European Stroke Organization and European Society for Swallowing Disorders guideline for the diagnosis and treatment of post-stroke dysphagia

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Abstract

Post-stroke dysphagia (PSD) is present in more than 50 % of acute stroke patients, increases the risk of complications, in particular aspiration pneumonia, malnutrition and dehydration, and is linked to poor outcome and mortality. The aim of this guideline is to assist all members of the multidisciplinary team in their management of patients with PSD. These guidelines were developed based on the European Stroke Organisation (ESO) standard operating procedure and followed the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) approach. An interdisciplinary working group identified 20 relevant questions, performed systematic reviews and meta-analyses of the literature, assessed the quality of the available evidence, and wrote evidence-based recommendations. Expert opinion was provided if not enough evidence was available to provide recommendations based on the GRADE approach. We found moderate quality of evidence to recommend dysphagia screening in all stroke patients to prevent post-stroke pneumonia and decrease risk of early mortality and low quality of evidence to suggest dysphagia assessment in stroke patients having been identified at being at risk of PSD. We found low to moderate quality of evidence for a variety of treatment options to improve swallowing physiology and swallowing safety. These options include dietary interventions, behavioral swallowing treatment including acupuncture, nutritional interventions, oral health care, different pharmacological agents and different types of neurostimulation treatment. Some of the studied interventions also had an impact on other clinical endpoints such as feedings status or pneumonia. Overall, further randomised trials are needed to improve the quality of evidence for the treatment of PSD.

Introduction

The oropharyngeal swallow involves a rapid, highly coordinated set of neuromuscular actions beginning with lip closure and terminating with upper oesophageal sphincter closure when the bolus has passed through. The central coordination of this complex sensorimotor task uses a widespread network of cortical, subcortical, and brainstem structures [1, 2]. Stroke is the most frequent disease leading to disruption of this swallowing network thereby causing an impairment of deglutition, i.e. post-stroke dysphagia (PSD) [3-5]. Depending on the diagnostic criteria, timing and method of assessment, alongside stroke features, PSD is found in 29 to 81% of acute stroke patients [6]. Although many stroke patients recover swallowing within the first weeks after the ictus, 11–50% still suffer from dysphagia at six months [7, 8]. PSD broadly affects swallowing safety leading to an increased risk of aspiration and subsequent pneumonia, and swallowing efficacy with the related danger of insufficient nutrition and hydration. Apart from these physical consequences, dysphagia has a significant impact on the psychological well-being and level of independence for the affected individuals and dysphagia has been linked to low mood and depression [9].

Because of its large epidemiological burden and hazardous clinical complications, the European Stroke Organization (ESO) and the European Society for Swallowing Disorders (ESSD) have decided to compile guidelines on the management of PSD. These recommendations are based on findings from randomized controlled trials (RCTs) and observational studies. They were agreed through consensus with the involved authors using the grading of recommendations assessment, development and evaluation (GRADE) approach and the ESO standard operating procedure (SOP) for guidelines development [10] and have the approval of the ESO Executive Committee.

The aim of this guideline document is to inform physicians, speech-and-language therapists (SLTs) as well as stroke-nurses, and all the members of the multidisciplinary team on how to screen, assess and treat patients with PSD to avoid dysphagia-related complications and to facilitate recovery of swallowing function.

Methods

Three group leaders, two SLTs (EM and MT) and one neurologist (RD) from three European countries with expertise in PSD were nominated by the Guideline Committee of the ESO. These three group leaders suggested a group of 11 experts covering a broad spectrum of medical professions involved in dysphagia care, in particular two SLTs (MW, SP), a phoniatrician (AS), a surgeon (PC), two neurologists (MA, JG), a geriatrician (RW), a gastroenterologist (SH), a stroke physician (PMB), a pharmacist (DW), and a rehabilitation physician (EV) from 7 European countries. The guideline team was completed by a guideline methodologist (AL). Seven members of the ESSD board were among the authors (RD, SH, PC, EV, AS, EM, MW). Due to the European-wide approach, stakeholders in terms of the target patient population were not included in this guideline project. The working group (WG) was confirmed by the ESO Executive Committee. Standardised steps which were undertaken by the WG are summarised as follows:

(1) The group discussed and decided by consensus on specific and clinically relevant patient, intervention, comparator, outcome (PICO) questions.

(2) The group identified all important outcomes for the PICO questions (Table 1).

(3) The group identified all available publications published in English related to the PICO questions in 4 separate searches. These were guided by the 2011 Centre for Evidence Based Medicine's levels of evidence [11]. We searched the databases such as MEDLINE, EMBASE,

CINAHL and Cochrane database of systematic reviews (CDSR), the Cochrane central register of controlled trials (CENTRAL) (1990 through August 2018). Furthermore, we searched the reference lists of review articles and clinical trials on PSD for further appropriate studies.

(4) The group selected eligible studies. Due to the high number of PICO questions different WG members were responsible for the 4 separate topics and screened the respective articles. As we identified relatively few RCTs and systematic reviews or meta-analyses of RCTs, we also included observational and epidemiological studies that might facilitate the recommendations or proposals (supplement 1).

(5) Meta-analysis was performed using the Review Manager (RevMan, version 5.3) Cochrane Collaboration software. The risk ratios (RRs), odds ratios (ORs), mean difference (MD) or standard mean difference (SMD) and 95% confidence intervals (CIs) were calculated, with a random effects model, for all outcomes, were calculated[12]. Where appropriate, subgroup analyses based on different treatment modalities within a given main category were performed. Results were then summarised in GRADE evidence profiles and summary of findings tables. Directness refers to the extent by which patient populations, interventions and outcomes are similar to those of interest.

