: incidence of pneumonia Excluded: (1) not an RCT - not randomised
ISRCTN18137204	RCT comparing electrical pharyngeal stimulation vs sham stimulation in severely dysphagic tracheotomised stroke patients Outcomes: intention to decannulate based on FEES performance; feeding status at discharge (dysphagia severity rating scale, functional oral intake scale); mRS; length of stay (ICU/hospital), time from stimulation to discharge Excluded: outcomes not relevant to the review
ISRCTN97286108	RCT assessing dose response of transcranial direct current stimulation for dysphagia after acute stroke Outcome: swallow safety Excluded: trial terminated due to problems in recruitment (according to study author)
Jin 2014a	RCT assessing effects of magnetic-ball sticking therapy at auricular points against acupuncture in 90 participants with chronic post-stroke dysphagia Outcomes: swallow score (VFSS), PAS, pneumonia, malnutrition Excluded: (1) confounded - all participants received treatment, (2) duration of stroke unknown
KCT0001907	Study looking at effects of NMES according to electrode placement in stroke patients with dysphagia Outcomes: videofluoroscopic dysphagia scale; PAS; functional oral intake scale Excluded: (1) confounded (comparing electrode placement on suprahyoid vs infrahyoid), (2) time post onset unclear
Kikuchi 2014	Double-blind RCT on participants > 65 years old with stroke and dysphagia from 2 hospitals and 2 nursing homes in Sendai, Japan Group 1: press needles (Pyonex; Seirin Corporation, Shizuoka, Japan) at 2 points on the legs (ST36 and KI3) Group 2: sham patches on acupuncture points Group 3: press needles on sham points Excluded: no relevant outcomes
Kobayashi 1996	Randomised crossover trial assessing levodopa in 27 participants with basal ganglia infarction and 20 healthy volunteers Outcomes: swallowing latency Excluded: (1) cross-over trial, (2) outcomes (swallowing latency) not relevant to this review, (3) < 50% stroke
Kulnik 2015	Single-blind RCT in acute stroke patients Expiratory training vs inspiratory training vs sham training Outcomes: peak expiratory cough flow of maximal voluntary cough, pneumonia

(*Continued*)

	Excluded: most participants do not have clinical dysphagia
Kushner 2013	Case-control study comparing the efficacy of NMES in addition to traditional dysphagia therapy including progressive resistance training vs that of traditional dysphagia therapy/progressive resistance training alone in participants with acute post-stroke dysphagia Outcomes: swallow score, dysphagia at end of trial Excluded: non-randomised trial
Lan 2013	Single-blind clinical intervention trial comparing biomechanical properties of swallowing in brainstem stroke patients with dysphagia following modified balloon dilation therapy vs regular dysphagia therapy Outcomes: Functional Oral Intake Scale, pharyngeal maximum pressures and duration, and upper oesophageal sphincter residual pressure and duration during swallowing were measured using high-resolution manometry Excluded: non-randomised trial
Logemann 2009	RCT assessing traditional swallowing therapy or the Shaker exercise in participants with prolonged oropharyngeal dysphagia and aspiration Outcomes: occurrence of aspiration (preswallow, intraswallow, postswallow) at 6-week follow-up period; occurrence of residue in the oral cavity, valleculae, or pyriform sinuses; Performance Status Scale for Diet Excluded: (1) head and neck cancer and stroke (< 50%); (2) no relevant outcome data
Ma 2014	Randomised trial comparing acupoint injection, neural electrical stimulation, combination of both and swallowing training Outcomes: swallow function using water swallow test Excluded: confounded - comparing 3 active treatments
Ma 2015	Randomised trial comparing effects of acupuncture and neck-skin electrical stimulation on dysphagia in participants with cerebral infarction Outcomes: swallow function using water swallow test and food-intake scale Excluded: confounded - comparing 2 active treatments
Maeda 2017	RCT 43 participants who were prescribed in-hospital dysphagia rehabilitation (most with history of stroke) Sensory stimulation vs sham stimulation Outcomes: cough latency times, functional oral intake scale scores, oral nutritional intake Excluded: (1) majority of participants without stroke (48.8% stroke participants), (2) timing of stroke unclear
Mao 2016	Non-randomised interventional study Standard swallowing training vs standard swallowing training with acupuncture All participants with post-stroke dysphagia Excluded: not an RCT - not randomised
McCullough 2012	Cross-over study investigating effects of intensive exercise using Mendelsohn manoeuvre on swallowing movement All 18 participants with stroke and dysphagia Outcomes: videofluoroscopic swallow assessment, swallow score Excluded: (1) not a true RCT - cross-over design, (2) majority of participants chronic

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McCullough 2013	Cross-over study assessing effect of Mendelsohn manoeuvre on hyoid movement All 18 participants with post-stroke dysphagia Outcomes: assessment of hyoid movements, upper oesophageal sphincter opening Excluded: (1) not a true RCT - cross-over design, (2) no relevant outcomes
Mepani 2009	RCT comparing traditional swallowing therapy vs Shaker exercise in 6 stroke and 5 cancer patients Outcome: deglutitive thyrohyoid shortening before and after completion of assigned therapy regimen Excluded: (1) no time of onset for stroke patients, (2) no separate results for stroke, (3) no relevant outcome data
Messaggi-Sartor 2015	RCT comparing effects of short-term inspiratory and expiratory muscle training on respiratory muscle strength in subacute stroke patients Outcomes: respiratory muscle strength (maximum inspiratory and expiratory pressures) Excluded: (1) outcomes not relevant to review, (2) not all participants had dysphagia
Michou 2010	RCT comparing transcranial magnetic stimulation vs sham stimulation in 12 stoke participants with dysphagia Outcome: pharyngeal electromyographic responses Excluded: no relevant outcome data
Michou 2011	RCT comparing transcranial magnetic stimulation vs pharyngeal electrical stimulation vs paired associative stimulation vs sham stimulation in 14 dysphagic stroke participants Outcome: videofluoroscopic swallowing assessments Excluded: no available outcome data
Nakamura 2013	Cross-over study assessing the effect of ice massage in triggering the swallow reflex Outcomes: videofluoroscopic assessment of swallowing Excluded: not a true RCT - cross-over design
Nakayama 1998	RCT comparing 5 mg imidapril or placebo in randomised, double-blind, cross-over design. Participants were normotensive patients with at least 1 episode of aspiration and healthy volunteers Outcome: swallowing reflex Excluded: no relevant outcome data
Nam 2012	Randomised trial comparing 2 neuromuscular stimulation techniques (VitalStim vs Stimplus DP 200) Outcomes: swallow function using videofluoroscopic swallowing studies Excluded: confounded - comparison of 2 treatment groups
NCT00376506a	Implanted neuroprosthesis (neuro control implantable receiver-stimulator) to stimulate the laryngeal nerve vs sensory training in dysphagic participants including stroke > 6 months post onset Excluded: (1) no control group, 2 active groups compared, (2) no outcome data
NCT00376506b	RCT assessing intramuscular stimulation device implanted in the neck vs vibrotactile stimulation of the throat in 20 participants with dysphagia secondary to stroke or chronic neurological disease Outcome: swallowing safety for 10 mL of thin liquid and 5 mL of pudding with and without stimulation Excluded: comparing 2 active treatments vs no control (confounded)

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NCT01971320	Single-blind RCT comparing active vs fake Urostim I stimulation in hemispheric stroke patients with oropharyngeal dysphagia Outcomes: evaluation of oropharyngeal dysphagia symptoms Excluded: no outcome data as trial terminated due to lack of recruitment
Nishiyama 2010	RCT comparing nicergoline (15 mg tds) vs control in 50 ischaemic stroke patients Outcome: substance P level Excluded: no relevant outcome data
Ortega 2016	RCT comparing 2 x 10-day treatment groups (transient receptor potential vanilloid 1 agonist vs transcutaneous sensory electrical stimulation) Outcomes: swallow function (videofluoroscopic), dysphagia at end of trial Excluded: (1) < 50% participants with stroke - duration unknown, (2) confounded - comparing 2 active treatments
Permsirivanich 2009	RCT Group 1: NMES (n = 12) Group 2: rehabilitation swallowing therapy (n = 11) All stroke Excluded: confounded, i.e. comparison of 2 active treatments
Pownall 2008	RCT assessing thickened fluids vs postural and/or swallowing strategies in 50 participants with post-stroke dysphagia: a further group of participants who were not dysphagic for liquids and who were given normal fluids compared with RCT Outcome: development of chest infection and dehydration Excluded: no control group - 2 interventional groups were compared in the RCT
Pryor 2011	RCT comparing NMSE vs vibrotactile stimulation in dysphagic participants Outcomes: swallow function, PAS Excluded: (1) mixed patient population, (2) confounded - comparison of 2 active interventions
Reidnauer 2006	RCT comparing vital stimulation (and electrotherapy intervention) vs traditional treatment in post-stroke participants with dysphagia Outcomes: swallow scores Excluded: no available outcome data
Rofes 2014	Double-blind RCT comparing effects of 2 doses of piperine (dual TRPV1/TRPA1 agonist) on the swallow response of dysphagic participants Participants were randomised into 2 groups: 1 group received 150 lM piperine and the other group received 1 mM Outcome: PAS, swallowing analysis with videofluoroscopic images Excluded: dose-response trial - all groups received treatment (either low or high dose of piperine)
Rosenbek 1991	Randomised cross-over trial assessing thermal stimulation in 7 male dysphagic participants with multiple previous strokes Outcome: duration of stage transition Excluded: (1) cross-over trial, (2) most participants recruited > 3 months after stroke onset, (3) randomisation status unclear

(*Continued*)

Rosenbek 1996	Randomised cross-over trial assessing thermal stimulation in 23 dysphagic participants with multiple previous strokes Outcome: duration of stage transition, total swallow duration Excluded: (1) cross-over trial, (2) 14 participants recruited > 3 months after stroke onset
Rosenbek 1998	Dose comparison RCT of thermal stimulation (150, 300, 450, 600 trials per week) in 45 dysphagic stroke participants recruited within 12 weeks Outcome: number of trials delivered, treatment time, duration of stage transition, aspiration (PAS) Excluded: no control group
Sdravou 2012	Interventional study comparing effects of carbonated thin liquids vs non-carbonated thin liquids on oropharyngeal swallowing in adults with neurogenic dysphagia Outcomes: oral transit time, pharyngeal transit time, PAS Excluded: (1) non-RCT, (2) many participants with chronic stroke (> 6 months)
Seki 2005	Randomised trial Group 1: acupuncture (n = 18) Group 2: no intervention (n = 14) Excluded: (1) incomplete outcome data, (2) time from stroke unclear
Shaker 2002a	RCT comparing head-raising exercise vs sham exercise in 27 dysphagic participants Outcomes: upper oesophageal sphincter function, functional swallow status Excluded: (1) dysphagia of mixed aetiology (cerebrovascular disease 56%), (2) most participants recruited > 3 months after stroke onset, (3) individual patient data unavailable, so not possible to analyse subgroup of appropriate participants
She 2014	RCT comparing acupuncture in 8 neck-occiput points vs meridian points Outcomes: speech and swallowing dysfunction at end of trial Excluded: (1) confounded - comparing 2 different treatment groups
SQACU01 2001	RCT comparing acupuncture vs sham acupuncture for 16 sessions in participants with dysphagia due to recent stroke Outcomes: tube feeding, pneumonia, mortality, each at 6 months Excluded: no outcome data
Steele 2016	RCT comparing 2 treatment protocols: tongue pressure profile training or tongue pressure strength-and-accuracy training Outcomes: swallow function Excluded: confounded - comparison between 2 treatment protocols
Sukthankar 1994	RCT assessing swallowing therapy (biofeedback) in 9 participants with dysphagia secondary to stroke or head injury Group 1: regular therapy (n = 4) Group 2: regular therapy and oral exercises (n = 2) Group 3: regular therapy and oral exercises with visual and audio biofeedback (n = 3) Excluded: (1) dysphagia of mixed aetiology, (2) outcome measures (tongue and lip motor force) not relevant to this review

(*Continued*)

Suntrup 2015	RCT comparing electrical pharyngeal stimulation vs sham stimulation (control) in severely dysphagic tracheotomised stroke participants Outcomes: ability to decannulate based on FEES performance; feeding status at discharge (FOIS); mRS; length of stay (ICU/hospital) and time from stimulation to discharge Excluded: outcomes (decannulation) not relevant to review (only data regarding decannulation available before trial unblinded)
Suzuki 2012	Randomised trial investigating the relationship between body position during nasogastric feed and aspiration pneumonia in acute stroke participants Outcomes: aspiration pneumonia rates Excluded: pseudo-randomised study; assessment of body position
Tai 2014	Quasi-experimental trial to investigate effectiveness of the chin-down swallowing technique in improvement of dysphagia in stroke participants Outcomes: Dysphasia Assessment Scale and Swallow Self-assessment Excluded: not an RCT - not randomised
Teramoto 2008	RCT assessing swallowing function using cilostazol vs placebo in 48 participants with dysphagia secondary to stroke Outcome: swallowing function Excluded: (1) onset of stroke to randomisation, 1 to 6 months, (2) cross-over study, no access to data on the first phase
Terre 2012	Randomised, alternating, cross-over study assessing effectiveness of chin-down posture in preventing aspiration in participants with neurogenic dysphagia secondary to acquired brain injury Outcomes: aspiration prevention Excluded: (1) pseudo-randomised study, (2) assessment of posture
Toyama 2014	Non-randomised interventional study comparing NMES and conventional treatment vs conventional treatment only Outcomes: swallow scores (VDS, FOIS), hyoid and laryngeal displacement Excluded: not an RCT - not randomised
Ueda 2004	21 participants Group 1: functional swallowing training (n = 11) Group 2: oral care (n = 11) in nursing home residents (% stroke unknown) who are tube fed Excluded: (1) < 50% stroke, (2) non-acute, (3) randomisation unclear
Varma 2006	Group 1: motor control programme (n = 30) Group 2: home exercise programme (n = 30) Randomisation method unclear Excluded: (1) insufficient data, (2) outcome methods unclear
Wang 2016	Randomised interventional trial comparing differences in effects between awn-like needle at Tiantu (CV 22) and filiform needle for dysphagia after cerebral infarction Outcomes: standard swallowing assessment scale and modified Bathel index Exlcuded: confounded - comparing 2 different treatment groups

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Xia 2016	RCT with 130 participants with post-stroke dysphagia In treatment group, acupuncture based on meridian differentiation was adopted. The main acupoints were Neiguan (PC 6), Shuigou (GV 26), Sanyinjiao (SP 6), Fengchi (GB 20), Lianquan (CV 23), Jialianquan (Extra), Jinjin (EX-HN 12), Yuye (EX-HN 13), etc Control group: points were selected 5 cm lateral to the acupoints used in the observation groups and stimulated with shallow puncture Outcomes: standardised swallowing assessment, VFSS, modified Barthel Index and swallowing-related quality of life (SWAL-QOL) Excluded: confounded - comparing 2 treatments
Zhang 2011	RCT comparing different depth of Chonggu (EX-HN 27) by electroacupuncture in participants with dysphagia after stroke Chonggu (EX-HN 27) deep insertion group (n = 99) Chonggu (EX-HN 27) shallow insertion group (n = 94) Traditional acupuncture group (n = 90) Outcomes: Kubota's Water Drinking Test Scale, standard swallowing function scale, and TCM Scale of Dysphagia After Stroke Excluded: no available outcome data
Zhang 2018a	RCT comparing effects of electroacupuncture with different frequencies in participants with dysphagia after stroke Low-frequency (2 Hz) electroacupuncture group vs high-frequency (100 Hz) electroacupuncture group Outcomes: VFSS, standardised swallowing assessment Excluded: not an RCT - dose-response study (no control group)
Zhang 2018b	Randomised interventional trial to assess clinical improvement of nursing intervention in swallowing dysfunction of elderly stroke participants Conventional nursing service vs nursing interventions (psychological intervention, health education, rehabilitation exercises, diet intervention) Outcomes: dysphagia at end of trial, functional outcomes (GQOL-74) Excluded: confounded - comparing 2 different treatment groups
Zhao 2015	Randomised trial of participants with stroke and swallowing disorders Group A: normal acupuncture Group B: NMES combined with acupuncture with uniform reinforcing-reducing manipulation as well as the piercing and blood-letting method Outcomes: Kubota water test, dysphagia at end of trial Excluded: confounded - comparison between 2 treatment groups

ACE: angiotensin-converting enzyme
CDM: conventional dysphagia management
CXR: chest x-ray
FEES: Fibreoptic Endoscopic Evaluation of Swallowing
FIM: Functional Independence Measure
FOIS: Functional Oral Intake Scale
GQOL-74: Generic Quality of Life Inventory
ICU: intensive care unit
IOro®: Orofacial device

mRS: modified Rankin Scale
NGT: nasogastric tube
NIHSS: National Institutes of Health Stroke Scale
NMES: neuromuscular electrical stimulation
PEG: percutaneous endoscopic gastrostomy
RCT: randomised controlled trial
rTMS: repetitive transcranial magnetic stimulation
SAH: subarachnoid haemorrhage
SWAL-QOL: Swallowing Quality of Life Questionnaire
TCM: Traditional Chinese Medicine
TMS: transcranial magnetic stimulation
VDS: videofluoroscopic dysphagia scale
VFSS: videofluoroscopy swallow study

Characteristics of studies awaiting assessment *[ordered by study ID]*

Azimov 2017

Methods	RCT although randomisation method unclear
Participants	34 participants with ischaemic stroke and dysphagia at onset 2 to 7 points of PAS Scale
Interventions	Experimental group: amantadine (200 mg/d) and levodopa (125 mg/d) after standard treatment (n = 17) Control group: standard treatment, including citicoline and anticholinesterase (n = 17)
Outcomes	PAS divided into group PAS score 2 to 4 and group PAS score 5 to 7; recheck after 2 months
Notes	Study completed; awaiting full published data