The Cochrane Collaboration's tool was used to perform the assessment of Risk of bias of RCT. The various components of this tool, such as risk of selection (randomization, allocation concealment), performance (blinding of participants and personal), detection (blinding of outcome assessment), attrition (incomplete outcome data), and reporting (selective reporting) bias were assessed in each RCT[13]. For NRCTs the different components of the SIGN-checklist such as conduct of study, selection of subjects, assessment, confounding the statistical analysis were using the Scottish Intercollegiate Guidelines Network (SIGN) checklist (https://www.sign.ac.uk/what-we-do/methodology/checklists/).

(6) The components of GRADE system such as, Study design, Risk of bias, Inconsistency, Indirectness, Imprecision, and other considerations were considered in grading the evidence. The study design specified the basic design of the study (RCT or non-RCT). The Risk of bias assessed if there was any limitation in the rating the RCT or non-RCT. Study Heterogeneity across studies was assessed using Cochran's Q (reported as a p value) and I^2 statistics. I^2 statistic, an expression of inconsistency of studies' results describes the percentage of variation across studies due to heterogeneity rather than by chance was calculated. A high value of I^2 (>50%) and p value <0.05 indicate statistically significant heterogeneity among the studies for an outcome. Indirectness assessed if the evidence answered the PICO question directly or there was indirectness in the available evidence. Directness refers to the extent by which patient populations, interventions, comparator, outcomes and study design are similar to those of our PICO question. Imprecision assessed the preciseness of overall results of the evidence (from meta-analysis or study). The other considerations assessed publication bias, effect size, residual confounding and dose effect gradient. The Funnel plots were performed if 10 or more studies reported the data of an outcome and their shape was visualized for symmetry. An asymmetry of the funnel plot (with ≥ 10 studies) or less than 10 studies for a meta-analysis for an outcome indicated publication bias. If there was any limitation in the risk of bias, heterogeneity, directness, imprecision or publication bias, the certainty of the evidence was downgraded. The certainty of the grade-evidence was upgraded if the effect size of the evidence was large (e.g., RR/OR > 2 or <0.5), studies reported the data of residual confounding, or studies reported data on dose effect gradient. For each PICO question and each outcome, the quality of evidence was rated using the GRADEpro Guideline Development Tool (McMaster University, 2015; developed by Evidence Prime, Inc.) as high, moderate, low or very low (see box 1).

(7) The final summaries of the quality and strength of evidence and recommendations for each PICO question were discussed by the whole group, recommendations were agreed on by the authors[14]. The strength of recommendations was graded as strong when the desirable effect of an intervention clearly outweighed the undesirable effects or clearly did not, or weak when the trade-off was less certain, either because of low-quality evidence, or because the evidence suggested that desirable and undesirable effects were more closely balanced (Box 2).

(8) This guideline document was subsequently reviewed several times by all MWG and modified until a consensus was reached.

(9) Finally, the Guideline document was reviewed and approved by five external reviewers, the ESO Guidelines board and the ESO Executive committee.

(10) The WGs who completed this guideline will be reviewing the evidence on a regular basis, with the first anticipated partial review in 2024. We envisage that this period after the publication of these guidelines will further increase the number of clinical studies published in the next few years.

Part 1: Impact of PSD on stroke outcome

The working group formulated one introductory research question.

1. In patients with acute and /or subacute stroke, does presence of dysphagia compared to no dysphagia have an effect on functional outcome and/or survival, aspiration risk, length of hospital stay, adverse events and complications, nutritional status, or quality of life?

Out of a total of 1867 studies the literature search revealed 43 prospective or retrospective studies that addressed one or more of the mentioned endpoints [7, 15-57]. Each outcome was assessed in a separate meta-analysis (Table 2, supplement 2). As evidenced by these analyses, there is a high probability that PSD has a considerable impact on nearly all of the mentioned outcomes. In particular, PSD was associated with an increased 12-months-mortality (OR 8.82 [3.56, 21.85]), poorer outcomes (mRS 4-5) (OR 5.03 [4.43, 5.72]), pneumonia (OR 7.45 [6.01, 9.24]), insertion of a percutaneous endoscopic gastrostomy (PEG)-feeding tube (OR 71.60 [34.38, 149.11]), hospital length-of-stay (OR 4.72 [3.53, 5.91]), and discharge to institutional care (OR 3.90 [2.93, 5.21]).

The most recent study and also the one with the biggest impact on the meta-analyses scrutinised registry data from 6677 stroke patients [37]. Failing dysphagia screening was associated with poor outcomes, including pneumonia (adjusted OR 4.71 [3.43, 6.47]), severe disability (adjusted OR 5.19 [4.48, 6.02]), discharge to long-term care (adjusted OR 2.79 [2.11, 3.79]), and 1-year mortality (adjusted hazard ratio, 2.42; [2.09, 2.80]). Aiming at developing a tool to predict pneumonia post stroke, Hoffmann and co-workers analysed registry data from 15335 patients [34]. Adjusted for other predictors such as age and stroke severity, dysphagia was associated with an OR of 2.64 [2.21, 3.15] to develop pneumonia. Consequently, the 10-point score (A^2DS^2) proposed by the authors attributed two points to

the presence of PSD (Age ≥75 years = 1 pt., Atrial fibrillation = 1 pt., Dysphagia = 2 pts., male Sex = 1 pt., stroke Severity, National Institutes of Health Stroke Scale 0–4 = 0, 5–15 = 3, ≥ 16 = 5 pts.).

Conclusion: In patients with acute and /or subacute stroke, the presence of dysphagia has an adverse effect on functional outcome and mortality, increases the risk of pneumonia, malnutrition, PEG-feeding, and discharge to institutional care and prolongs hospital length-of-stay. Quality of evidence: Moderate (Expert consensus).

Part 2: Dysphagia and nutritional screening

Dysphagia screening

Due to the impact of PSD on specific complications and global outcome post stroke, many hospitals globally use dysphagia screening protocols to identify patients at risk of aspiration and to guide subsequent diagnostic and therapeutic procedures. In addition, dysphagia screening has also been implemented in various guidelines [58-62] and is part of auditing systems for stroke units [63].

This guideline does not review evidence for the accuracy and reliability of different dysphagia screening protocols compared with gold standard assessments, in particular the Videofluoroscopic Swallowing Study (VFSS) and Flexible Endoscopic Evaluation of Swallowing (FEES). This has previously been done in different reviews [64-70] that generally favoured one or the other specific protocol but did not provide "the optimal screening protocol" due to a lack of sufficient comparative studies. In the main, the widely used water swallow tests (WST) usually expose the patient to drinking a predefined volume of water (for example 50 or 90 ml). Where clinical aspiration signs (cough, voice change, stridor) occur during or after the screening, the test is considered positive and the patient is kept nil-by-mouth and more sophisticated diagnostic procedures are initiated. If the patient passes the test, oral feeding is recommended. Apart from WSTs, multiple consistency tests have also been proposed (see PICO 3 in this chapter).

The WG formulated three PICO questions. Because these questions are closely intertwined an overall conclusion is given at the end of this section after the third PICO question has been discussed.

1. In patients with acute stroke does screening compared to no screening for dysphagia improve functional outcome and/or survival, reduce aspiration risk, reduce length of hospital stay, reduce adverse events and complications, have an effect on nutritional status, and have an effect on quality-of-life?

Out of 3084 titles our search resulted in 13 studies with data pertinent to this question [15, 40, 47, 71-80] (Table 3, supplement 3). As revealed by the meta-analysis, dysphagia screening for PSD was related to a reduced risk of pneumonia (OR 0.55 [0.36, 0.83]) and there was a trend for reduced mortality during acute care associated with dysphagia screening (OR 0.67 [0.45, 1.02], p=0.06). Dysphagia screening was not related to 1-month mortality, length-of-stay or discharge destination. Quality of evidence was low since there were no randomized trials available. Most data were obtained either from cohort-studies or from studies comparing 'pre-post-scenarios'. Thus, for example, Hinchey et al. compared the incidence of pneumonia post stroke in hospitals providing a formalized dysphagia screen versus incidence rates from hospitals not-providing screening. In their study, the use of a formal protocol performed on all stroke admissions decreased the risk of pneumonia by 3-fold [72]. More recently, Titsworth and co-workers adopted a 'prospective interrupted time-series trial' to evaluate the effect of implementing a dysphagia protocol with a nurse-administered bedside dysphagia screen and a rapid clinical swallow evaluation by a SLT. Their main findings were that adherence to dysphagia screening nearly doubled (39.3% to 74.2 %) and incidence of pneumonia was more than halved (6.5% to 2.8%) after protocol implementation [77].

2. In patients with acute stroke, does early dysphagia screening compared to no screening or late screening, improve functional outcome and/or survival, reduce aspiration risk,

length of hospital stay, adverse events and complications and have an effect on nutritional status and on quality of life?

Based on the same search as for PICO 1 above 13 studies were analysed [15, 74, 80-90] (Table 4, supplement 3). Meta-analysis revealed that early screening for PSD was related to a reduced mortality at different points in time (acute hospital stay (OR 0.74 [0.61, 0.89], 1 year (0R 0.94 [0.90, 0.97]), whereas there was a trend for reduced mortality at 1 months (OR 0.66 [0.42, 1.02]) and 6 months (OR 0.51 [0.26, 1.03]).

Most studies available concerning this PICO question addressed the issue of pneumonia. Here, a significant reduction in pneumonia risk (9% vs. 15%) related to early dysphagia screening was identified by the meta-analysis summarising the evidence from 10 studies and 96367 patients (OR 0.45 [0.35, 0.58]). Finally, early dysphagia screening was also associated with a reduced LOS (MD -2.27 [-3.12, -1.43]), whereas all other endpoints had too few studies to provide reliable conclusions based on further meta-analyses. As already mentioned above, quality of evidence was generally low, because no randomized-controlled trials have been conducted in this area. The two most influential studies with regards to this PICO question were derived from prospective stroke registries based on comparatively large cohorts. Based on the analysis of 12276 patients, Al-Khaled et al. found that dysphagia screening within 24 hours after admission was independently associated with a reduced risk of pneumonia (OR 0.68 [0.52, 0.89]) and disability at discharge (OR 0.60 [0.46, 0.77]) when compared to no or later screening [15]. Bray and co-workers analysed data from 63500 acute stroke patients [74]. Dysphagia screening was performed 2.9 hours (median [IQR 1.3–5.7h]) after admission and the incidence of pneumonia was 8.7%. One of this study's main findings was an association between delays in dysphagia screening and incidence of pneumonia with patients with the longest delays in screening (fourth quartile, ≥345 minutes delay) having

36% higher odds of pneumonia as compared to those in the first quartile (0-79 minutes delay).