Carnaby 2012

Methods	RCT
Participants	53 stroke participants from a subacute rehabilitation facility
Interventions	Group 1: usual care Group 2: McNeill Dysphagia Therapy plus sham NMES Group 3: McNeill Dysphagia Therapy plus active NMES
Outcomes	Increase of 10 or more points on the Mann Assessment of Swallowing and improvement of 2 or more scale points on the Functional Oral Intake Scale, without significant weight loss or complication
Notes	In the process of retrieving full-text article and data

Chang 2014

Methods	RCT
Participants	74 participants with dysphagia after stroke
Interventions	Functional electrical stimulation vs a combination of electrical stimulation and acupuncture
Outcomes	Swallow score, removal rate of nasogastric tube
Notes	In the process of retrieving full-text article

Chaudhuri 2008

Methods	RCT
Participants	People with stroke and dysphagia
Interventions	Traditional dysphagia treatment vs combined neuromuscular electrical stimulation and traditional treatment
Outcomes	Swallow score (ASHA NOMS)
Notes	Awaiting published data (full text)

Chen 2017

Methods	RCT
Participants	People with dysphagia due to stroke (onset 2 to 7 days)
Interventions	Levetiracetam (Keppra) vs carbidopa/levodopa (Sinemet) vs placebo
Outcomes	Qualitative and quantitative swallow function
Notes	Study published; in the process of extracting data

Cheng 2005

Methods	RCT
Participants	People with Ischaemic stroke with pseudobulbar palsy
Interventions	Early throat muscle training vs control
Outcomes	Effects on vertebral and basilar artery blood flow
Notes	In the process of retrieving full-text article

Cheng 2014

Methods	RCT
Participants	180 participants with post-stroke dysphagia
Interventions	Group 1 (Acupuncture A): acupuncture at Lianquan (CV 23) Group 2 (Acupuncture B): acupuncture at Hegu (LI 4) and Neiguan (PC 6) Group 3 (Control): rehabilitation group
Outcomes	NIHSS scores, VFSS scale, pneumonia, clinical efficacy
Notes	In the process of retrieving full-text article

ChiCTR-TRC-07000010

Methods	RCT
Participants	People with dysphagia in the convalescence phase of stroke (2 and 6 months)
Interventions	Combination of body acupuncture, scalp acupuncture, and electroacupuncture vs routine rehabilitation training
Outcomes	Safety and tolerability of acupuncture
Notes	Study completed; awaiting published data

ChiCTR-TRC-08000463

Methods	RCT
Participants	People with stroke 2 to 60 days from onset
Interventions	Dysphagia therapeutic apparatus on acupoints vs regular dysphagia rehabilitation vs both
Outcomes	Swallowing function and mastication function
Notes	Study completed; awaiting published data

ChiCTR-TRC-14004235

Methods	RCT
Participants	People with dysphagia symptoms appearing within 1 to 6 months after stroke
Interventions	Modified Dihuang Yinzi Decoction (herb treatment group) vs control
Outcomes	Swallowing rehabilitation improvement diagnosed by videofluoroscopy, adverse events

ChiCTR-TRC-14004235 (*Continued*)

Notes	Study completed; awaiting published data

ChiCTR-TRC-14004955

Methods	Randomised parallel controlled trial
Participants	60 people with stroke; onset of stroke at least 2 times but occurrence of stroke at least 1 month before admission
Interventions	Manipulation + sham tDCS Manipulation + tDCS
Outcomes	Lingual movement; buccofacial apraxia; Modified Assessment of Swallowing Ability; VFSS; EEG non-linear analysis
Notes	Study likely completed; website not updated; awaiting published data

Choi 2017

Methods	RCT
Participants	Stroke survivors with dysphagia
Interventions	Experimental group: Shaker exercise + conventional therapy (n = 16) Control group: conventional therapy (n = 16)
Outcomes	PAS and oral diet level
Notes	In the process of retrieving full-text article

Chu 2017

Methods	RCT
Participants	Dysphagia patients with pseudobulbar palsy
Interventions	Basic treatment vs GAO neck acupuncture at Fengchi (GB 20), Yiming (EX-HN 14), Gongxue (Extra), Lianquan (CV 23), Wai Jinjin Yuye (Extra), Tunyan (Extra), Zhiqiang (Extra), Fayin (Extra) with basic treatment
Outcomes	Repetitive saliva-swallowing test, standardised swallowing assessment, swallow quality-of-life questionnaire
Notes	In the process of retrieving full-text article

de Fraga 2017

Methods	RCT
Participants	10 participants with ischaemic stroke and speech therapy-diagnosed oropharyngeal dysphagia
Interventions	Rx: myofunctional therapy plus voice therapy C: myofunctional therapy only
Outcomes	Swallow function
Notes	Study published; in the process of extracting data

Eom 2017

Methods	RCT
Participants	Stroke patients with oropharyngeal dysphagia
Interventions	Resistance expiratory muscle strength training vs sham expiratory muscle strength training
Outcomes	Videofluoroscopic dysphagia scale, PAS
Notes	In the process of retrieving full-text article

Erfmann 2017

Methods	RCT
Participants	Subacute stroke patients with oropharyngeal dysphagia
Interventions	Expiratory muscle strength training; no further details available
Outcomes	No further details available at the time
Notes	In the process of retrieving text

Fan 2007

Methods	RCT
Participants	60 post-stroke patients with dysphagia
Interventions	Experimental group: acupuncture plus Western drugs Control group: Western drugs
Outcomes	Swallowing test

Fan 2007 (*Continued*)

Notes	In the process of retrieving full-text article

Feng 2016

Methods	RCT
Participants	60 cases of post-stroke dysphagia
Interventions	Rx: deep acupuncture at Lianquan (CV 23) and Yifeng (TE 17) with swallowing training C: swallowing training only
Outcomes	VFSS dysphagia evaluation scale and Watian water swallow test
Notes	In the process of retrieving full-text article

Gao 2016

Methods	RCT
Participants	90 patients with dysphagia after cerebral infarction
Interventions	Chin tuck resistance vs Shaker exercise vs control
Outcomes	VFSS, Self-Rating Depression Scale, PAS
Notes	In the process of retrieving full-text article

Guillen-Sola 2017

Methods	RCT
Participants	Subacute ischaemic stroke (1 to 3 weeks) and dysphagia confirmed by videofluoroscopic study with a score ≥ 3 on the 8-point PAS
Interventions	Group I: standard swallow therapy Group II: inspiratory and expiratory muscle training + standard swallow therapy Group III: neuromuscular electrical stimulation of suprahyoid muscles, sham inspiratory and expiratory muscle training, and standard swallow therapy
Outcomes	Respiratory muscle function (baseline, 3 weeks, and 3 months), severity of dysphagia (PAS) (baseline and 3 months) , and occurrence of respiratory complications (chest x-ray, fever); also volume-viscosity swallow test (V-VST), Functional Oral Intake Scale, and Dysphagia Outcome and Severity Scale (baseline, 3 weeks, and 3 months)
Notes	Study published; in the process of extracting data

Hamada 2017

Methods	Study design not clear
Participants	56 people with acute stroke and dysphagia
Interventions	General dysphagia therapy vs combination of surface electrical stimulation and general dysphagia therapy
Outcomes	Pulmonary infection
Notes	In the process of retrieving full-text article

Hong 2011

Methods	RCT
Participants	People with cerebral apoplexy and dysphagia
Interventions	Strengthened diet nursing vs control
Outcomes	Incidence of aspiration, malnutrition, dehydration
Notes	In the process of retrieving full-text article

Huang 2008

Methods	RCT
Participants	66 participants with dysphagia post-ischaemic stroke
Interventions	Group 1: electro-acupuncture group Group 2: rehabilitation training combined with acupoint percutaneous electrical stimulation Group 3: rehabilitation training combined with acupoint token puncturing
Outcomes	Quality of life scale specified for dysphagia (name not stated)
Notes	In process of retrieving full-text article

Huang 2014

Methods	RCT
Participants	People with acute stroke and dysphagia
Interventions	Traditional swallowing vs oropharyngeal NMES vs combined NMES/traditional swallowing
Outcomes	Swallow score, PAS, VFSS

Huang 2014 (*Continued*)

Notes	In process of retrieving relevant outcome data

Huimin 2015

Methods	RCT
Participants	76 people with pharyngeal dysphagia after stroke
Interventions	Surface electromyographic biofeedback with conventional therapy vs conventional therapy only
Outcomes	Degree of openness of upper oesophageal sphincter, pharyngeal transit time, maximum displacement of the hyoid bone
Notes	In the process of retrieving full-text article

Jefferson 2008

Methods	RCT
Participants	People with chronic stroke and dysphagia
Interventions	Repetitive transcranial magnetic stimulation vs sham stimulation over the unaffected pharyngeal motor cortex
Outcomes	Measurements of cortico-pharyngeal excitability
Notes	In the process of retrieving full-text article

Ji-Ye 2017

Methods	RCT
Participants	Dysphagia patients with ischaemic stroke and pseudobulbar palsy
Interventions	Oral aspirin vs acupuncture (XNJ-AI at Fengchi (GB 20)) with oral aspirin
Outcomes	Water-swallowing test, plasma thromboxane B2 and 6-keto-prostaglandin F1a levels
Notes	In the process of retrieving full-text article

Jia 2006

Methods	RCT
Participants	40 cases of post-apoplectic dysphagia with 2 out of 5 symptoms such as hemiplegia, coma, slurred speech, unilateral sensory disturbance, dry mouth and tongue, difficulty in swallowing
Interventions	Treatment group was treated by acupuncturing points Fengchi (GB 20), Tianzhu (BL 10), Tongli (HT 5), and Lianquan (CV 23) plus rehabilitation exercises Control group only by rehabilitation exercise
Outcomes	Therapeutic effect assessed by 1 to 10 point scale
Notes	Study published; in the process of extracting data

Jiang 2014

Methods	RCT
Participants	People with stroke and dysphagia
Interventions	Electroacupuncture group vs VitalStim group vs combined group
Outcomes	Water swallow test, swallow score
Notes	In the process of retrieving full-text article

Jing 2016

Methods	RCT
Participants	60 people with dysphagia after stroke
Interventions	NMES with conventional therapy vs conventional therapy only
Outcomes	Curative effects, swallowing function, aspiration, laryngeal elevation, food residue, food intake scores
Notes	In the process of retrieving full-text article

Kim 2017

Methods	RCT
Participants	People with post-stroke oropharyngeal dysphagia confirmed by VFSS
Interventions	Tongue-to-palate resistance training vs control
Outcomes	Swallowing function - videofluoroscopic dysphagia scale and PAS

Kim 2017 (*Continued*)

Notes	Study published; in the process of extracting data

Koch 2015

Methods	RCT
Participants	People with stroke and dysphagia
Interventions	Swallowing training using surface electromyography as biofeedback vs standard treatment
Outcomes	Swallow score
Notes	In the process of retrieving full-text article

Konecny 2018

Methods	RCT
Participants	54 people with early-stage stroke and dysphagia
Interventions	Transcutaneous electrical nerve stimulation of suprahyoid muscles vs control
Outcomes	Swallow function - videofluoroscopic study, oral transit time, pharyngeal transit time
Notes	Study published; in the process of extracting data

Koyama 2017

Methods	RCT
Participants	16 participants with stroke-related dysphagia
Interventions	Modified jaw opening exercise vs control
Outcomes	Swallow function - videofluorographic swallowing study, distance between the mental spine and the hyoid bone, hyoid displacement
Notes	Study published; in the process of extracting data

Lee 2015b

Methods	RCT
Participants	24 people with dysphagia after ischaemic stroke
Interventions	Treatment: 10 Hz rTMS over the brain cortex where motor evoked potential was obtained from the suprahyoid muscle Control: 10 Hz rTMS over the brain cortex where motor evoked potential was obtained from the abductor pollicis brevis muscle
Outcomes	Functional Dysphagia Scale, PAS, Dysphagia Outcome and Severity Scale
Notes	Study published; in the process of extracting data

Li 2008

Methods	RCT
Participants	60 people with ischaemic stroke and dysphagia
Interventions	Group 1: acupuncture group and routine treatment and rehabilitation training Group 2: routine treatment and rehabilitation training
Outcomes	Not stated
Notes	In the process of retrieving full-text article

Li 2009

Methods	RCT
Participants	60 people post stroke with dysphagia
Interventions	Experimental group: acupuncture plus feeding and swallowing rehabilitation training Control group: swallowing and feeding rehabilitation training
Outcomes	Swallowing test
Notes	In the process of retrieving full-text article

Li 2016

Methods	RCT
Participants	60 people with pseudobulbar palsy paralysis dysphagia
Interventions	Treatment: 5 needles of the Nape acupuncture Control: routine acupuncture (Lian Quan, Tong Li, Zhao Hai)

Li 2016 (*Continued*)

Outcomes	Curative effect dysphagia (unclear)
Notes	In the process of retrieving full-text article

Liu 2018

Methods	RCT
Participants	100 people with dysphagia caused by pseudobulbar palsy
Interventions	Nape acupuncture with rehabilitative swallowing training vs rehabilitative swallowing training only
Outcomes	Repetitive saliva-swallowing test, water swallow test, standardised swallowing assessment, swallow quality-of-life questionnaire (SWAL-QOL)
Notes	In the process of retrieving full-text article

Ma 2016

Methods	RCT
Participants	80 people with dysphagia and pseudobulbar palsy
Interventions	Quick needle insertion at Aqiang point vs routine acupuncture at Lianquan (CV 23)
Outcomes	Water swallow test, curative rate
Notes	In the process of retrieving full-text article

Malik 2017

Methods	RCT
Participants	People with dysphagia (95% of patients with stroke aetiology)
Interventions	Thermal stimulation vs swallowing manoeuvres vs combination of both
Outcomes	Function Outcome Swallowing Scale
Notes	Study published; in the process of extracting data

Mehndiratta 2017

Methods	RCT
Participants	98 people with dysphagia within the first month after ischaemic stroke
Interventions	Sensory-level electrical stimulation to bilateral masseter muscles vs sham stimulation
Outcomes	Bedside Dysphagia Score, Neurological Examination Dysphagia Score, Total Dysphagia Score, Mann Assessment of Swallowing Ability test, flexible fibreoptic endoscopic evaluation of swallowing
Notes	Study published; in the process of extracting data

Meng 2015

Methods	RCT
Participants	251 people with dysphagia after stroke
Interventions	Group 1: deep acupuncture with conventional glossopharyngeum acupuncture Group 2: shallow acupuncture with conventional glossopharyngeum acupuncture Group 3: conventional glossopharyngeum acupuncture only (control)
Outcomes	Water swallowing test evaluation scale
Notes	In the process of retrieving full-text article

Meng 2018

Methods	RCT
Participants	30 people with post-stroke dysphagia
Interventions	2 groups given surface NMES at different sites of patients' neck vs control
Outcomes	Water swallow test, repetitive saliva swallowing test, dysphagia outcome and severity scale
Notes	In the process of retrieving full-text article

Moon 2017

Methods	RCT
Participants	18 people with stroke and dysphagia
Interventions	Expiratory muscle strength training vs control
Outcomes	Functional dysphagia scale, PAS, vallecular residue, pyriform sinuses residue

Moon 2017 (*Continued*)

Notes	Study published; in the process of extracting data

Moon 2018

Methods	RCT
Participants	16 people with subacute stroke and dysphagia
Interventions	Tongue pressure strength and accuracy training vs control
Outcomes	Maximum isometric tongue pressures of the anterior and posterior tongue, Mann Assessment of Swallowing Ability, Swallowing-Quality of Life
Notes	In the process of retrieving full-text article

NCT00722111

Methods	Randomised, open label
Participants	200 people post stroke
Interventions	Group 1: lingual press (high-intensity, oral, non-swallowing) Group 2: effortful swallowing (high-intensity swallowing) Group 3: natural swallowing (high-frequency, low-intensity swallowing) Group 4: non-oral sham (control) exercise
Outcomes	Composite score of PAS and Residue Scale with no worsening of either at baseline, week 4, and week 8
Notes	Study completed; awaiting published data

NCT01081444

Methods	RCT
Participants	People with dysphagia and first episode of stroke
Interventions	Active vs sham rTMS
Outcomes	Videofluoroscopy and high-resolution manometry
Notes	Study completed; awaiting published data

NCT01085903

Methods	Randomised, double-blind (participant, investigator), cross-over assignment
Participants	People with stroke, neglect, dysphagia
Interventions	Modafinil 200 mg once daily vs placebo for 3 days
Outcomes	Predicting response to modafinil among participants with neglect, dysphagia
Notes	Study completed; awaiting published data

NCT01777672

Methods	RCT
Participants	100 people with oropharyngeal dysphagia due to stroke episode within last 3 months
Interventions	Control group: recommendations from patient healthcare providers Experimental group 1: oral TRPV1 (natural capsaicin) plus recommendations from patient healthcare providers Experimental group 2: pharyngeal electrical stimulation plus recommendations from patient healthcare providers Experimental group 3: transcutaneous electrical stimulation plus recommendations from patient healthcare providers
Outcomes	VFSS-PAS, oropharyngeal reconfiguration, timing and extent of hyoid motion, bolus propulsion force of tongue Episodes of aspiration pneumonia and lower respiratory tract infection Clinical outcomes of nutritional status, complications and clinical symptoms, mortality rates, cause of death
Notes	Study completed; awaiting published data