3. In patients with acute stroke does dysphagia screening with multiple consistencies compared to screening with single consistencies improve functional outcome and/or survival, reduce aspiration risk, length of hospital stay, adverse events and complications, and have an effect on nutritional status and/or quality of life?

Apart from water-screening tests, which are the most commonly used methods to screen for dysphagia in acute stroke and which provide a binary test results (i.e. fail or pass), there are also screening tests available that use more than one consistency for screening. These multi-consistency-tests therefore allow for a graded stepwise rating of swallowing impairment and usually add dietary recommendations to their risk assessments. Thus, the Gugging Swallowing Screen (GUSS) sequentially evaluates the patient's ability to swallow semisolid, liquid and solid boluses of increasing volumes. The test is terminated if clinical aspiration signs are observed. As a result of this test, dysphagia is graded into one of four categories (severe, moderate, mild or no dysphagia) and for each severity level a special diet and further strategies are recommended [82, 91, 92]. Similar to this approach, the volume-viscosity swallow test (V-VST) evaluates boluses of different volumes (5, 10, 20 ml) and viscosities (nectar-like, thin liquid, extreme spoon-thick) following a defined algorithm. In addition to swallowing safety (clinical aspiration signs) swallowing efficacy is also established (oral residue, piecemeal deglutition) [93-95]. In spite of the methodological differences between water-swallow-tests and multiple-consistency-tests, there are to date no comparative

studies that help to determine which approach might work better in the context of stroke. Therefore, no specific recommendation with regards to this PICO question could be made.

Recommendation 1: In all patients with acute stroke, we recommend a formal dysphagia screening test to prevent post-stroke pneumonia and decrease risk of early mortality. We recommend to screen the patients as fast as possible after admission. For screening, either water-swallow-tests or multiple consistency tests may be used.

Quality of evidence: Moderate ⊕⊕⊕

Strength of recommendation: Strong for intervention ↑↑

Recommendation 2: In patients with acute stroke, we recommend no administration of any food or liquid items, including oral medication, until a dysphagia screening has been done and swallowing was judged to be safe.

Quality of evidence: Moderate ⊕⊕⊕

Strength of recommendation: Strong for intervention ↑↑

Although the scientific quality of the single studies included in the mentioned meta-analyses was mostly judged to be low with risk of bias, the authors decided, in line with the ESO-guideline standard operation procedure, to upgrade the summary rating of the quality of evidence because study results were generally consistent and the association between early screening and the respective complications was at least in part strong (OR <0.5) or even very strong (OR < 0.2) as shown in the separate meta-analyses [10]. In addition, the authors decided to upgrade the strength of recommendation because the risk of the intervention (dysphagia

screening) is judged to be very low so that its potential benefit clearly outweighs the associated risk of harm [10].

Nutritional screening

Malnutrition is present in about one quarter of stroke patients with studies reporting prevalence between 6 and 62% depending on the timing of assessment, patients' characteristics, and methods used [96]. Commonly patients will present with malnutrition on admission, while in others malnutrition develops during the further course of the disease [97-99]. Malnutrition has been shown to be associated with an excess in mortality, bad functional outcome, prolonged length of stay in hospital and increased healthcare costs [60, 100-102]. The aetiology of malnutrition in the context of stroke is heterogeneous and includes, apart from dysphagia, functional disability, impaired consciousness, perception deficits, cognitive dysfunction and depression [103].

The working-group formulated one PICO question.

1. In patients with post-stroke dysphagia does nutritional screening/assessment compared to no nutritional screening/assessment improve functional outcome and/or survival, reduce aspiration risk, reduce length of hospital stay, reduce adverse events and complications, improve swallowing status/function, have an effect on nutritional status, and have an effect on quality of life?

Our literature search did not find any comparative studies pertinent to this question. However, with regards to the applicability in the clinical routine the Nutritional Risk Screening (NRS 2002) [104] and the Malnutrition Universal Screening Tool (MUST) [105] are

proposed by two different guidelines [59, 60] and have been used extensively in stroke patients in prospective cohort studies [100, 106, 107].

Therefore, the authors agreed on the following expert opinion that takes into account the recommendation of two guidelines dedicated to the topic of nutrition[59, 60].

Expert opinion: There is consensus among the guideline group (15/15) that patients with acute stroke should be screened for nutritional risk within the first days after hospital admission using validated screening tools.

Part 3: Dysphagia Assessment

In contrast to aspiration screening, dysphagia assessment provides a more comprehensive picture about the specific swallowing impairment. Therefore, any dysphagia assessment usually offers a graded evaluation of dysphagia severity, incorporates recommendations targeting protective and rehabilitative strategies and allows for a monitoring of the patient's swallowing ability during the further clinical course [59].