NCT02090231

Methods	RCT
Participants	Post-stroke dysphagia more than 3 months
Interventions	Real 5 Hz rTMS vs sham 5 Hz rTMS
Outcomes	Dysphagia severity, swallow function
Notes	Study completed; awaiting published data

NCT02379182

Methods	RCT
Participants	90 people with stroke > 3 months

NCT02379182 (*Continued*)

Interventions	Control group: standard clinical care Sensory group: transcutaneous electrical stimulation at sensory level Motor group: transcutaneous electrical stimulation at motor level
Outcomes	PAS; incidence of all adverse events; change in pharyngeal residue prevalence; change in Eating Assessment Tool-10 scores; frequency of chest infection; time from randomisation to death
Notes	Study completed; awaiting published data

Nowicki 2003

Methods	RCT
Participants	People with stroke and dysphagia
Interventions	Manual + electro-acupuncture (6 to 8 treatments 2 to 3 times per week for 3 weeks) vs control
Outcomes	Not available in the study summary
Notes	In the process of retrieving full-text article

Oshima 2009

Methods	Unclear design (not stated in abstract)
Participants	218 people with stroke complicated by dysphagia
Interventions	Group 1: swallowing training with nutritional and high-risk management Group 2: control (none of the above)
Outcomes	Time taken to oral intake, nutritional status, incidence rate of infection, activities of daily living
Notes	In the process of retrieving full-text article

Pan 2015

Methods	RCT
Participants	70 people with post-stroke dysphagia
Interventions	Acupoint massage vs control
Outcomes	Improvement rate in swallow function
Notes	In the process of retrieving full-text article

Park 2017

Methods	RCT
Participants	40 participants with dysphagia after stroke 6 months < stroke onset
Interventions	Group 1: head lift exercise and conventional dysphagia therapy Group 2: conventional dysphagia therapy
Outcomes	Movement of hyolaryngeal complex; PAS
Notes	Study completed; in the process of retrieving data

Park 2018

Methods	RCT
Participants	People with dysphagia following subacute stroke
Interventions	Chin tuck against resistance exercise vs control
Outcomes	Functional dysphagia scale, PAS
Notes	In the process of retrieving full-text article

Shao 2017

Methods	RCT
Participants	64 people with post-stroke upper oesophageal sphincter dystrophy and severe dysphagia
Interventions	Drug therapy and conventional swallowing rehabilitation training vs columnar balloon dilatation combined with drug therapy and conventional swallowing rehabilitation training
Outcomes	Upper sphincter dynamics and dysphagia scores
Notes	In the process of retrieving full-text article

Su 2010

Methods	RCT
Participants	60 people with dysphagia after stroke
Interventions	Group 1: electroacupuncture Group 2: swallowing training
Outcomes	VFSS and Kubota water swallowing function test

Su 2010 (*Continued*)

Notes	In the process of retrieving full-text article

Sun 2008

Methods	RCT
Participants	People with dysphagia after stroke
Interventions	Acupuncture at Lianquan, Yamen, and Tian Zhu acupoints vs VitalStim therapy
Outcomes	Swallowing function
Notes	In the process of retrieving full-text article

Sun 2018

Methods	RCT
Participants	People with stroke and dysphagia
Interventions	Treatment group treated by intradermal needle-embedding at Lianquan (CV 23), Jialianquan-point, Yifeng (TE 17) , Ashi-point, etc. (once every other day for 20 days) on the basis of treatments used in the control group Control group was treated with conventional medicines, NMES of the bilateral midlines of the neck, and swallowing function training
Outcomes	Swallowing function (0 to 10 point scaling), surface electromyography
Notes	Study published; in the process of extracting data

Suntrup-Krueger 2018

Methods	RCT
Participants	People with dysphagia due to stroke
Interventions	Experimental group: transcranial direct current stimulation vs sham group: sham stimulation
Outcomes	Fibreoptic Endoscopic Dysphagia Severity Scale, diet at discharge, dysphagia severity rating score, endoscopically assessed swallow function
Notes	Study completed; in the process of retrieving data

Tageldin 2017

Methods	RCT
Participants	30 people with dysphagia following brain stem infarction
Interventions	rTMS vs sham rTMS on bilateral supratentorial motor area
Outcomes	Modified dysphagia outcome and severity scale
Notes	Study completed; awaiting full published data

Umay 2017

Methods	RCT
Participants	98 people with dysphagia within the first month after ischaemic stroke
Interventions	Sensory-level electrical stimulation vs sham sensory-level electrical stimulation to bilateral masseter muscles
Outcomes	Bedside Dysphagia Score, Neurological Examination Dysphagia Score, Total Dysphagia Score, and Mann Assessment of Swallowing Ability test, flexible fibreoptic endoscopic evaluation of swallowing
Notes	Study published; in the process of extracting data

Wang 2010

Methods	RCT
Participants	84 people with cerebral stroke and dysphagia
Interventions	Group 1: routine therapy and acupuncture Group 2: routine therapy
Outcomes	Not stated
Notes	In the process of retrieving full-text article

Wang 2014

Methods	RCT
Participants	54 nasal feeding patients with pseudobulbar palsy or bulbar palsy after acute ischaemic stroke
Interventions	Integrated swallowing function rehabilitation training vs routine treatment
Outcomes	Swallow score, oral intake function

Wang 2014 (*Continued*)

Notes	In the process of retrieving full-text article

Wang 2015

Methods	RCT
Participants	91 people with post-stroke deglutition disorders
Interventions	Acupuncture using the Tong Guan Li Qiao needling method vs control
Outcomes	Standard Swallowing Assessment (Modified Barthel Index), Swallowing-related Quality of Life, Hamilton Depression Scale
Notes	In the process of retrieving full-text article

Wang 2017

Methods	RCT
Participants	96 people with dysphagic stroke
Interventions	Observation group to receive Rood intervention; control group to receive routine oral intervention
Outcomes	Swallowing function, nutritional status and interventional effect - no further details
Notes	Study published; in the process of extracting data

Wei 2017

Methods	RCT
Participants	30 people with upper oesophageal sphincter dysfunction due to unilateral brainstem stroke
Interventions	Modified balloon dilatation therapy vs control
Outcomes	Amplitude of bilateral submental motor evoked potentials induced by transcranial magnetic stimulations over bilateral motor cortex, diameters of upper oesophageal sphincter opening, maximal displacement of hyoid
Notes	Study published; in the process of extracting data

Wu 2011

Methods	RCT
Participants	229 people with dysphagia after stroke
Interventions	Group 1: acupuncture Group 2: acupuncture and rehabilitation training Group 3: control group with rehabilitation training
Outcomes	Traditional Chinese medicine swallowing assessment, swallowing test, Swallowing Quality of Life Scale - SWAL-QOL
Notes	In the process of retrieving full-text article

Wu 2013

Methods	RCT
Participants	90 people with dysphagia after stroke
Interventions	Group 1: routine acupuncture group + routine treatment and swallowing training Group 2: acupuncture kinesitherapy simultaneously at ezhongxian, lianquan (RN23), jialianquan points + routine treatment, and swallowing training Group 3: routine treatment and swallowing training
Outcomes	Water drinking test and brainstem auditory evoked potential
Notes	In the process of retrieving full-text article

Xia 2010

Methods	RCT
Participants	120 people with dysphagia after stroke
Interventions	Experimental group: feeding-swallowing training and acupuncture treatment Control group: feeding-swallowing training
Outcomes	Standardised Swallowing Assessment, VFSS, Modified Barthel Index, Swallowing Quality of LIfe Scale - SWAL-QOL
Notes	In the process of retrieving full-text article

Xie 2011

Methods	RCT
Participants	148 people with stroke and dysphagia
Interventions	Acupuncture group (body acupuncture, electrical acupuncture, and scalp acupuncture) vs rehabilitation group
Outcomes	Intention-to-treat analysis and on-treatment/per-protocol analysis, Watian swallowing ability, pulmonary infection rate, mortality
Notes	In the process of retrieving full-text article

Xu 2013

Methods	RCT
Participants	140 people with stroke
Interventions	Experimental group: acupuncture and Western medicine Control group: Western medicine
Outcomes	Water drinking test
Notes	In the process of retrieving full-text article

Xue 2004

Methods	RCT
Participants	People with post-stroke dysphagia
Interventions	Early rehabilitation + acupuncture vs control
Outcomes	Not available in the study summary
Notes	In the process of retrieving full-text article

Yang 2008

Methods	RCT
Participants	People with post-stroke dysphagia
Interventions	Functional electrical stimulation 40 minutes/d vs functional electrical stimulation 40 minutes twice daily
Outcomes	Swallowing function

Yang 2008 (*Continued*)

Notes	In the process of retrieving full-text article

Yang 2012

Methods	RCT
Participants	People with post-stroke dysphagia diagnosed using VFSS
Interventions	Anodal tDCS group (1 mA for 20 minutes) vs sham group (1 mA for 30 seconds)
Outcomes	Functional dysphagia scale
Notes	In the process of retrieving full-text article

Zeng 2017

Methods	RCT
Participants	112 people with cerebral infarction and dysphagia
Interventions	NMES vs control
Outcomes	Water-drinking test, Hamilton Anxiety Scale test, Hamilton Depression Scale
Notes	In the process of retrieving full-text article

Zhang 2007

Methods	RCT
Participants	People with stroke, dysphagia, and poor elevation of the larynx
Interventions	Comparison of 2 methods of larynx elevation (15 minutes, 5 × day for 4 weeks)
Outcomes	Not available in the study summary
Notes	In the process of retrieving full-text article

Zhang 2015

Methods	RCT
Participants	198 people with dysphagia after stroke
Interventions	Huoshe Liyan Decoction vs control

Zhang 2015 (*Continued*)

Outcomes	Efficacy rate, swallow function (unclear)
Notes	In the process of retrieving full-text article

Zhang 2016

Methods	RCT
Participants	People with dysphagia with medullary infarction
Interventions	Traditional swallowing therapy vs sensory approach combined with traditional swallowing therapy vs motor approach combined with traditional swallowing therapy
Outcomes	Swallow function, quality of life, cognition
Notes	In the process of retrieving relevant data

Zhang 2017

Methods	RCT
Participants	80 people with stroke and dysphagia
Interventions	Vitalstim Electroacupuncture of Fengchi (GB 20), Jinjin (EX-HN 12) and Yuye (EX-HN 13) with a Vitalstim Electrostimulator, and manual acupuncture stimulation of Lianquan (CV 23), Tiantu (CV 22) vs control. Both groups received conventional therapy
Outcomes	Kubota swallowing ability test, dysphagia subscale (0 to 6 scores) of the neurological deficit degrees, videofluorography assessment, Medical Outcomes Study Item Short Form Health Survey (SF-36)
Notes	In the process of retrieving full-text article

Zhen 2014

Methods	RCT
Participants	97 people with post-stroke deglutition dysfunction
Interventions	Group A: acupuncture with conventional treatment Group B: VitalStim electric stimulation with conventional treatment Group C: conventional treatment only
Outcomes	Swallow function (water-drinking test, stethocatharsis scoring, and fluoroscopic examination)
Notes	In the process of retrieving full-text article

Zhong 2003

Methods	RCT
Participants	People with stroke and dysphagia 15 to 40 days post stroke
Interventions	Head acupuncture vs body acupuncture vs control
Outcomes	Not available in the study summary
Notes	In the process of retrieving full-text article

Zhu 2015a

Methods	RCT
Participants	People with dysphagia after stroke
Interventions	Conventional training vs surface electromyographic biofeedback treatment with conventional training
Outcomes	Upper oesophageal sphincter opening, pharyngeal transit time
Notes	In the process of retrieving full-text article

Zhu 2015b

Methods	RCT
Participants	68 people with dysphagia after ischaemic stroke
Interventions	Combined treatment group (n = 34) receiving swallowing training, feeding strategies, and low-frequency electrical stimulation Control group (n = 34) receiving swallowing training and feeding strategies
Outcomes	VFSS, Standardized Swallowing Assessment
Notes	Study published; in the process of extracting data

ASHA-NOMS: American Speech-Language-Hearing Association National Outcomes Measurement System
EEG: electroencephalography
Hz: Hertz
NIHSS: National Institutes of Health Stroke Scale
NMES: neuromuscular electrical stimulation
PAS: Penetration Aspiration Scale
RCT: randomised controlled trial
rTMS: repetitive transcranial magnetic stimulation
SWAL-QOL: Swallowing Quality of Life Questionnaire
tDCS: transcranial direct current stimulation

TRPV1: transient receptor potential vanilloid 1
VFSS: videofluoroscopic swallow study
V-VST: volume-viscosity swallow test

Characteristics of ongoing studies *[ordered by study ID]*

ChiCTR-ICR-15006004

Trial name or title	Clinical observation of YiShen-TongQiao acupuncture on pharyngeal dysphagia after stroke
Methods	RCT
Participants	90 stroke patients with pharyngeal dysphagia
Interventions	Observational group: YiShen-TongQiao acupuncture treatment Control group: rehabilitation training
Outcomes	Kubota drinking water test score; Swallow Quality of Life
Starting date	2015
Contact information	Yu Chuan; yuchuan106@126.com
Notes	Funding: general planning project of BeiJing Municipal Science and Technology Project of Traditional Chinese Medicine

ChiCTR-IOR-17010505

Trial name or title	Fire N needle for patients with dysphagia caused by post-stroke pseudobulbar palsy: a randomized controlled clinical trial
Methods	Randomised, parallel controlled trial
Participants	64 participants with dysphagia after stroke, 30 to 75 years old, onset time < 8 months
Interventions	Group A: fire needle Group B: rehabilitation treatment of dysphagia
Outcomes	Watian water test evaluation, TengShi swallowing disorder evaluation, swallowing-related quality of life, dysphagia assessment scale of Traditional Chinese Medicine, pulse oximetry
Starting date	2017, but not yet recruiting
Contact information	Xiaolu Qian; qian_xiaolu@163.com
Notes	Funding: Shanghai Municipal Commission of Health and Family Planning

ChiCTR-IOR-17011359

Trial name or title	The study on the effect of electroacupuncture at Lianquan and Fengfu on one side of brain swallowing function
Methods	Randomised parallel controlled trial
Participants	30 participants aged 18 to 65 years; inclusion criteria not clear
Interventions	Electroacupuncture group Sham acupuncture group
Outcomes	MEP of mylohyoid muscle Resting motion threshold of mylohyoid muscle
Starting date	2017
Contact information	Lin Wang; 373670740@qq.com
Notes	Funding: Education Department of Guangdong

ChiCTR-IPC-14005435

Trial name or title	Research on mechanism of central regulation of transcranial magnetic stimulation on post-stroke dysphagia patients
Methods	Randomised parallel controlled trial, phase 1
Participants	20 virtual lesion group; 20 stroke patient group; 20 control
Interventions	Virtual lesion group: continuous theta burst stimulation Patient group: transcranial magnetic stimulation Control: conventional treatments
Outcomes	MEP; pharyngeal pressure waveform; upper oesophageal sphincter pressure waveform; centre network of swallowing
Starting date	2013
Contact information	Yue Lan; bluemooning@163.com
Notes	Funding: National Science Foundation of China

ChiCTR-ROC-17011673

Trial name or title	Neuromodulation on post-stroke patients: a clinical control trial based on mapping swallowing musculature motor cortex
Methods	Clinical control (randomisation unclear)
Participants	120 participants with dysphagia post stroke
Interventions	Experimental group: TMS Control group: sham TMS
Outcomes	Pharyngeal musculature MEP; MEP amplitude; latency of MEP; hotspot
Starting date	2017
Contact information	Wanqi Li; 1170782244@qq.com
Notes	Funding: -

ChiCTR1800014337

Trial name or title	High frequency repetitive transcranial magnetic stimulation in the rehabilitation of post-stroke swallowing disorder
Methods	Randomised parallel controlled trial
Participants	40 participants with acute stroke (> 2 weeks post onset) with dysphagia
Interventions	High-frequency rTMS + routine swallow training vs routine swallow training alone
Outcomes	Surface EMG; VFSS; Standardised Swallowing Study; VGF (no explanation provided on website); PAS; water drinking test scale for depression
Starting date	2018
Contact information	Zhu Qixiu; szjzqxsx@163.com
Notes	Funding: Shandong Province Science and Technology Plan

ChiCTR1800015837

Trial name or title	A randomized controlled clinical study on stroke with dysphagia with treatment of combined of traditional Chinese and west medicine
Methods	Randomised parallel controlled trial
Participants	242 stroke patients with dysphagia from 2 weeks to 6 months

ChiCTR1800015837 (*Continued*)

Interventions	Treatment: acupuncture treatment based on surface electromyography Control: traditional acupuncture treatment
Outcomes	Water swallow test rating scale of depression, Standardized Swallowing Assessment, videofluoroscopic swallowing study
Starting date	2016
Contact information	Guoping Zhou; doctorzgp@sina.com
Notes	Funding: Construction of High-level University Scientific Research Funding

ISRCTN14124645

Trial name or title	Metoclopramide and selective oral decontamination for avoiding pneumonia after stroke (MAPS-2) Trial
Methods	2 × 2 factorial double-blind randomised controlled trial (treatment)
Participants	Acute stroke within 9 hours of clinical onset
Interventions	Metoclopramide and placebo paste Metoclopramide and antibiotic paste Placebo metoclopramide and antibiotic paste Placebo metoclopramide and placebo paste
Outcomes	Mortality up to the end of the study (90 days), pneumonia within 14 days, number of days of antibiotic treatment for pneumonia within the first 30 days, neurological recovery (NIHSS), disability (mRS), quality of life (EuroQol)
Starting date	1 January 2017
Contact information	Christine Roffe - Institute for Applied Clinical Sciences (IACS), Keele University Guy Hilton Research Centre, Thornburrow Drive, Hartshill ST4 7QB, Stoke-on-Trent, United Kingdom
Notes	Funding: Health Technology Assessment Programme

ISRCTN68981054

Trial name or title	Treatment of dysphagia after stroke with He's santong needling method: a prospective randomized controlled study
Methods	RCT
Participants	60 stroke patients with oral and pharyngeal dysphagia

ISRCTN68981054 (*Continued*)

Interventions	Experimental group: He's santong needling method acupuncture combined with swallowing rehabilitation Control group: swallowing rehabilitation
Outcomes	Dynamics of swallowing function measured using FEES and Caiteng 7 Rank Swallowing Quality of Life - SWAL-QOL, Modified MASA, surface EMG
Starting date	2017
Contact information	Bin Li; libin@bjzhongyi.com
Notes	Funding: Beijing Traditional Chinese Medicine Administration Administrative Project

NCT01758991

Trial name or title	Therapeutic Impact of tDCS on dysphagia in the acute phase of stroke (improving swallowing after stroke with transcranial direct current stimulation (iSWAT))
Methods	RCT
Participants	100 acute stroke patients with dysphagia
Interventions	Experimental group: tDCS Control group: sham tDCS
Outcomes	Videofluoroscopy; fiberoptic endoscopic evaluation of swallowing; NIHSS; clinical records; swallowing quality of life - SWAL-QOL
Starting date	2013
Contact information	Katalin de Fays; katalin.defays@uclouvain.be
Notes	Funding: University Hospital of Mont-Godinne; Université Catholique de Louvain

NCT01919112

Trial name or title	Non-invasive brain stimulation for swallowing recovery after a dysphagic stroke
Methods	RCT
Participants	Moderate to severe dysphagic patients with acute stroke documented by imaging
Interventions	High dose vs low dose vs sham (control) anodal tDCS
Outcomes	Improvement in swallowing
Starting date	2013

NCT01919112 (*Continued*)

Contact information	Sandeep Kumar; Beth Israel Deaconess Medical Center; 617-632-8917; skumar@bidmc.harvard.edu
Notes	Funding: Beth Israel Deaconess Medical Center

NCT02322411

Trial name or title	Effects of device-facilitated isometric progressive resistance oropharyngeal (I-PRO) therapy on dysphagia related outcomes in patients post-stroke
Methods	Randomised controlled pilot study
Participants	30 ischaemic stroke patients within 6 months of acute stroke diagnosis
Interventions	Group 1: 12 weeks of Isometric Progressive Resistance Oropharyngeal Therapy plus compensatory treatment Group 2: compensatory treatment only
Outcomes	Change in maximum isometric tongue pressures; bolus flow durational measures; swallowing-related pressures; swallowing quality of life - SWAL-QOL; functional oral intake scale; pneumonia diagnoses; hospital admissions
Starting date	2014
Contact information	Nicole Pulia; nicolepulia@gmail.com
Notes	Sponsors and collaborators: University of Wisconsin, Madison

NCT02470078

Trial name or title	Randomised controlled trial of pharyngeal electrical stimulation for the treatment of post-extubation dysphagia in acute stroke patients
Methods	Randomised parallel assignment trial
Participants	60 stroke patients with severe dysphagia post extubation due to acute stroke
Interventions	Pharyngeal electrical stimulation vs sham stimulation
Outcomes	Pneumonia rate; reintubation rate; length of stay; PEG tube placement; swallowing function; time until oral nutrition
Starting date	2015
Contact information	Rainer Dziewas; dziewas@uni-muenster.de
Notes	Funding: University Hospital Muenster

NCT02576470

Trial name or title	Motor learning in dysphagia rehabilitation
Methods	Randomised, parallel assignment trial
Participants	21 to 100 years with a swallowing problem
Interventions	Investigating 3 forms of biofeedback for training swallowing manoeuvres or compensatory techniques and pairing with adjuvant techniques - tDCS, TMS, and financial reward Group 1: VFSS biofeedback Group 2: submental EMG biofeedback Group 3: mixed VFSS and submental EMG biofeedback Group 4: VFSS biofeedback with anodal tDCS and TMS Group 5: submental EMG biofeedback with anodal tDCS and TMS Group 6: mixed VFSS, submental EMG with anodal tDCS and TMS. Group 7: VFSS with sham tDCS Group 8: submental EMG with sham tDCS Group 9: mixed VFSS and submental EMG with sham tDCS Group 10: VFSS with financial reward Group 11: submental EMG with financial reward Group 12: mixed VFSS and submental EMG with financial reward
Outcomes	PAS, targeted dysphagia training biofeedback using VFSS images, submental EMG measures and both VFSS and submental EMG measures; dysphagia manoeuvres, kinematic analysis, financial reward analysis
Starting date	
Contact information	
Notes	Study completed; awaiting full published data

NCT02960737

Trial name or title	Dysphagia evaluation after stroke-incidence and effect of oral screen intervention on swallowing dysfunction (DESIRE)
Methods	Interventional, randomised, parallel assignment. Double-blind (investigator, outcomes assessor)
Participants	Acute stroke patients 6 (± 2) weeks after first-time transient ischaemic attack and stroke
Interventions	Experimental group: intensive training with oral screen and traditional compensatory swallowing training Control group: no intervention; traditional compensatory swallowing training only
Outcomes	Swallowing ability, swallowing function, lip force, swallowing quality of life, dysarthria, oral health, activities of daily living, global disability, NIHSS
Starting date	2016
Contact information	Patricia Hägglund, PhD Student; +46907850000; patricia.hagglund@umu.se

NCT02960737 (*Continued*)

Notes	Sponsor: Umeå University

NCT03021252

Trial name or title	The RETORNUS-2 study: impact of respiratory muscle training on swallowing disorders in stroke patients
Methods	Interventional, randomised, parallel assignment; single-blind (outcomes assessor)
Participants	Stroke onset 1 month
Interventions	Experimental group: high-intensity inspiratory and expiratory muscle training (IEMT) (IEMT + standard swallow therapy) vs control Sham IEMT Sham IEMT + standard swallow therapy
Outcomes	Change in dysphagia severity, change in respiratory muscle strength
Starting date	2017
Contact information	Anna Guillen-Sola; aguillen@parcdesalutmar.cat
Notes	Funding: Parc de Salut Mar

NCT03247374

Trial name or title	Bio-feedback treatment versus standard treatment for dysphagic post-stroke patients: a randomized controlled trial
Methods	RCT
Participants	40 patients (> 6 weeks onset) with post-stroke dysphagia
Interventions	Experimental group: biofeedback (visual and verbal feedback) Control group: standard SLT (verbal feedback)
Outcomes	Functional Oral Intake Scale; change in pooling score during endoscopic evaluation; PAS
Starting date	2017
Contact information	Sara Nordio; sara.nordio@ospedalesancamillo.net
Notes	Funding: IRCCS San Camillo, Venezia, Italy

NCT03274947

Trial name or title	The utility of cerebellar transcranial magnetic stimulation in the neurorehabilitation of dysphagia after stroke
Methods	RCT
Participants	72 participants with post-stroke dysphagia within 6 weeks of symptom onset
Interventions	Protocol 1 Experimental group: cerebellar TMS Control group: sham TMS Protocol 2 Experimental group: low-level cerebellar TMS stimulation (once per day for 3 days) plus standard SLT Experimental group: high-level cerebellar TMS stimulation (twice per day for 5 days) plus standard SLT Control group: sham stimulation (twice per day for 5 days) plus standard SLT
Outcomes	Protocol 1: videofluoroscopy before and at 1 hour Protocol 2: videofluoroscopy; functional oral intake scale; dysphagia severity rating scale; feeding status; mRS
Starting date	2017
Contact information	Shaheen Hamdy; shaheen.hamdy@manchester.ac.uk
Notes	Funding: University of Manchester, Medical Research Council University of Nottingham

NCT03358810

Trial name or title	Pharyngeal electrical stimulation evaluation for dysphagia after stroke
Methods	RCT
Participants	270 acute ischaemic or hemorrhagic cerebral stroke within 7 to 28 days of baseline VFSS
Interventions	Experimental group: pharyngeal electrical stimulation Control group: sham pharyngeal electrical stimulation
Outcomes	PAS (based on VFSS); time to removal of NG/PEG tube/transition to oral feeding or first diet upgrade; functional oral intake scale
Starting date	2017
Contact information	Phagenesis Ltd.
Notes	Funding: Phagenesis Ltd.; Regulatory and Clinical Research Institute; Cytel

NCT03499574

Trial name or title	A randomized controlled feasibility trial of dysphagia therapy using biofeedback in patients with acute stroke
Methods	RCT
Participants	Participants with new diagnosis of acute stroke and dysphagia
Interventions	Experimental: biofeedback using surface EMG with usual care Control: usual care only
Outcomes	Dysphagia Severity Rating Scale, Functional Oral Intake Scale, PAS, Dysphagia Handicap Index, modified Rankin Scale, NIHSS, mortality, incidence of pneumonia
Starting date	2018
Contact information	Timothy England; timothy.england@nottingham.ac.uk
Notes	Funding: University of Nottingham

PACTR201710002724163

Trial name or title	Effect of transcutaneous electrical nerve stimulation and conventional therapy in post-stroke dysphagic patients: a randomized controlled trial
Methods	RCT
Participants	Dysphagic patients following ischaemic stroke less than 1 month (aged 45 to 70 years)
Interventions	TENS vs TENS + conventional treatment vs conventional treatment
Outcomes	Swallow function
Starting date	2017
Contact information	Rami Maged; ramimaged@hotmail.com
Notes	Funding: Taheal Rehabilitation Centre

U1111-1188-0335

Trial name or title	Program of rehabilitation with therapeutic efficacy control in oropharyngeal dysphagia after stroke
Methods	Randomised, parallel trial
Participants	20 participants with dysphagia after stroke
Interventions	Group 1: neuromuscular electrical stimulation associated with sour taste swallowing and cold temperature Group 2: stimulation of swallowing sour taste and cold temperature

U1111-1188-0335 (*Continued*)

Outcomes	Decreased episodes of penetration and aspiration (verified by objective examination of swallowing), nasoendoscopy
Starting date	2015
Contact information	Paula Cristina Cola, paccola@hotmail.com
Notes	Funding: Faculdade Filosofia e Ciências de Marília

C: control
EMG: electromyography
EuroQoL: European Quality of Life Scale
FEES: Fibreoptic Endoscopic Evaluation of Swallowing
MASA: Mann Assessment of Swallowing Ability
MEP: motor evoked potential
mRS: modified Rankin Scale
NG: nasogastric
NIHSS: National Institutes of Health Stroke Scale
PAS: Penetration Aspiration Scale
PEG: percutaneous endoscopic gastroscopy
RCT: randomised controlled trial
rTMS: repetitive transcranial magnetic stimulation
Rx: treatment
SD: standard deviation
SLT: speech and language therapy
SWAL-QOL: Swallowing Quality of Life Questionnaire
tDCS: transcranial direct current stimulation
TMS: transcranial magnetic stimulation
VFSS: videofluoroscopy swallow study
VGF: no explanation provided on website as to abbreviation

DATA AND ANALYSES

Comparison 1. Swallowing therapy

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Functional outcome - death or dependency, death or disability at end of trial	2	306	Odds Ratio (M-H, Random, 95% CI)	1.05 [0.63, 1.75]
1.1 Behavioural interventions	2	306	Odds Ratio (M-H, Random, 95% CI)	1.05 [0.63, 1.75]
2 Case fatality at end of trial	14	766	Odds Ratio (M-H, Random, 95% CI)	1.00 [0.66, 1.52]
2.1 Behavioural interventions	2	306	Odds Ratio (M-H, Random, 95% CI)	0.83 [0.46, 1.51]
2.2 Drug therapy	3	148	Odds Ratio (M-H, Random, 95% CI)	1.40 [0.31, 6.28]
2.3 Pharyngeal electrical stimulation	4	215	Odds Ratio (M-H, Random, 95% CI)	0.92 [0.38, 2.26]
2.4 Physical stimulation (thermal, tactile)	1	19	Odds Ratio (M-H, Random, 95% CI)	1.05 [0.16, 6.92]
2.5 Transcranial magnetic stimulation	4	78	Odds Ratio (M-H, Random, 95% CI)	0.28 [0.03, 2.93]
3 Length of inpatient stay (days)	8	577	Mean Difference (IV, Random, 95% CI)	-2.90 [-5.65, -0.15]
3.1 Behavioural interventions	4	370	Mean Difference (IV, Random, 95% CI)	-2.70 [-5.68, 0.28]
3.2 Pharyngeal electrical stimulation	4	207	Mean Difference (IV, Random, 95% CI)	-6.05 [-16.40, 4.31]
4 Proportion of participants with dysphagia at end of trial	23	1487	Odds Ratio (M-H, Random, 95% CI)	0.42 [0.32, 0.55]
4.1 Acupuncture	8	676	Odds Ratio (M-H, Random, 95% CI)	0.31 [0.20, 0.49]
4.2 Behavioural interventions	6	511	Odds Ratio (M-H, Random, 95% CI)	0.45 [0.28, 0.74]
4.3 Drug therapy	1	17	Odds Ratio (M-H, Random, 95% CI)	0.48 [0.07, 3.35]
4.4 Neuromuscular electrical stimulation	2	76	Odds Ratio (M-H, Random, 95% CI)	0.51 [0.18, 1.49]
4.5 Pharyngeal electrical stimulation	3	66	Odds Ratio (M-H, Random, 95% CI)	0.55 [0.15, 2.11]
4.6 Physical stimulation (thermal, tactile)	2	127	Odds Ratio (M-H, Random, 95% CI)	0.65 [0.07, 5.85]
4.7 Transcranial direct current stimulation	1	14	Odds Ratio (M-H, Random, 95% CI)	0.29 [0.01, 8.39]
5 Swallowing ability	26	1173	Std. Mean Difference (IV, Random, 95% CI)	-0.66 [-1.01, -0.32]
5.1 Acupuncture	6	496	Std. Mean Difference (IV, Random, 95% CI)	-0.55 [-1.20, 0.11]
5.2 Behavioural intervention	3	121	Std. Mean Difference (IV, Random, 95% CI)	-0.56 [-1.07, -0.05]
5.3 Drug therapy	1	71	Std. Mean Difference (IV, Random, 95% CI)	-0.46 [-0.93, 0.01]
5.4 Neuromuscular electrical stimulation	2	100	Std. Mean Difference (IV, Random, 95% CI)	-1.34 [-3.39, 0.71]
5.5 Pharyngeal electrical stimulation	3	194	Std. Mean Difference (IV, Random, 95% CI)	0.06 [-0.22, 0.34]
5.6 Physical stimulation (thermal, tactile)	1	16	Std. Mean Difference (IV, Random, 95% CI)	-0.30 [-1.29, 0.68]
5.7 Transcranial direct current stimulation	2	34	Std. Mean Difference (IV, Random, 95% CI)	-0.33 [-2.22, 1.56]

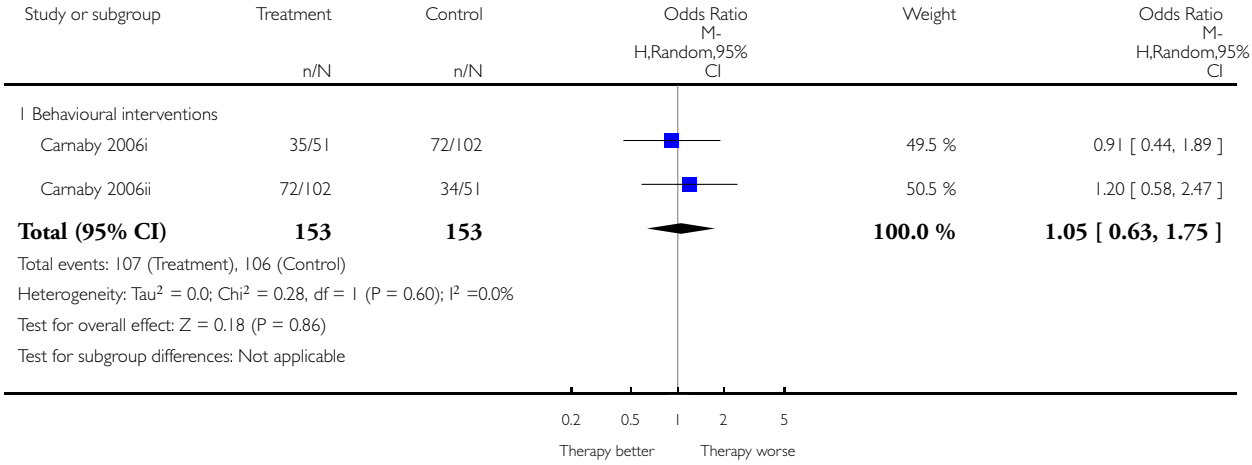
5.8 Transcranial magnetic stimulation	8	141	Std. Mean Difference (IV, Random, 95% CI)	-1.29 [-2.37, -0.21]
6 Penetration aspiration score	11	303	Std. Mean Difference (IV, Random, 95% CI)	-0.37 [-0.74, -0.00]
6.1 Behavioural intervention	1	27	Std. Mean Difference (IV, Random, 95% CI)	-0.88 [-1.68, -0.08]
6.2 Neuromuscular electrical stimulation	1	18	Std. Mean Difference (IV, Random, 95% CI)	0.57 [-0.38, 1.52]
6.3 Pharyngeal electrical stimulation	4	177	Std. Mean Difference (IV, Random, 95% CI)	-0.17 [-0.53, 0.19]
6.4 Transcranial magnetic stimulation	5	81	Std. Mean Difference (IV, Random, 95% CI)	-0.53 [-1.22, 0.16]
7 Chest infection or pneumonia	9	618	Odds Ratio (M-H, Random, 95% CI)	0.36 [0.16, 0.78]
7.1 Behavioural interventions	6	473	Odds Ratio (M-H, Random, 95% CI)	0.56 [0.31, 1.00]
7.2 Drug therapy	1	60	Odds Ratio (M-H, Random, 95% CI)	0.06 [0.01, 0.21]
7.3 Neuromuscular electrical stimulation	1	57	Odds Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
7.4 Pharyngeal electrical stimulation	1	28	Odds Ratio (M-H, Random, 95% CI)	0.43 [0.06, 3.09]
8 Pharyngeal transit time (seconds)	6	187	Mean Difference (IV, Random, 95% CI)	-0.23 [-0.32, -0.15]
8.1 Drug therapy	1	17	Mean Difference (IV, Random, 95% CI)	-0.21 [-0.91, 0.49]
8.2 Neuromuscular electrical stimulation	3	126	Mean Difference (IV, Random, 95% CI)	-0.23 [-0.39, -0.08]
8.3 Pharyngeal electrical stimulation	1	28	Mean Difference (IV, Random, 95% CI)	-0.15 [-0.67, 0.37]
8.4 Physical stimulation (thermal, tactile)	1	16	Mean Difference (IV, Random, 95% CI)	-0.19 [-0.34, -0.04]
9 Institutionalisation	3	447	Odds Ratio (M-H, Random, 95% CI)	0.75 [0.47, 1.19]
9.1 Behavioural interventions	2	306	Odds Ratio (M-H, Random, 95% CI)	0.76 [0.39, 1.48]
9.2 Pharyngeal electrical stimulation	1	141	Odds Ratio (M-H, Random, 95% CI)	0.73 [0.36, 1.48]
10 Nutritional (albumin)	3	169	Mean Difference (IV, Random, 95% CI)	0.37 [-1.50, 2.24]
10.1 Behavioural interventions	2	64	Mean Difference (IV, Random, 95% CI)	0.20 [-4.77, 5.17]
10.2 Pharyngeal electrical stimulation	1	105	Mean Difference (IV, Random, 95% CI)	0.40 [-1.62, 2.42]

Analysis 1.1. Comparison 1 Swallowing therapy, Outcome 1 Functional outcome - death or dependency, death or disability at end of trial.