In the context of stroke, dysphagia assessment is usually based on a clinical swallow examination (CSE) and/or VFSS or FEES. In brief, the CSE involves an examination of the oral cavity and the caudal cranial nerves. Subsequently, different food items are tested, and, in case of abnormal findings, manoeuvres are introduced to improve swallowing safety and efficacy. For documentation and interpretation of these evaluations different protocols are available [108, 109]. Although CSE is widely used in the clinical context, its validity has been questioned frequently [110-113]. Therefore, additional procedures, such as cough reflex testing, swallow-provocation test or peak-flow measurement have been introduced to assess, in particular, aspiration risk and risk of pneumonia [114-117]. VFSS dynamically visualizes the oral, pharyngeal and oesophageal phases of swallowing. VFSS provides a comprehensive assessment of swallowing, determining not only whether the patient is aspirating but also why. Furthermore, it allows for experimentation with different textures, postures and manoeuvres suggested to improve the safety and efficiency of the swallow [118]. Apart from determining specific parameters like "oral transit time", "pharyngeal transit time" or "laryngeal vestibule closure time" [119-121], VFSS also allows for a global rating of swallowing function by aggregating a number of single items to a sum score. To this end, the Modified Barium Swallow Study Impairment Profile (MBSImP©™) [122], which results from combined rating of 17 parameters, has been introduced into practice and received first clinical testing

[123]. FEES is an instrumental assessment of swallowing using a flexible nasolaryngoscope which is passed through the nares, over the velum into the pharynx. FEES is used to assess the pharyngeal swallow and to derive indirect signs of impairments of the oral and oesophageal stages of deglutition [124]. The merits of FEES are that (i) it can be performed at the bedside, thus facilitating examination of severely motor-impaired, bedridden or uncooperative patients; (ii) follow-up examinations can be performed at short notice and, if necessary, frequently; (iii) oropharyngeal secretion management and efficacy of clearing mechanisms, such as coughing and throat clearing, can be assessed simply and directly; and (iv) pharyngeal sensation can be directly tested [125].

In addition to the PICO questions and related conclusions given below, this guideline adopts the following recommendations from other guidelines because of its clinical impact.

1. Following the suggestion of other guidelines [59, 60], stroke patients should be subjected to a dysphagia assessment if they have failed the dysphagia screen. Regardless of the outcome of the initial screening, a dysphagia assessment is also recommended in patients presenting with pertinent clinical risk factors for PSD or its complications, in particular severe dysarthria, aphasia, facial palsy, cognitive impairments and increased stroke severity (NIH-SS ≥ 10 points) [26, 36, 126-131].
2. Taking into account the conclusion of a review focused on pharmacotherapy and dysphagia [132] and a recent guideline on neurogenic dysphagia [133] pill swallowing should be routinely evaluated as part of dysphagia assessment. Taking oral medication, especially swallowing tablets, is difficult for many patients with dysphagia. In addition to aspiration and the resulting complications and discontinuation of medication, unsuitable modification of the oral medication can often be observed (e.g. crushing, breaking, and opening of tablets and capsules),

which may lead to numerous problems, such as decreased accuracy of dose, increased toxicity, reduced stability, and alteration of pharmacokinetics [134]. Therefore, in stroke patients who are usually required to take oral medication, swallowing of tablets should be routinely evaluated and the optimal formulation (if available) should be identified [132].

The working group formulated 6 PICO questions. Because these questions are closely related, an overall conclusion is given at the end of this section after the sixth PICO question has been discussed.

1. In patients with acute and/or subacute stroke does full clinical and instrumental assessment compared to no assessment improve functional outcome and/or survival, reduce aspiration risk, reduce length of hospital stay, reduce adverse events and complications, have an effect on nutritional status, and/or have an effect on quality of life?

Out of 5574 items our literature search resulted in no studies with data pertinent to this question.

2. In patients with acute and /or subacute stroke does early assessment for dysphagia compared to late assessment improve functional outcome and/or survival, reduce aspiration risk, reduce length of hospital stay, reduce adverse events and complications, have an effect on nutritional status, and/or have an effect on quality of life?

Based on the same search as for PICO 1 in this section, we detected 2 NRCTs that addressed this question [74, 85]. In a multicentre prospective cohort study CSE was done in 38.6% of 63 650 acute stroke patients after a median time of 22.9 hours (IQR 6.2–49.4 hours) after admission [74]. The authors found a strong independent relationship between delay in

dysphagia assessment and incidence of pneumonia. Delays in SLT assessment were associated with an absolute increase in the risk of pneumonia of 3% over the first 24 h. Delays in CSE beyond 24 h were associated with an additional 4% absolute increase in pneumonia. Dhufaigh and co-workers showed in a retrospective chart review that stroke patients receiving clinical dysphagia assessment within 48 hours after admission had significant fewer respiratory tract infections than patients seen thereafter [85].

3. In patients with acute and /or subacute stroke do repeated assessments compared to single assessments improve functional outcome and/or survival, reduce aspiration risk, reduce length of hospital stay, reduce adverse events and complications, have an effect on nutritional status, and/or have an effect on quality of life?

Based on the same search as for PICO 1 in this section we did not find any study pertinent to this question.

4. In patients with stroke does clinical bedside assessment compared to instrumental assessment improve functional outcome and/or survival, reduce aspiration risk, reduce length of hospital stay, reduce adverse events and complications, have an effect on nutritional status, and/or have an effect on quality of life?

Based on the same search as for PICO 1 in this section we found 2 NRCTs pertinent to this question [135, 136]. Bax and co-workers showed in a pre-post-comparison that after implementation of a FEES-service nearly 40% of stroke patients were assessed with this tool as opposed to 6.4% before [135]. In conjunction with this, the mean time to investigation decreased from 10.5 days to 2.3 days. With regards to clinical endpoints, after improving access to FEES, pneumonia rate significantly dropped from 12.3% to 6.4% (OR 2.06 [1.05, 4.04]) and the proportion of patients being on a normal diet at discharge significantly

increased from 51.1% to 65.6% (0.47 [0.31, 0.71]), while length-of-stay (LOS) in hospital also significantly increased from 15.2 to 20.2 days (Table 5, supplement 4) [135]. Radhakrishnan et al. recruited a small cohort of tube-fed chronic stroke patients and showed that FEES and CSE substantially varied with regards to both rating of dysphagia severity and suggested feeding strategy [136].

In addition to these two studies, three additional trials, which were methodologically not suitable for inclusion in this meta-analysis, should briefly be addressed here. The benefit of using FEES in acute stroke patients in addition to CSE has been explored in a recent prospective observational study recruiting 152 acute stroke patients with FEES having been performed in median 6 days after admission [137]. Amongst other issues this study investigated whether the feeding strategy determined by the CSE was found to be appropriate when compared to FEES. Remarkably, FEES confirmed the chosen feeding strategy in less than one third of patients, but no information regarding health outcomes was collected. Based on FEES results 31.6% of patients needed a more restricted diet, while in 37.5% a more liberal diet was possible [137]. The multicentre FEES-registry study, that recruited 2401 patients with different neurological diseases with stroke being the most frequent one (61%), demonstrated a comparable result [138]. VFSS has been employed in a retrospective observational study that also focused on feeding strategy [139]. In that study VFSS was done close to two weeks post stroke and only tube-fed patients were recruited. Removal of the nasogastric tube and start of an oral diet was suggested by VFSS in 199 out of 499 patients. During follow-up only 5 patients developed pneumonia, showing that swallowing safety had adequately been assessed by VFSS [139].

5. In patients with acute and/or subacute stroke does instrumental assessment with VFSS compared to FEES improve functional outcome and/or survival, reduce aspiration risk,

reduce length of hospital stay, reduce adverse events and complications, have an effect on nutritional status, and/or have an effect on quality of life?

Based on the same search as above, we found one study related to this topic. Aviv randomized 126 dysphagic patients seen in an outpatient setting to receive either VFSS or FEES for swallowing evaluation to guide dysphagia management [140]. Primary endpoint was pneumonia during follow-up. Chronic stroke represented the largest subgroup in this study (N=45). Pneumonia was diagnosed more frequently in stroke patients managed with VFSS (7 out of 24) than with FEES (1 out of 21) (OR 8.24 [0.92, 73.79]), however this difference was not significant (p=0.06) (Table 6, supplement 4).

6. In patients with acute and / or subacute stroke do complementary assessments to clinical assessments (i.e. spirometry, EMG) compared to standard clinical assessment improve functional outcome and/or survival, reduce aspiration risk, reduce length of hospital stay, reduce adverse events and complications, have an effect on nutritional status, and/or have an effect on quality of life?

Based on the same search as above, we found one study pertinent to this topic. Miles and co-workers evaluated whether the implementation of cough reflex testing reduces pneumonia incidence and other outcomes in a cohort of acute stroke patients [141]. In a multicenter randomized controlled trial with a follow-up period of 3 months 312 patients were randomized to either CSE alone or CSE plus cough reflex testing. This study did not find significant differences between both groups with regards to rate of pneumonia (OR 1.26 [0.75, 2.14]), mortality (OR 0.64 [0.35, 1.18]), discharge destination, length of stay in hospital (OR 1.00 [-0.16, 2.16]) and type of diet at 3 months (OR 0.20 [-0.08, 0,48]) (Table 7, supplement 4). Patients receiving the study intervention were significantly more frequently

submitted to instrumental swallowing evaluation. Therefore, this trial could not confirm a prior cohort study, which featured a significantly lower incidence of pneumonia in stroke patients treated in a hospital using cough reflex testing than in stroke patients treated in another hospital that had not embedded this tool in the dysphagia management algorithm [114].

Recommendation 3: We suggest a dysphagia assessment in all stroke patients failing a dysphagia screening and/or showing other clinical predictors of post-stroke dysphagia, in particular a severe facial palsy, severe dysarthria, severe aphasia or an overall severe neurological deficit (NIH-SS ≥ 10 points). Dysphagia assessment should be done as soon as possible. In addition to the clinical swallow examination, VFSS, or, preferentially, FEES should be available.

Quality of evidence: Low ⊕⊕

Strength of recommendation: Weak for intervention ↑?

Recommendation 4: We suggest that in acute stroke patients swallowing of tablets should routinely be evaluated as part of dysphagia assessment in addition to assessing the swallowing of liquid and different food consistencies and quantities.

Quality of evidence: Low ⊕⊕

Strength of recommendation: Weak for intervention ↑?

There were only a small number of studies included in the different meta-analyses pertinent to this topic. In addition, the scientific quality of these studies was generally judged to be low with risk of bias. However, since the risk of the intervention, i.e. dysphagia assessment, is judged to be very low so that its potential benefits outweighs the associated risks, a

positive recommendation seems warranted [10]. Since instrumental assessment is superior to the clinical swallowing evaluation, at least one of those techniques should be available with FEES being probably more useful and easier to apply than VFSS in the context of acute stroke.