Review: Swallowing therapy for dysphagia in acute and subacute stroke

Comparison: 1 Swallowing therapy

Outcome: 1 Functional outcome - death or dependency, death or disability at end of trial

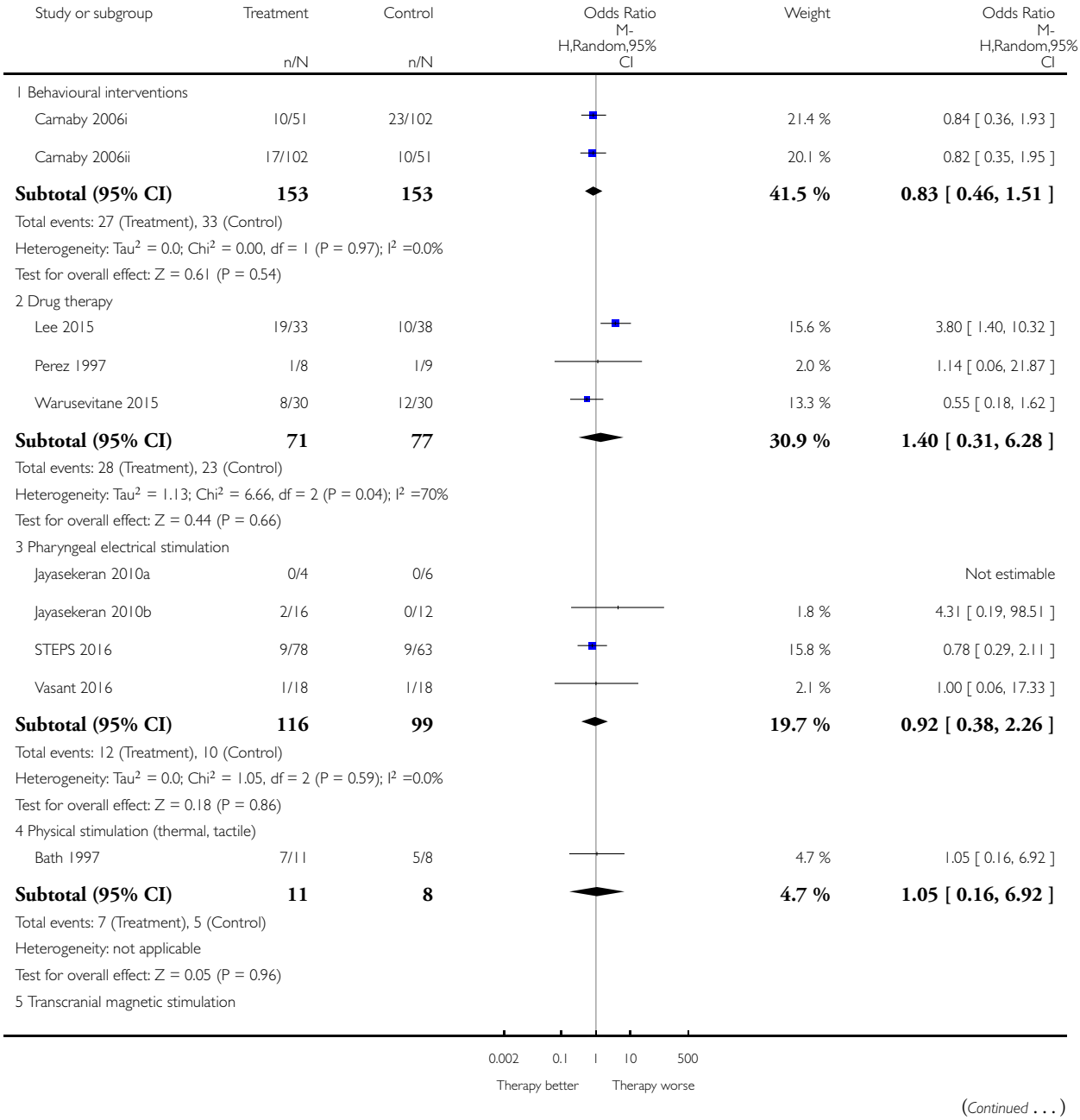


Analysis 1.2. Comparison 1 Swallowing therapy, Outcome 2 Case fatality at end of trial.

Review: Swallowing therapy for dysphagia in acute and subacute stroke

Comparison: 1 Swallowing therapy

Outcome: 2 Case fatality at end of trial



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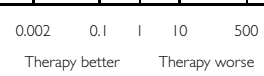
Study or subgroup	Treatment n/N	Control n/N	Odds Ratio M-H,Random,95% CI	Weight	Odds Ratio M-H,Random,95% CI
Khedr 2009	0/14	1/12		1.6 %	0.26 [0.01, 7.12]
Khedr 2010	0/11	1/11		1.6 %	0.30 [0.01, 8.32]
Kim 2012i	0/10	0/5			Not estimable
Kim 2012ii	0/10	0/5			Not estimable
Subtotal (95% CI)	**45**	**33**		**3.2 %**	**0.28 [0.03, 2.93]**
Total events: 0 (Treatment), 2 (Control)					
Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.00$, df = 1 (P = 0.95); $I^2 = 0.0\%$					
Test for overall effect: Z = 1.06 (P = 0.29)					
Total (95% CI)	**396**	**370**		**100.0 %**	**1.00 [0.66, 1.52]**
Total events: 74 (Treatment), 73 (Control)					
Heterogeneity: $Tau^2 = 0.03$; $Chi^2 = 10.64$, df = 10 (P = 0.39); $I^2 = 6\%$					
Test for overall effect: Z = 0.01 (P = 0.99)					
Test for subgroup differences: $Chi^2 = 1.36$, df = 4 (P = 0.85), $I^2 = 0.0\%$					

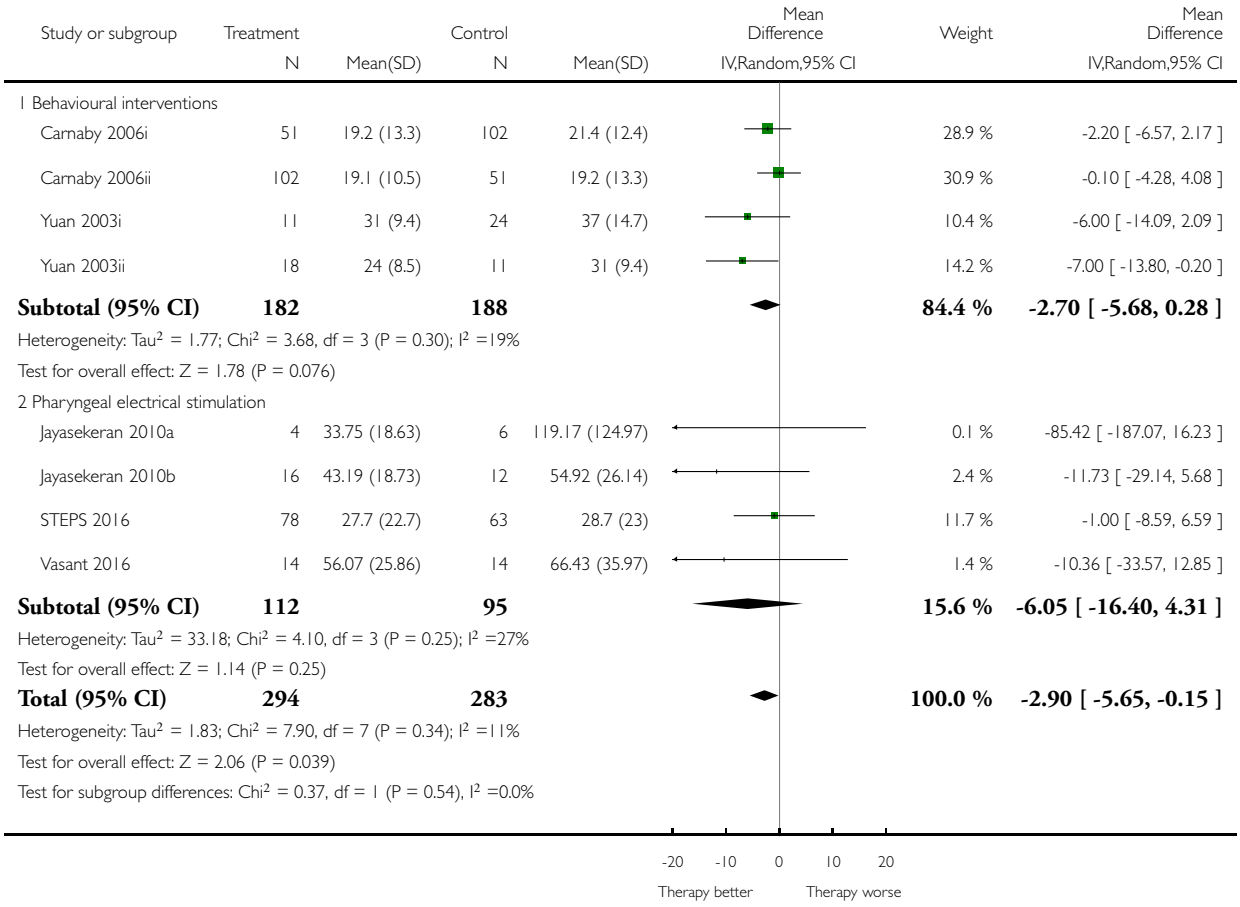


Analysis 1.3. Comparison 1 Swallowing therapy, Outcome 3 Length of inpatient stay (days).

Review: Swallowing therapy for dysphagia in acute and subacute stroke

Comparison: 1 Swallowing therapy

Outcome: 3 Length of inpatient stay (days)

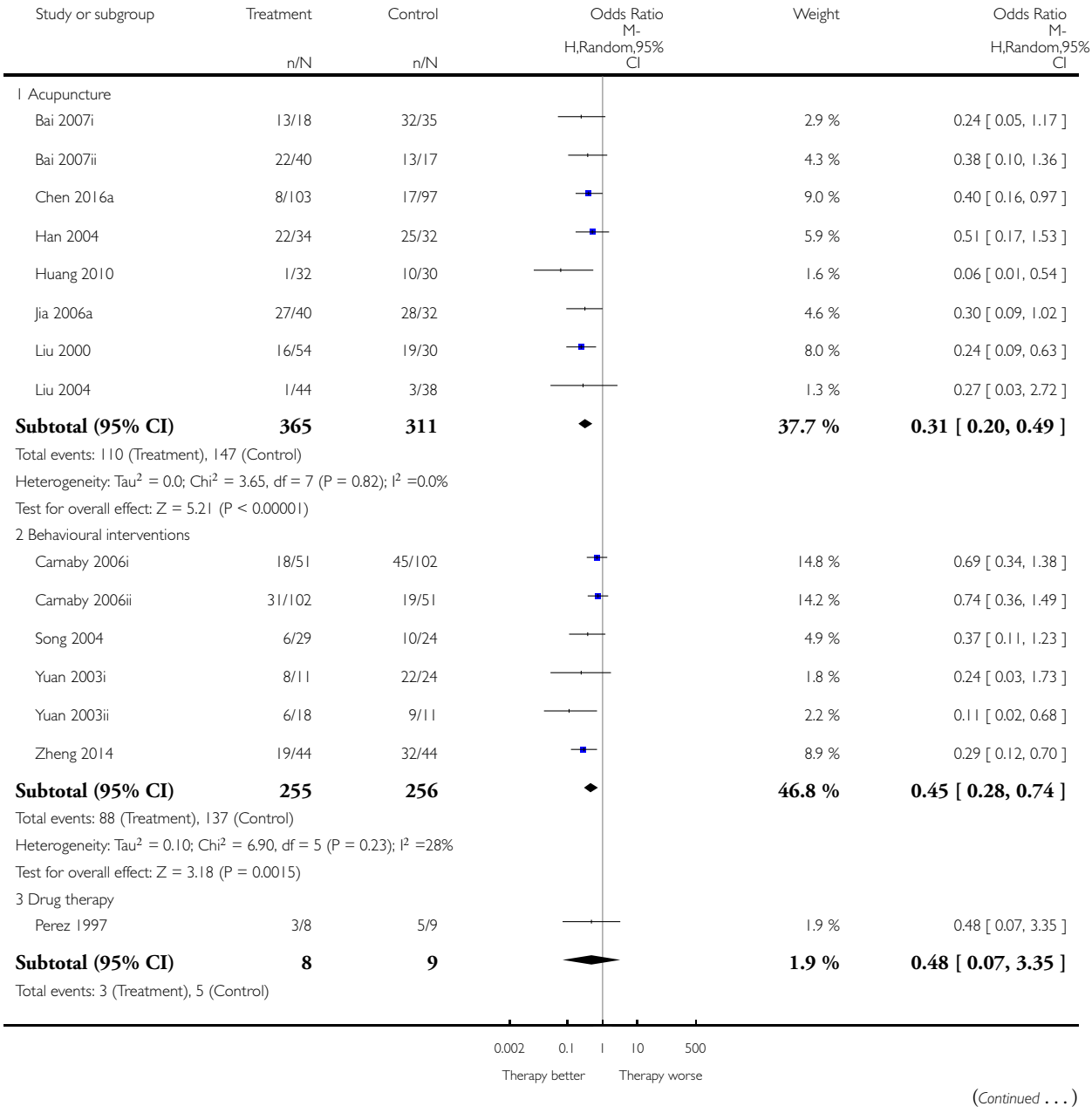


Analysis 1.4. Comparison 1 Swallowing therapy, Outcome 4 Proportion of participants with dysphagia at end of trial.

Review: Swallowing therapy for dysphagia in acute and subacute stroke

Comparison: 1 Swallowing therapy

Outcome: 4 Proportion of participants with dysphagia at end of trial



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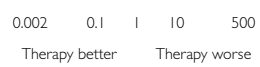
Study or subgroup	Treatment n/N	Control n/N	Odds Ratio M-H,Random,95% CI	Weight	Odds Ratio M-H,Random,95% CI
Heterogeneity: not applicable					
Test for overall effect: Z = 0.74 (P = 0.46)					
4 Neuromuscular electrical stimulation					
Lee 2014	16/31	16/26		6.4 %	0.67 [0.23, 1.92]
Lim 2009	6/12	6/7		1.2 %	0.17 [0.02, 1.84]
Subtotal (95% CI)	**43**	**33**		**7.6 %**	**0.51 [0.18, 1.49]**
Total events: 22 (Treatment), 22 (Control)					
Heterogeneity: Tau^2 = 0.07; Chi^2 = 1.08, df = 1 (P = 0.30); I^2 =7%					
Test for overall effect: Z = 1.23 (P = 0.22)					
5 Pharyngeal electrical stimulation					
Jayasekeran 2010a	4/4	6/6			Not estimable
Jayasekeran 2010b	13/16	12/12		0.8 %	0.15 [0.01, 3.30]
Vasant 2016	6/14	7/14		3.2 %	0.75 [0.17, 3.33]
Subtotal (95% CI)	**34**	**32**		**4.0 %**	**0.55 [0.15, 2.11]**
Total events: 23 (Treatment), 25 (Control)					
Heterogeneity: Tau^2 = 0.0; Chi^2 = 0.85, df = 1 (P = 0.36); I^2 =0.0%					
Test for overall effect: Z = 0.86 (P = 0.39)					
6 Physical stimulation (thermal, tactile)					
Bath 1997	3/4	3/3		0.6 %	0.33 [0.01, 11.34]
Feng 2012	59/60	59/60		0.9 %	1.00 [0.06, 16.37]
Subtotal (95% CI)	**64**	**63**		**1.5 %**	**0.65 [0.07, 5.85]**
Total events: 62 (Treatment), 62 (Control)					
Heterogeneity: Tau^2 = 0.0; Chi^2 = 0.23, df = 1 (P = 0.63); I^2 =0.0%					
Test for overall effect: Z = 0.38 (P = 0.70)					
7 Transcranial direct current stimulation					
Kumar 2011	6/7	7/7		0.6 %	0.29 [0.01, 8.39]
Subtotal (95% CI)	**7**	**7**		**0.6 %**	**0.29 [0.01, 8.39]**
Total events: 6 (Treatment), 7 (Control)					
Heterogeneity: not applicable					
Test for overall effect: Z = 0.72 (P = 0.47)					
Total (95% CI)	**776**	**711**		**100.0 %**	**0.42 [0.32, 0.55]**
Total events: 314 (Treatment), 405 (Control)					
Heterogeneity: Tau^2 = 0.0; Chi^2 = 15.62, df = 21 (P = 0.79); I^2 =0.0%					
Test for overall effect: Z = 6.37 (P < 0.00001)					
Test for subgroup differences: Chi^2 = 2.10, df = 6 (P = 0.91), I^2 =0.0%					



Analysis 1.5. Comparison 1 Swallowing therapy, Outcome 5 Swallowing ability.