4. Treatment of post-stroke dysphagia

Mirroring the prognostic importance of PSD there is a significant body of literature dealing with a variety of different treatment strategies for this debilitating condition. The therapeutic armamentarium has been steadily growing over the last decades and consists of dietary and nutritional interventions, behavioural treatment, dedicated oral health care, different pharmacological treatment options and peripheral or central neurostimulation strategies. In spite of undeniable progress in this notoriously difficult clinical field a Cochrane review from 2018 - mainly focusing on the outcomes of death and dependency, did not find sufficient evidence to recommend any of these interventions [142]. This guideline devotes 12 PICO questions pertinent to this topic.

4a Dietary interventions

The use of texture-modified foods and thickened liquids has become a cornerstone of clinical practice to address PSD. The principle behind this approach arises from the assumption that modifying the properties of normal foods and liquids will make them safer and easier to swallow [143]. In particular with regards to liquid thickening, several studies [144-146], two systematic reviews [143, 147] and one white paper [148] examined the physiological implications of this intervention and concordantly showed that with increasing levels of viscosity the risk of airway penetration and aspiration is reduced. Recent studies demonstrated the specific range of viscosity values providing this effect on safety of swallow in poststroke patients [145, 149]. On the other hand, liquid thickening seems to increase the risk of post-swallow residue indicating less effective bolus propulsion [143, 147, 148]. Of late, studies suggest that this detrimental effect may be ameliorated with gum-based thickeners [145, 149]. For decades there

were no established and universally used terminology and definitions to describe the target consistency recommended for dysphagic patients and to guide its preparation [143]. Therefore, the comparability of studies performed and the validity of conclusions reached in this area are principally limited to date. Several countries have developed their own taxonomies or classification systems [150]. Only recently two different systems have been proposed, the "International Dysphagia Diet Standardization Initiative" and the ESSD labelling system [151, 152].

The working-group formulated two PICO-questions.

In patients with post-stroke dysphagia does texture diet modification compared to no texture diet modification improve functional outcome and/or survival, reduce aspiration risk, reduce length of hospital stay, reduce adverse events and complications, improve swallowing status/ ability, have an effect on nutritional status, and have an effect on quality of life?

And:

In patients with post-stroke dysphagia, does fluid thickening compared to no fluid thickening, improve functional outcome and/or survival, reduce aspiration risk, reduce length of hospital stay, reduce adverse events and complications, improve swallowing status/ ability, have an effect on nutritional status, and have an effect on quality of life?

Out of 2624 abstracts screened, the meta-analysis included 6 RCTs [153-158] and 3 NRCTs [159-161]. Since many studies combined interventions with texture modified food and liquid thickening and the overall number of RCTs is comparatively low, this meta-analysis does not target each intervention separately. Overall, dietary modifications were associated with a trend for a decreased risk of pneumonia (RR 0.19 [0.03, 1.40], p=0.1, Table 8, supplement 5). Data on

mortality and functional outcome were rarely provided. In addition, several studies reported a reduced fluid and nutritional intake in patients receiving a modified diet and/or thickened liquids [156, 157, 159-161]. Although not dedicated to the population of stroke patients, the largest RCT in this field should be briefly mentioned here. Robbins and co-workers recruited more than 500 patients with dysphagia due to Parkinsonism or dementia and proven aspiration on thin liquids. Patients were randomized to thickened liquids or treatment with the chin-down posture and normal liquids. There was no difference in the incidence of pneumonia between both groups during a three-months follow-up (9.8 vs. 11.6%) [162].

Recommendations 5: In patients with post-stroke dysphagia, we suggest that texture modified diets and/or thickened liquids may be used to reduce the risk of pneumonia.

Quality of evidence: Low ⊕⊕

Strength of recommendation: Weak for intervention ↑?

Recommendation 6: In patients with post-stroke dysphagia, we recommend that texture modified diets and/or thickened liquids are prescribed only based on an appropriate assessment of swallowing.

Quality of evidence: Low ⊕⊕

Strength of recommendation: Strong for intervention ↑↑

Recommendation 7: In stroke patients put on texture modified diet and/or thickened liquids we recommend to monitor fluid balance and nutritional intake.

Quality of evidence: Moderate ⊕⊕⊕

Strength of recommendation: Strong for intervention ↑↑

The number of trials included in the different meta-analyses pertinent to this topic is low and the scientific quality of most studies was judged to be low with risk of bias. On the other hand, similar risks of the intervention (texture modified diet and liquid thickening) have been described across several albeit small trials. To adequately balance benefits and risks of the intervention a cautious positive recommendation was supplemented by two strong recommendations addressing precautions when implementing the intervention into the daily clinical routine.

4.b Behavioural interventions

Exercises and manoeuvres probably constitute the most widespread treatment approach for patients with dysphagia of different aetiologies worldwide. A variety of different interventions exist, ranging from direct to indirect, isolated to combined and those incorporating swallowing and non-swallowing tasks. Rehabilitation exercises, such as the Shaker head lift (targeting patients with impaired opening of the upper esophageal sphincter) [163], the Masako manoeuvre (intended to strengthen base of the tongue and pharyngeal wall movement) [164] or expiratory muscle strength training (EMST; used for strengthening the expiratory and submental muscles) [165] are intended to change and improve the swallowing physiology in force, speed or timing and are meant to produce long-term effects. In contrast to this, compensatory interventions like the Chin-down posture (designed to reduce the risk of aspiration in patients with premature spillage) [166] or the Mendelsohn manoeuvre (adopted in patients with impaired laryngeal excursion) [167] are used for short-term effects on the swallow [168]. Finally, acupuncture is an ancient Chinese medical

technique which has been a common therapy for stroke and many of its different clinical sequelae in China [169].