Review: Swallowing therapy for dysphagia in acute and subacute stroke

Comparison: 1 Swallowing therapy

Outcome: 5 Swallowing ability

Study or subgroup	Treatment N	Mean(SD)	Control N	Mean(SD)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
1 Acupuncture							
Bai 2007i	18	5.48 (1.2)	35	6.03 (1.39)		4.3 %	-0.41 [-0.98, 0.17]
Bai 2007ii	40	4.21 (1.44)	17	5.48 (1.2)		4.3 %	-0.91 [-1.50, -0.32]
Chan 2012	48	5.59 (0.98)	20	5.8 (1)		4.4 %	-0.21 [-0.73, 0.31]
Chen 2016a	65	9.35 (0.77)	68	9.77 (0.45)		4.7 %	-0.67 [-1.02, -0.32]
Wei 2005	32	5.51 (0.81)	33	5.01 (0.62)		4.5 %	0.69 [0.19, 1.19]
Xia 2016a	60	3.7 (1.1)	60	5.8 (1.3)		4.6 %	-1.73 [-2.15, -1.31]
Subtotal (95% CI)	**263**		**233**			**26.8 %**	**-0.55 [-1.20, 0.11]**
Heterogeneity: Tau^2 = 0.61; Chi^2 = 56.73, df = 5 (P<0.00001); I^2 =91%							
Test for overall effect: Z = 1.63 (P = 0.10)							
2 Behavioural intervention							
Heo 2015	22	25.72 (10.03)	22	26.72 (10.45)		4.3 %	-0.10 [-0.69, 0.50]
Kang 2012	25	3.6 (1.2)	25	4.6 (1)		4.3 %	-0.89 [-1.47, -0.31]
Park 2016b	14	4.4 (0.8)	13	5.4 (1.7)		3.9 %	-0.74 [-1.52, 0.05]
Subtotal (95% CI)	**61**		**60**			**12.6 %**	**-0.56 [-1.07, -0.05]**
Heterogeneity: Tau^2 = 0.10; Chi^2 = 3.80, df = 2 (P = 0.15); I^2 =47%							
Test for overall effect: Z = 2.14 (P = 0.032)							
3 Drug therapy							
Lee 2015	38	3.5 (1.5)	33	4.2 (1.5)		4.5 %	-0.46 [-0.93, 0.01]
Subtotal (95% CI)	**38**		**33**			**4.5 %**	**-0.46 [-0.93, 0.01]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.91 (P = 0.056)							
4 Neuromuscular electrical stimulation							
Terre 2015	10	4.6 (2.5)	10	5.3 (2.5)		3.7 %	-0.27 [-1.15, 0.61]
Xia 2011	40	21.4 (3.5)	40	30.1 (3.8)		4.3 %	-2.36 [-2.94, -1.78]
Subtotal (95% CI)	**50**		**50**			**8.1 %**	**-1.34 [-3.39, 0.71]**
Heterogeneity: Tau^2 = 2.04; Chi^2 = 15.13, df = 1 (P = 0.00010); I^2 =93%							
Test for overall effect: Z = 1.28 (P = 0.20)							
5 Pharyngeal electrical stimulation							
Jayasekeran 2010b	16	6.3 (4.4)	12	5.6 (5.54)		4.0 %	0.14 [-0.61, 0.89]

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Therapy better Therapy worse

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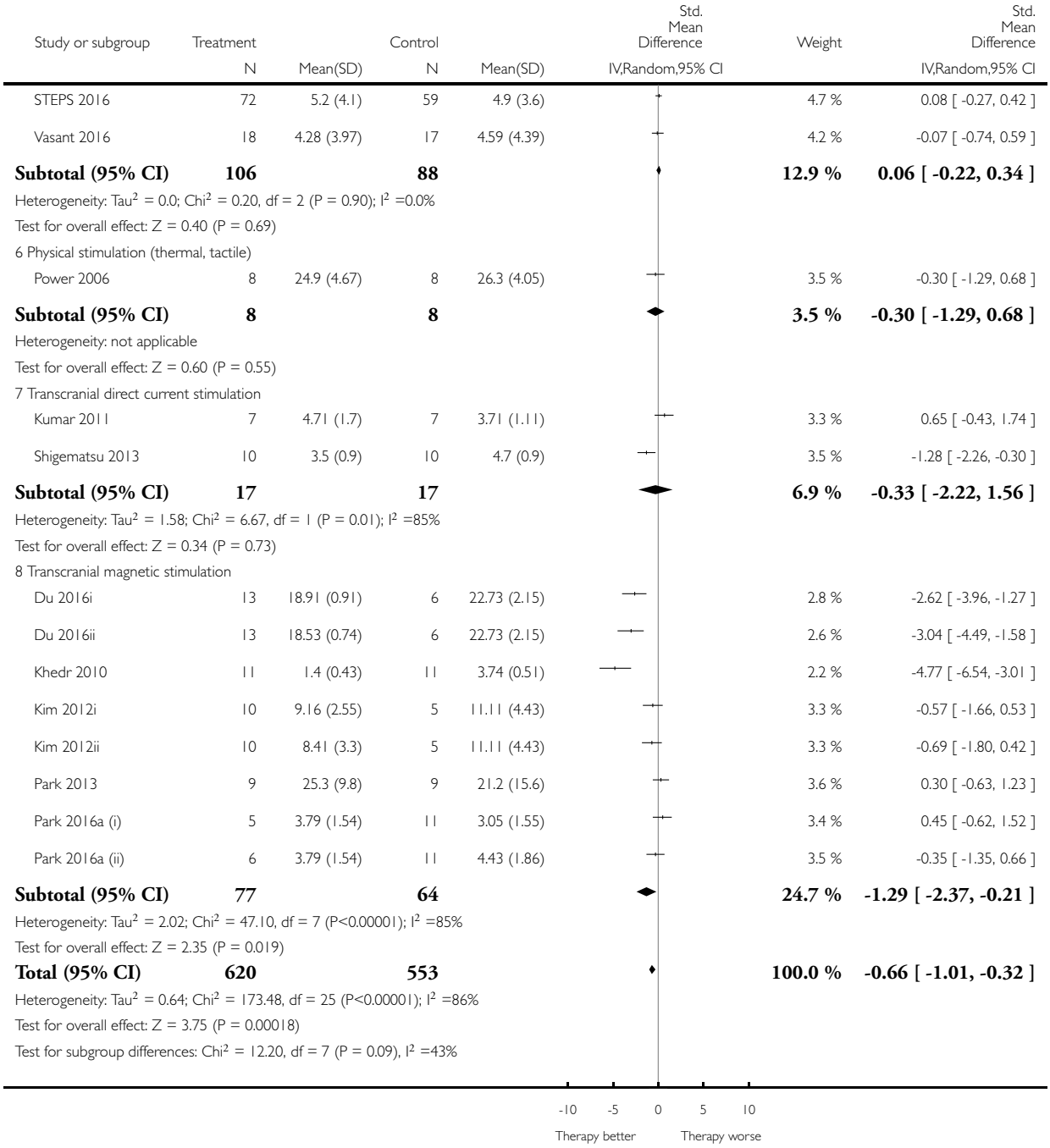


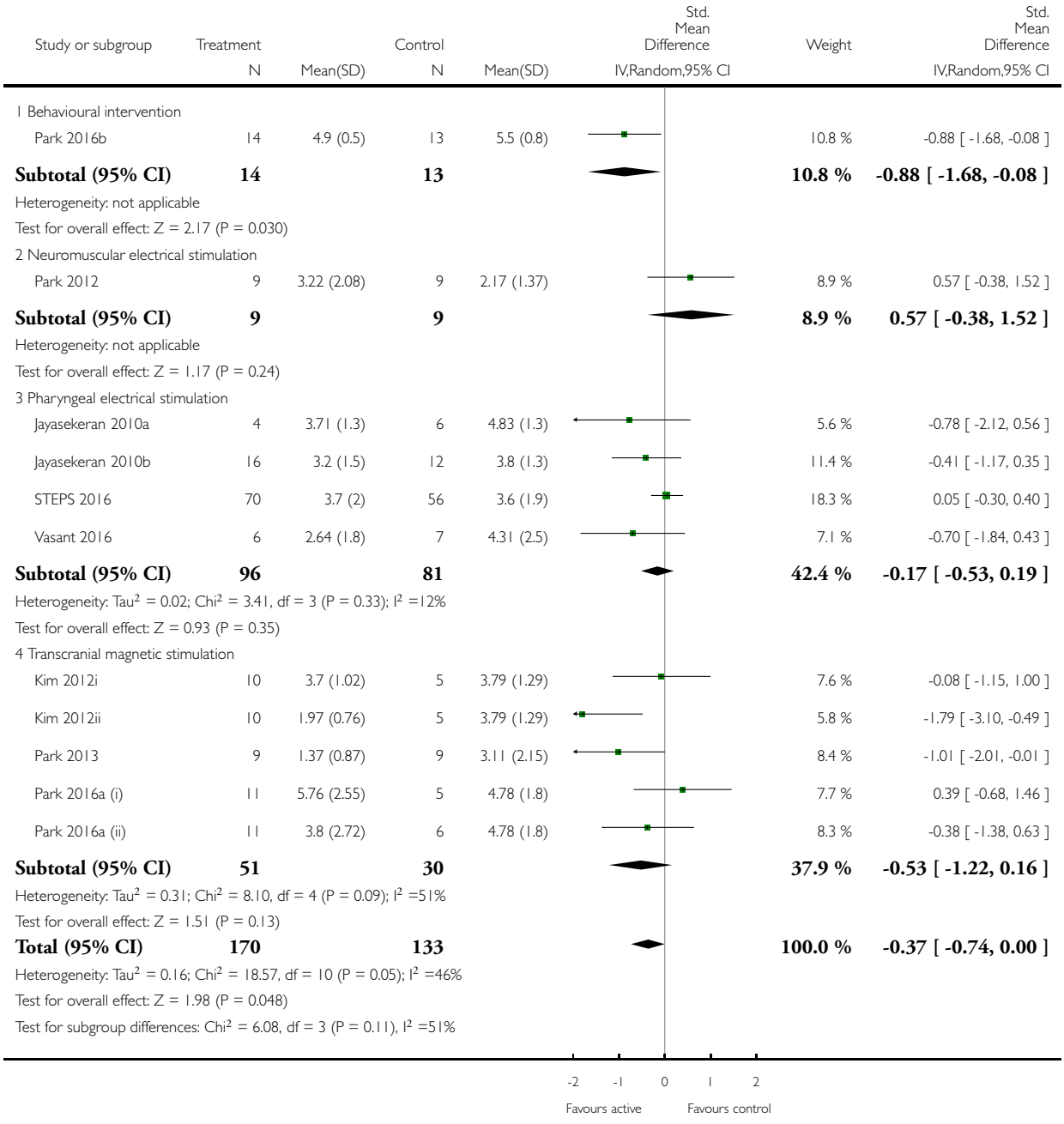
Study or subgroup	Treatment N	Mean(SD)	Control N	Mean(SD)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
STEPS 2016	72	5.2 (4.1)	59	4.9 (3.6)		4.7 %	0.08 [-0.27, 0.42]
Vasant 2016	18	4.28 (3.97)	17	4.59 (4.39)		4.2 %	-0.07 [-0.74, 0.59]
Subtotal (95% CI)	**106**		**88**			**12.9 %**	**0.06 [-0.22, 0.34]**
Heterogeneity: Tau^2 = 0.0; Chi^2 = 0.20, df = 2 (P = 0.90); I^2 =0.0%							
Test for overall effect: Z = 0.40 (P = 0.69)							
6 Physical stimulation (thermal, tactile)							
Power 2006	8	24.9 (4.67)	8	26.3 (4.05)		3.5 %	-0.30 [-1.29, 0.68]
Subtotal (95% CI)	**8**		**8**			**3.5 %**	**-0.30 [-1.29, 0.68]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.60 (P = 0.55)							
7 Transcranial direct current stimulation							
Kumar 2011	7	4.71 (1.7)	7	3.71 (1.11)		3.3 %	0.65 [-0.43, 1.74]
Shigematsu 2013	10	3.5 (0.9)	10	4.7 (0.9)		3.5 %	-1.28 [-2.26, -0.30]
Subtotal (95% CI)	**17**		**17**			**6.9 %**	**-0.33 [-2.22, 1.56]**
Heterogeneity: Tau^2 = 1.58; Chi^2 = 6.67, df = 1 (P = 0.01); I^2 =85%							
Test for overall effect: Z = 0.34 (P = 0.73)							
8 Transcranial magnetic stimulation							
Du 2016i	13	18.91 (0.91)	6	22.73 (2.15)		2.8 %	-2.62 [-3.96, -1.27]
Du 2016ii	13	18.53 (0.74)	6	22.73 (2.15)		2.6 %	-3.04 [-4.49, -1.58]
Khedr 2010	11	1.4 (0.43)	11	3.74 (0.51)		2.2 %	-4.77 [-6.54, -3.01]
Kim 2012i	10	9.16 (2.55)	5	11.11 (4.43)		3.3 %	-0.57 [-1.66, 0.53]
Kim 2012ii	10	8.41 (3.3)	5	11.11 (4.43)		3.3 %	-0.69 [-1.80, 0.42]
Park 2013	9	25.3 (9.8)	9	21.2 (15.6)		3.6 %	0.30 [-0.63, 1.23]
Park 2016a (i)	5	3.79 (1.54)	11	3.05 (1.55)		3.4 %	0.45 [-0.62, 1.52]
Park 2016a (ii)	6	3.79 (1.54)	11	4.43 (1.86)		3.5 %	-0.35 [-1.35, 0.66]
Subtotal (95% CI)	**77**		**64**			**24.7 %**	**-1.29 [-2.37, -0.21]**
Heterogeneity: Tau^2 = 2.02; Chi^2 = 47.10, df = 7 (P<0.00001); I^2 =85%							
Test for overall effect: Z = 2.35 (P = 0.019)							
Total (95% CI)	**620**		**553**			**100.0 %**	**-0.66 [-1.01, -0.32]**
Heterogeneity: Tau^2 = 0.64; Chi^2 = 173.48, df = 25 (P<0.00001); I^2 =86%							
Test for overall effect: Z = 3.75 (P = 0.00018)							
Test for subgroup differences: Chi^2 = 12.20, df = 7 (P = 0.09), I^2 =43%							

Analysis 1.6. Comparison 1 Swallowing therapy, Outcome 6 Penetration aspiration score.

Review: Swallowing therapy for dysphagia in acute and subacute stroke

Comparison: 1 Swallowing therapy

Outcome: 6 Penetration aspiration score

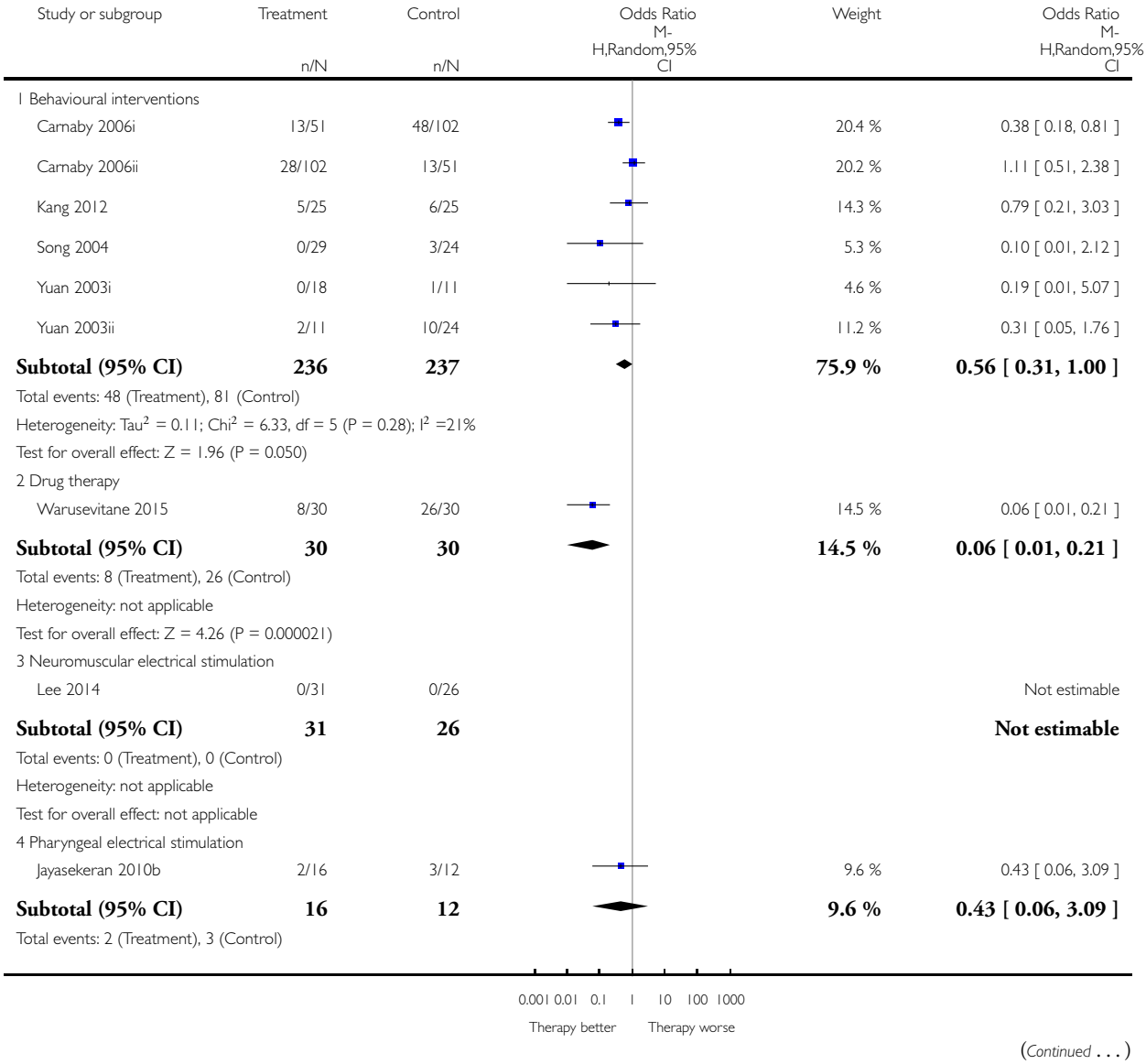


Analysis 1.7. Comparison 1 Swallowing therapy, Outcome 7 Chest infection or pneumonia.

Review: Swallowing therapy for dysphagia in acute and subacute stroke

Comparison: 1 Swallowing therapy

Outcome: 7 Chest infection or pneumonia



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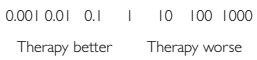
Study or subgroup	Treatment n/N	Control n/N	Odds Ratio M-H,Random,95% CI	Weight	Odds Ratio M-H,Random,95% CI
Heterogeneity: not applicable					
Test for overall effect: Z = 0.84 (P = 0.40)					
Total (95% CI)	**313**	**305**		**100.0 %**	**0.36 [0.16, 0.78]**
Total events: 58 (Treatment), 110 (Control)					
Heterogeneity: Tau^2 = 0.63; Chi^2 = 17.04, df = 7 (P = 0.02); I^2 =59%					
Test for overall effect: Z = 2.60 (P = 0.0093)					
Test for subgroup differences: Chi^2 = 9.72, df = 2 (P = 0.01), I^2 =79%					



Analysis 1.8. Comparison 1 Swallowing therapy, Outcome 8 Pharyngeal transit time (seconds).

Review: Swallowing therapy for dysphagia in acute and subacute stroke

Comparison: 1 Swallowing therapy

Outcome: 8 Pharyngeal transit time (seconds)

Study or subgroup	Treatment N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 Drug therapy							
Perez 1997	8	2.19 (0.64)	9	2.4 (0.83)		1.5 %	-0.21 [-0.91, 0.49]
Subtotal (95% CI)	**8**		**9**			**1.5 %**	**-0.21 [-0.91, 0.49]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.59 (P = 0.56)							
2 Neuromuscular electrical stimulation							
Li 2014	38	0.8 (0.1)	40	1.1 (0.1)		52.0 %	-0.30 [-0.34, -0.26]
Lim 2009	16	0.86 (0.19)	12	0.97 (0.22)		20.3 %	-0.11 [-0.27, 0.05]
Terre 2015	10	1.15 (0.21)	10	1.5 (0.78)		2.8 %	-0.35 [-0.85, 0.15]
Subtotal (95% CI)	**64**		**62**			**75.1 %**	**-0.23 [-0.39, -0.08]**
Heterogeneity: Tau^2 = 0.01; Chi^2 = 5.37, df = 2 (P = 0.07); I^2 =63%							
Test for overall effect: Z = 3.01 (P = 0.0026)							

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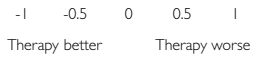
Study or subgroup	Treatment N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
3 Pharyngeal electrical stimulation							
Jayasekeran 2010b	16	1.089 (0.68)	12	1.24 (0.707)		2.6 %	-0.15 [-0.67, 0.37]
Subtotal (95% CI)	**16**		**12**			**2.6 %**	**-0.15 [-0.67, 0.37]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.58 (P = 0.56)							
4 Physical stimulation (thermal, tactile)							
Power 2006	8	0.74 (0.14)	8	0.93 (0.17)		20.8 %	-0.19 [-0.34, -0.04]
Subtotal (95% CI)	**8**		**8**			**20.8 %**	**-0.19 [-0.34, -0.04]**
Heterogeneity: not applicable							
Test for overall effect: Z = 2.44 (P = 0.015)							
Total (95% CI)	**96**		**91**			**100.0 %**	**-0.23 [-0.32, -0.15]**
Heterogeneity: Tau^2 = 0.00; Chi^2 = 7.04, df = 5 (P = 0.22); I^2 =29%							
Test for overall effect: Z = 5.36 (P < 0.00001)							
Test for subgroup differences: Chi^2 = 0.21, df = 3 (P = 0.98), I^2 =0.0%							

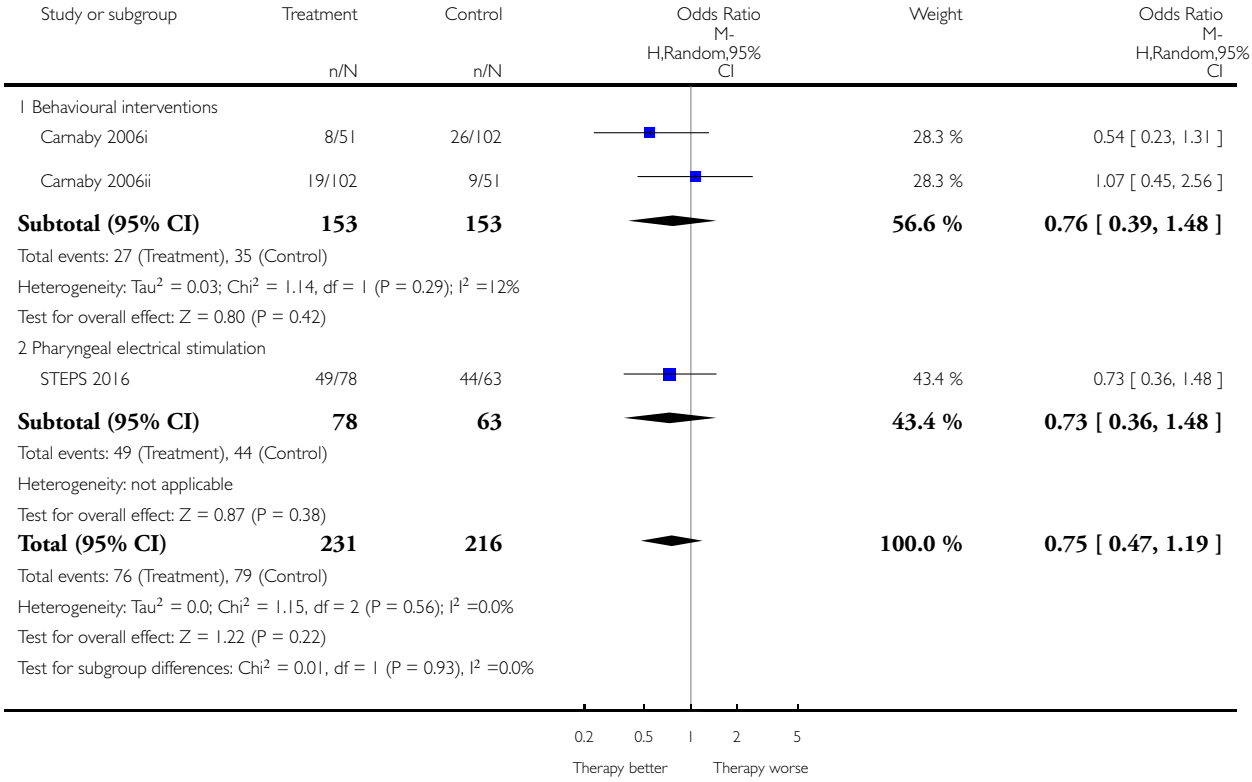


Analysis 1.9. Comparison 1 Swallowing therapy, Outcome 9 Institutionalisation.

Review: Swallowing therapy for dysphagia in acute and subacute stroke

Comparison: 1 Swallowing therapy

Outcome: 9 Institutionalisation

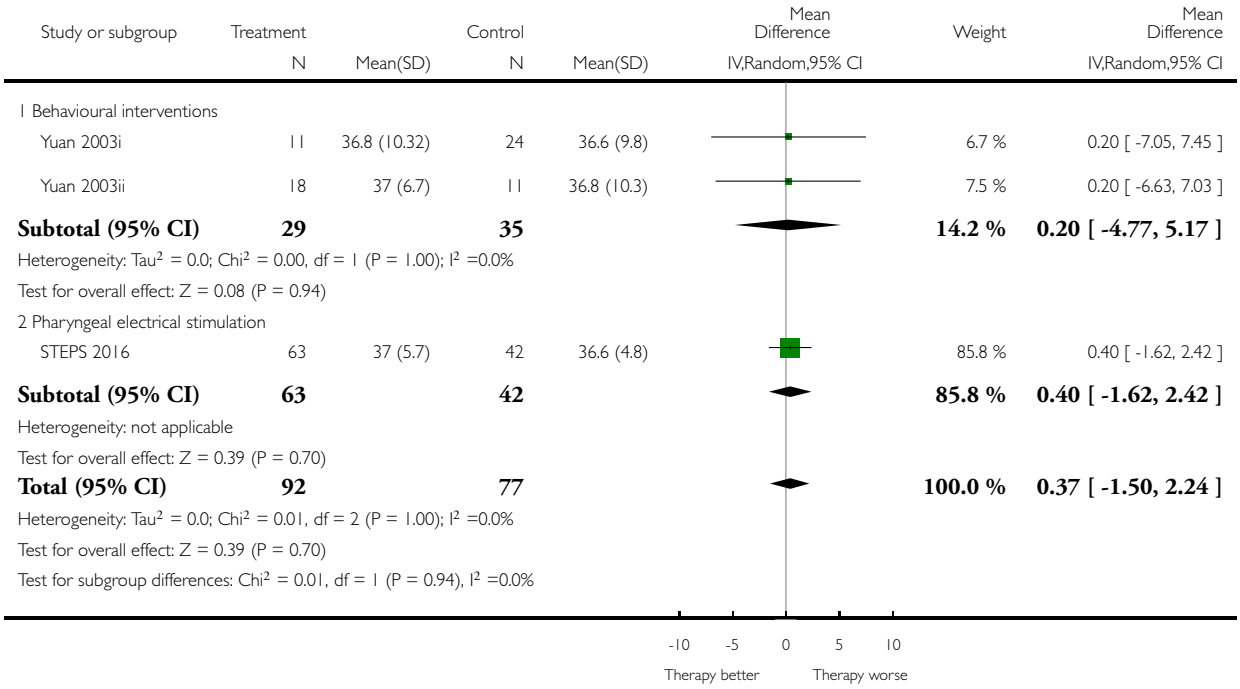


Analysis 1.10. Comparison 1 Swallowing therapy, Outcome 10 Nutritional (albumin).

Review: Swallowing therapy for dysphagia in acute and subacute stroke

Comparison: 1 Swallowing therapy

Outcome: 10 Nutritional (albumin)



APPENDICES

Appendix 1. CENTRAL search strategy

1. MeSH descriptor: [Cerebrovascular Disorders] this term only
2. MeSH descriptor: [Basal Ganglia Cerebrovascular Disease] this term only
3. MeSH descriptor: [Brain Ischemia] explode all trees
4. MeSH descriptor: [Carotid Artery Diseases] explode all trees
5. MeSH descriptor: [Cerebral Small Vessel Diseases] explode all trees
6. MeSH descriptor: [Intracranial Arterial Diseases] explode all trees
7. MeSH descriptor: [Intracranial Embolism and Thrombosis] explode all trees
8. MeSH descriptor: [Intracranial Hemorrhages] explode all trees
9. MeSH descriptor: [Stroke] explode all trees
10. MeSH descriptor: [Stroke, Lacunar] this term only

11. (stroke* or poststroke or apoplex* or cerebral vasc* or brain vasc* or cerebrovasc* or cva*):ti,ab,kw (Word variations have been searched)
12. ((brain or cerebr* or cerebell* or vertebrobasil* or hemispher* or intracran* or intracerebral or infratentorial or supratentorial or middle cerebral artery or MCA* or anterior circulation or posterior circulation or basilar artery or vertebral artery) near/5 (isch?emi* or infarct* or thrombo* or emboli* or occlus*)):ti,ab,kw (Word variations have been searched)
13. ((brain* or cerebr* or cerebell* or intracerebral or intracran* or parenchymal or intraparenchymal or intraventricular or infratentorial or supratentorial or basal gangli* or putaminal or putamen or posterior fossa or hemispher*) near/5 (h?emorrhag* or h?ematoma* or bleed*)):ti,ab,kw (Word variations have been searched)
14. {or #1-#13}
15. MeSH descriptor: [Deglutition] this term only
16. MeSH descriptor: [Deglutition Disorders] explode all trees
17. ((swallow* or deglutit* or dysphag*) near/3 (disturbance* or disorder* or difficult* or dysfunction* or impair* or condition* or abnormal* or damage* or injur*)):ti,ab,kw (Word variations have been searched)
18. MeSH descriptor: [Pharynx] this term only
19. MeSH descriptor: [Pharyngeal Muscles] this term only
20. ((pharyn* or oropharyn*) near/3 (disturbance* or disorder* or difficult* or dysfunction* or impair* or condition* or abnormal* or damage* or injur*)):ti,ab,kw (Word variations have been searched)
21. {or #15-#20}
22. #14 and #21

Appendix 2. MEDLINE search strategy

1. cerebrovascular disorders/ or basal ganglia cerebrovascular disease/ or exp brain ischemia/ or exp carotid artery diseases/ or exp cerebral small vessel diseases/ or exp intracranial arterial diseases/ or exp "intracranial embolism and thrombosis"/ or exp intracranial hemorrhages/ or stroke/ or stroke, lacunar/
2. (stroke$ or poststroke or apoplex$ or cerebral vasc$ or brain vasc$ or cerebrovasc$ or cva$).tw.
3. ((brain$ or cerebr$ or cerebell$ or vertebrobasil$ or hemispher$ or intracran$ or intracerebral or infratentorial or supratentorial or middle cerebral artery or MCA$ or anterior circulation or posterior circulation or basilar artery or vertebral artery) adj5 (isch?emi$ or infarct$ or thrombo$ or emboli$ or occlus$)).tw.
4. ((brain$ or cerebr$ or cerebell$ or intracerebral or intracran$ or parenchymal or intraparenchymal or intraventricular or infratentorial or supratentorial or basal gangli$ or putaminal or putamen or posterior fossa or hemispher$) adj5 (h?emorrhag$ or h?ematoma$ or bleed$)).tw.
5. or/1-4
6. Deglutition/
7. exp Deglutition Disorders/
8. ((swallow$ or deglutit$ or dysphag$) adj5 (disturbance$ or disorder$ or difficult$ or dysfunction$ or impair$ or condition$ or abnormal$ or damage$ or injur$)).tw.
9. Pharynx/ or pharyngeal muscles/
10. ((pharyn$ or oropharyn$) adj3 (disturbance$ or disorder$ or difficult$ or dysfunction$ or impair$ or condition$ or abnormal$ or damage$ or injur$)).tw.
11. or/6-10
12. randomized controlled trial.pt.
13. controlled clinical trial.pt.
14. randomized.ab.
15. placebo.ab.
16. random$.ab.
17. trial.ab.
18. groups.ab.
19. or/12-18
20. 5 and 11 and 19

Previous version of search strategy

1. stroke.mp.

2. infarction.mp.
3. exp cerebral infarction/
4. exp cerebrovascular disease/
5. cerebrovascular disease.mp.
6. hemorrhage.mp.
7. exp cerebral hemorrhage/
8. cerebral haemorrhage.mp.
9. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8
10. (dysphagia or deglutition or swallowing or deglutition disorders or swallowing disorders or malnutrition or undernutrition).mp.
11. (intervention or supplementation or feeding or nutrition or nutritional supplementation or therapy or swallowing therapy or tube feeding or fluid or fluid supplementation or sip feeding or feeding route or timing or diet or hydration).mp.
12. 10 or 11
13. 9 and 12
14. (randomized controlled trial.pt. or controlled clinical trial.pt.or randomized.ab. or placebo.ab. or clinical trials as topic.sh. or randomly.ab. or trial.ti.) and humans.sh.
15. 13 and 14

Appendix 3. Embase search strategy

1. cerebrovascular disease/ or brain disease/ or exp basal ganglion hemorrhage/ or exp brain hematoma/ or exp brain hemorrhage/ or exp brain infarction/ or exp brain ischemia/ or exp carotid artery disease/ or exp cerebral artery disease/ or exp cerebrovascular accident/ or exp intracranial aneurysm/ or exp occlusive cerebrovascular disease/ or exp vertebrobasilar insufficiency/
2. (stroke$ or poststroke or apoplex$ or cerebral vasc$ or brain vasc$ or cerebrovasc$ or cva$).tw.
3. ((brain or cerebr$ or cerebell$ or vertebrobasil$ or hemispher$ or intracran$ or intracerebral or infratentorial or supratentorial or middle cerebral artery or MCA$ or anterior circulation or posterior circulation or basilar artery or vertebral artery) adj5 (isch?emi$ or infarct$ or thrombo$ or emboli$ or occlus$)).tw.
4. ((brain$ or cerebr$ or cerebell$ or intracerebral or intracran$ or parenchymal or intraparenchymal or intraventricular or infratentorial or supratentorial or basal gangli$ or putaminal or putamen or posterior fossa or hemispher$) adj5 (h?emorrhag$ or h?ematoma$ or bleed$)).tw.
5. or/1-4
6. dysphagia/
7. swallowing/
8. ((swallow$ or deglutit$ or dysphag$) adj3 (disturbance$ or disorder$ or difficult$ or dysfunction$ or impair$ or condition$ or abnormal$ or damage$ or injur$)).tw.
9. exp pharynx/
10. ((pharyn$ or oropharyn$) adj3 (disturbance$ or disorder$ or difficult$ or dysfunction$ or impair$ or condition$ or abnormal$ or damage$ or injur$)).tw.
11. or/6-10
12. Randomized Controlled Trial/ or "randomized controlled trial (topic)"/
13. Randomization/
14. Controlled clinical trial/ or "controlled clinical trial (topic)"/
15. control group/ or controlled study/
16. clinical trial/ or "clinical trial (topic)"/ or phase 1 clinical trial/ or phase 2 clinical trial/ or phase 3 clinical trial/ or phase 4 clinical trial/
17. Crossover Procedure/
18. Double Blind Procedure/
19. Single Blind Procedure/ or triple blind procedure/
20. placebo/ or placebo effect/
21. (random$ or RCT or RCTs).tw.
22. (controlled adj5 (trial$ or stud$)).tw.
23. (clinical$ adj5 trial$).tw.
24. ((control or treatment or experiment$ or intervention) adj5 (group$ or subject$ or patient$)).tw.

25. ((control or experiment$ or conservative) adj5 (treatment or therapy or procedure or manage$)).tw.
26. ((singl$ or doubl$ or tripl$ or trebl$) adj5 (blind$ or mask$)).tw.
27. (cross-over or cross over or crossover).tw.
28. (placebo$ or sham).tw.
29. trial.ti.
30. (assign$ or allocat$).tw.
31. controls.tw.
32. or/12-31
33. 5 and 11 and 32

Previous version of search strategy

1. stroke.mp.
2. infarction.mp.
3. exp brain Infarction/
4. cerebrovascular disease.mp.
5. exp cerebrovascular disease/
6. hemorrhage.mp.
7. exp cerebral hemorrhage/
8. cerebral haemorrhage.mp.
9. 9. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8
10. (dysphagia or deglutition or swallowing or deglutition disorders or swallowing disorders or malnutrition or undernutrition).mp.
11. (intervention or supplementation or feeding or nutrition or nutritional supplementation or therapy or swallowing therapy or tube feeding or fluid or fluid supplementation or sip feeding or feeding route or timing or diet or hydration).mp.
12. 10 or 11
13. 09 and 12
14. ((RANDOMIZED-CONTROLLED-TRIAL/ or RANDOMIZATION/ or CONTROLLED-STUDY/ or MULTICENTER-STUDY/ or PHASE-3-CLINICAL-TRIAL/ or PHASE-4-CLINICAL-TRIAL/ or DOUBLE-BLIND-PROCEDURE/ or SINGLE-BLIND-PROCEDURE/) or ((RANDOM* or CROSS?OVER* or FACTORIAL* or PLACEBO* or VOLUNTEER*) or ((SINGL* or DOUBL* or TREBL* or TRIPL*) adj3 (BLIND* or MASK*))).ti,ab) and human*.ec,hw,fs.
15. 13 and 14

Appendix 4. CINAHL search strategy

1. S1 (MH "Cerebrovascular Disorders") OR (MH "Basal Ganglia Cerebrovascular Disease+") OR (MH "Carotid Artery Diseases+") OR (MH "Cerebral Ischemia+") OR (MH "Cerebral Vasospasm") OR (MH "Intracranial Arterial Diseases+") OR ((MH "Intracranial Embolism and Thrombosis")) OR (MH "Intracranial Hemorrhage+") OR (MH "Stroke") OR (MH "Vertebral Artery Dissections") OR (MH "Stroke Patients") OR (MH "Stroke Units")
2. S2 TI (stroke or poststroke or post-stroke or cerebrovasc* or brain vasc* or cerebral vasc or cva or apoplex) or AB (stroke or poststroke or post-stroke or cerebrovasc* or brain vasc* or cerebral vasc or cva or apoplex)
3. S3 TI ((brain or cerebr* or cerebell* or vertebrobasil* or hemispher* or intracran* or intracerebral or infratentorial or supratentorial or middle cerebral artery or MCA* or anterior circulation or posterior circulation or basilar artery or vertebral artery) N5 (ischemi* or ischaemi* or infarct* or thrombo* or emboli* or occlus*)) OR AB ((brain or cerebr* or cerebell* or vertebrobasil* or hemispher* or intracran* or intracerebral or infratentorial or supratentorial or middle cerebral artery or MCA* or anterior circulation or posterior circulation or basilar artery or vertebral artery) N5 (ischemi* or ischaemi* or infarct* or thrombo* or emboli* or occlus*))
4. S4 TI ((brain* or cerebr* or cerebell* or intracerebral or intracran* or parenchymal or intraparenchymal or intraventricular or infratentorial or supratentorial or basal gangli* or putaminal or putamen or posterior fossa or hemispher*) N5 (haemorrhage* or hemorrhage* or haematoma* or hematoma* or bleed*)) OR AB ((brain* or cerebr* or cerebell* or intracerebral or intracran* or parenchymal or intraparenchymal or intraventricular or infratentorial or supratentorial or basal gangli* or putaminal or putamen or posterior fossa or hemispher*) N5 (haemorrhage* or hemorrhage* or haematoma* or hematoma* or bleed*))
5. S5 S1 OR S2 OR S3 OR S4
6. S6 (MH "Deglutition") OR (MH "Gagging")
7. S7 (MH "Deglutition Disorders")

8. S8 TI ((swallow* or deglutit* or dysphag*) N3 (disturbance* or disorder* or difficult* or dysfunction* or impair* or condition* or abnormal* or damage* or injur*)) OR AB ((swallow* or deglutit* or dysphag*) N3 (disturbance* or disorder* or difficult* or dysfunction* or impair* or condition* or abnormal* or damage* or injur*))
9. S9 TI ((swallow* or deglutit* or dysphag*) N3 (scale* or screen* or checklist* or assess* or exam* or identif* or recogni* or evaluat* or diagnos* or detect* or hazard or risk or test)) OR AB ((swallow* or deglutit* or dysphag*) N3 (scale* or screen* or checklist* or assess* or exam* or identif* or recogni* or evaluat* or diagnos* or detect* or hazard or risk or test))
10. S10 S6 OR S7 OR S8 OR S9
11. S11 MH Random Assignment or MH Single-blind Studies or MH Double-blind Studies or MH Triple-blind Studies or MH Crossover design or MH Factorial Design
12. S12 TI ("multicentre study" or "multicenter study" or "multi-centre study" or "multi-center study") or AB ("multicentre study" or "multicenter study" or "multi-centre study" or "multi-center study") or SU ("multicentre study" or "multicenter study" or "multi-centre study" or "multi-center study")
13. S13 TI random* or AB random*
14. S14 AB "latin square" or TI "latin square"
15. S15 TI (crossover or cross-over) or AB (crossover or cross-over) or SU (crossover or cross-over)
16. S16 MH Placebos
17. S17 TI (((singl* or doubl* or trebl* or tripl*) N3 (blind* or mask*))) OR AB (((singl* or doubl* or trebl* or tripl*) N3 (blind* or mask*)))
18. S18 TI Placebo* or AB Placebo* or SU Placebo*
19. S19 MH Clinical Trials
20. S20 TI (Clinical AND Trial) or AB (Clinical AND Trial) or SU (Clinical AND Trial)
21. S21 S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20
22. S22 S5 AND S10 AND S21

Previous version of review search strategy

1. S1. stroke
2. S2. infarction
3. S3. brain Infarction
4. S4. cerebrovascular disease
5. S5. hemorrhage
6. S6. cerebral hemorrhage
7. S7. cerebral haemorrhage
8. S8. S1 or S2 or S3 or S4 or S5 or S6 or S7
9. S9. dysphagia or deglutition or swallowing or deglutition disorders or swallowing disorders or malnutrition or undernutrition
10. S10. intervention or supplementation or feeding or nutrition or nutritional supplementation or therapy or swallowing therapy or tube feeding or fluid or fluid supplementation or sip feeding or feeding route or timing or diet or hydration
11. S11. S9 or S10
12. S12. S8 and S11
13. S13. randomised controlled trials or controlled clinical trial or randomized or clinical trials
14. S14. S12 and S13

Appendix 5. Web of Science search strategy

1. TS=(stroke* or poststroke or apoplex* or cerebral vasc* or brain vasc* or cerebrovasc* or cva*)
2. TS=((brain or cerebr* or cerebell* or vertebrobasil* or hemispher* or intracran* or intracerebral or infratentorial or supratentorial or middle cerebral artery or MCA* or anterior circulation or posterior circulation or basilar artery or vertebral artery) NEAR/5 (isch? emi* or infarct* or thrombo* or emboli* or occlus*))
3. TS=((brain* or cerebr* or cerebell* or intracerebral or intracran* or parenchymal or intraparenchymal or intraventricular or infratentorial or supratentorial or basal gangli* or putaminal or putamen or posterior fossa or hemispher*) NEAR/5 (h?emorrhag* or h? ematoma* or bleed*))
4. #3 OR #2 OR #1
5. TS=((swallow* or deglutit* or dysphag*) NEAR/3 (disturbance* or disorder* or difficult* or dysfunction* or impair* or condition* or abnormal* or damage* or injur*))

6. TS=((pharyn* or oropharyn*) NEAR/3 (disturbance* or disorder* or difficult* or dysfunction* or impair* or condition* or abnormal* or damage* or injur*))
7. #6 OR #5
8. TS=(random* or RCT or RCTs)
9. TS=(controlled NEAR/5 (trial* or stud*))
10. TS=(clinical* NEAR/5 trial*)
11. TS=((control or treatment or experiment* or intervention) NEAR/5 (group* or subject* or patient*))
12. TS=((control or experiment* or conservative) NEAR/5 (treatment or therapy or procedure or m.anage*))
13. TS=((singl* or doubl* or tripl* or trebl*) NEAR/5 (blind* or mask*))
14. TS=(cross-over or cross over or crossover)
15. TS=(placebo* or sham)
16. TS=trial
17. #16 OR #15 OR #14 OR #13 OR #12 OR #11 OR #10 OR #9 OR #8
18. #17 AND #7 AND #4

Previous version of review search strategy

1. stroke
2. infarction
3. brain infarction
4. cerebrovascular disease
5. hemorrhage
6. cerebral haemorrhage
7. cerebral hemorrhage
8. 1 or 2 or 3 or 4 or 5 or 6 or 7
9. dysphagia or deglutition or swallowing or deglutition disorders or swallowing disorders
10. randomized controlled trial or controlled clinical trial randomized or placebo or clinical trials or trial
11. 8 and 9 and 10

Appendix 6. SpeechBITE search stategy

1. Speech Pathology Practice Area: Dysphagia
2. Type of intervention: Swallowing/ feeding
3. Within this population: Stroke/CVA
4. Research Design : Randomised Controlled Trial
5. Age group: Adults

1. Speech Pathology Practice Area: Dysphagia
2. Type of intervention: Swallowing/ feeding
3. Within this population: Stroke/CVA
4. Research Design: Non Randomised Controlled Trial
5. Age group: Adults

Appendix 7. US National Institutes of Health Ongoing Trials Register ClinicalTrials.gov (www.clinicaltrials.gov)

1. (Dysphagia AND (Brain Infarction OR Intracranial Hemorrhages OR Carotid Artery Diseases OR Brain Ischemia OR Cerebral Hemorrhage OR Cerebrovascular Disorders OR Stroke)) [DISEASE]

Appendix 8. World Health Organization International Clinical Trials Registry Platform (apps.who.int/trialsearch)

1. stroke AND swallowing OR stroke AND dysphagia

Appendix 9. Google Scholar

1. Stroke
2. Dysphagia
3. Interventions
4. Randomised Controlled Trials

WHAT'S NEW

Date	Event	Description
28 March 2018	New citation required but conclusions have not changed	More significant outcomes reported as compared to the 2012 review, but largely based on moderate- to low-quality evidence. Changes made to authorship
28 March 2018	New search has been performed	New studies added. 14 studies (883 participants) included in the 2012 review. 27 studies (1777 participants) added to this updated review. Total number of included studies reported is 41 (2660 participants). Focus of this review is limited to treatment of dysphagia in acute and subacute stroke (nutritional, feeding, and fluid support removed from this review and will become the focus of a separate review)

HISTORY

Protocol first published: Issue 1, 1997

Review first published: Issue 4, 1999

Date	Event	Description
14 March 2012	New citation required but conclusions have not changed	Changes made to authorship. No changes made to conclusions
14 March 2012	New search has been performed	Results of 27 new studies involving 6567 participants added to the review. Total of 33 studies involving 6779 participants now included. 15 new ongoing studies also added. Modifications made to analysis method, types of stroke patients included, and outcome measures assessed (Differences between protocol and review)

(*Continued*)

13 April 2008	Amended	Review converted to new review format

CONTRIBUTIONS OF AUTHORS

Philip Bath: conceived and designed the review, undertook searches, analysed and interpreted data, wrote the original review, and updated the review in 2007 (interim update), 2012, and 2018.

Han Sean Lee: undertook searches, extracted data, analysed and interpreted data, and updated the review in 2018.

Lisa Everton: undertook searches and data extraction, analysed and interpreted data, and updated the review in 2018.

DECLARATIONS OF INTEREST

PB was chief investigator of two included trials (Bath 1997, academic; STEPS 2016, commercial - funded by Phagenesis Ltd); he consults for this company and receives honoraria and expenses for this work; he did not contribute to decisions on PES studies including deciding which trials should be included and extracting outcome data. No pharmaceutical or device companies, or other commercial entities, were involved in data analysis, data interpretation, writing of this review, or comments on it.

SL: none known.

LE: none known.

SOURCES OF SUPPORT

Internal sources

- King's College Hospital Audit Committee, UK.
- Division of Stroke, University of Nottingham, UK.

External sources

- South Thames NHS Executive, UK.
- Trent NHS Executive, UK.
- Wolfson Foundation, UK.
- The Stroke Association, UK.
- Royal College of Physicians, UK.
- Dunhill Medical Trust, UK.
- National Institutes of Health Research Stroke Research Network, UK.

Support for recruitment of patients into UK-based trials

- National Institutes of Health Research - Cochrane Incentive Scheme, UK.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

Separation of dysphagia treatment from nutritional support

For this version of the review, we removed all trials related to nutritional support and feeding to allow focus on swallowing therapy for post-stroke dysphagia.

Modification of analysis method

We changed the analysis method from fixed-effect to random-effects models (odds ratio (OR), mean difference (MD)) because we noted the presence of significant trial and statistical heterogeneity. Two studies included more than one interventional group (Yuan 2003; Carnaby 2006), producing different treatment intensities. In these cases, we divided the low-intensity (middle) groups and entered data from the study as two data sets (e.g. data set 1: medium (M), low (L), or none; and data set 2: high (H) or medium (M)). Similarly, in the case of repetitive transcranial magnetic stimulation, when a trial compared high- versus low-frequency stimulation or unilateral versus bilateral stimulation (Kim 2012i; Kim 2012ii; Du 2016i; Du 2016ii; Park 2016a (i); Park 2016a (ii)), we divided control group participants equally between treatment groups to prevent counting control participants more than once, thereby artificially narrowing the confidence intervals (CIs).

We combined different interventions, collectively referred to as 'swallowing therapy', for the purposes of analysing their effects on main outcomes to evaluate whether any intervention is better than no intervention, and to try to establish where the most positive effects are seen, and where more research is needed.

Modification of type of stroke patients

We excluded trials in which a majority of participants did not present with stroke, along with trials for which enrolment occurred after six months.

Addition or modification of outcome measures

Modification of search strategies: we have revised and updated the search strategies used for this review to account for newly identified relevant terms *keywords* and *indexing terms*. We have included both versions of each search strategy in the review appendices.

We divided swallowing therapy into subcategories: acupuncture, drug therapy, NMES, PES, physical stimulation (thermal, tactile), tDCS, and TMS.

We added additional outcome measures, especially focusing on intermediate outcomes: chest infection or pneumonia rates and penetration aspiration scores. We retained outcomes related to improvement of dysphagia as listed with proportion of participants with dysphagia at end of trial. However, we also included changes in some measurements on videofluoroscopy (pharyngeal transit time) and changes in swallowing ability as determined by change in swallow scores. We included discharge destination within the outcome 'institutionalisation': the number of participants discharged to long-term care.

INDEX TERMS

Medical Subject Headings (MeSH)

Acupuncture Therapy [methods]; Acute Disease; Deglutition; Deglutition Disorders [etiology; mortality; *rehabilitation]; Nutritional Support [*methods]; Physical Stimulation [*methods]; Randomized Controlled Trials as Topic; Stroke [*complications]; Stroke Rehabilitation

MeSH check words

Humans