The working-group formulated one PICO-question.

In patients with post-stroke dysphagia do behavioural swallowing exercises compared to no treatment improve functional outcome and/or survival, reduce aspiration risk, reduce length of hospital stay, reduce adverse events and complications, improve swallowing status/ ability, have an effect on nutritional status, and have an effect on quality of life?

Based on the same search as mentioned above (see 4a), 24 RCTs [25, 165, 170-192] and 3 NRCTs [193-195] were included in this meta-analysis. In addition, 27 RCTs dedicated to acupuncture have been analysed separately [196-222]. For all different techniques including acupuncture, the meta-analysis revealed an improvement of dysphagia severity, which, in a smaller proportion of trials, was also reflected by an upgrade of the feeding strategy (Tables 9 and 10, supplements 6 and 7). 6 RCTs including more than 600 patients showed a significant reduction of pneumonia (RR 0.57 [0.43, 0.75]), whereas no effect on functional outcome and mortality was observed. For acupuncture no effect on the incidence of pneumonia was observed (RR 0.40 [0.08, 1.98]), while quality of life indicators (RR 32 [24.99, 39.01]) were improved and removal of a feeding tube was more likely with acupuncture than with sham treatment (RR 1.79 [1.27, 2.53]).

In contrast to most interventions, which were tested in smaller single-centre trials, the study of Carnaby and co-workers stood out and had a strong impact on the mentioned findings [171]. In this multicentre RCT the change of dietary status after usual care (N = 102), standard low-intensity intervention (N = 102) and standard high-intensity intervention (N = 102) was compared. After six months, the percentage of patients returning to a normal diet was 56%

for usual care, 64% for standard low-intensity and 70% for standard high-intensity treatment. In patients who received standard therapy (either low or high intensity) medical complications, chest infections and death or institutionalization decreased significantly.

Recommendation 8: In patients with post-stroke dysphagia, we suggest behavioural swallowing exercises to rehabilitate swallowing function.

Quality of evidence: Moderate ⊕⊕⊕

Strength of recommendation: Weak for intervention ↑?

Recommendation 9: In patients with post-stroke dysphagia, we suggest that behavioural interventions should not be limited to one specific manoeuvre or training, but the treatment should be tailored to the specific swallowing impairment of the individual patient based on a careful assessment of dysphagia.

Quality of evidence: Moderate ⊕⊕⊕

Strength of recommendation: Weak for intervention ↑?

Recommendation 10: In patients with post-stroke dysphagia, we suggest that acupuncture may be used to rehabilitate swallowing function.

Quality of evidence: Moderate ⊕⊕⊕

Strength of recommendation: Weak for intervention ↑?

The number of trials included in the different meta-analyses pertinent to this topic is, in part, quite high and most results of single trials have a similar trend. The scientific quality of most

studies was judged to be low with risk of bias. The only exception was a multicentre-trial employing a comprehensive behavioural swallowing intervention with different techniques in dysphagic stroke patients.

4c Nutritional interventions

Malnutrition either already present prior to stroke onset or developing thereafter, has been identified as key risk factor for increased mortality, worse functional outcome, prolonged length of stay in hospital and higher healthcare costs [60]. In the clinical context, timing of nutritional therapy after stroke and the route of artificial feeding when required are the most important topics here.

The WG has formulated two PICO questions. Because these questions are closely related, an overall conclusion is given at the end of this section after the second PICO question has been discussed.

In patients with post-stroke dysphagia does early initiation of oral nutritional therapy compared to late initiation of nutritional therapy improve functional outcome and/or survival, reduce aspiration risk, reduce length of hospital stay, reduce adverse events and complications, improve swallowing status/function, have an effect on nutritional status, and have an effect on quality of life?

Based on the same search as mentioned above (see 4a), five RCTs were included in the meta-analysis [223-227]. These studies used oral supplementation either in unselected [223] or selected stroke patients, in particular those with impaired cognition or with a risk of or manifest malnutrition [224-227]. Generally, these studies focused on patients free of severe

dysphagia that would have precluded oral intake. The meta-analysis showed no effect of nutritional therapy on the key outcomes, namely mortality (RR 0.88 [0.57, 1.37]), functional status (independence) (RR 0.98 [0.91, 1.06]) or pneumonia (RR 1.12 [0.88, 1.42]) (Table 11, supplement 8). This result was mainly driven by the first sub-study of the FOOD (feed or ordinary diet) trial that randomized more than 4000 patients to normal hospital diet or normal hospital diet plus oral nutritional supplements, which failed to show significant differences in any of the outcome parameters including among others mortality, functional status and in-hospital complications [223, 228]. Contrasting with this, the subgroup of smaller studies recruiting selected stroke patients showed an impact of the intervention on different nutritional parameters (Table 11, supplement 8).

In patients with post-stroke dysphagia does early enteral or parenteral feeding compared to late or restrictive enteral or parenteral feeding improve functional outcome and/or survival, reduce aspiration risk, reduce length of hospital stay, reduce adverse events and complications, improve swallowing status/ability, have an effect on nutritional status, and have an effect on quality of life?

Based on the same search as mentioned above (see 4a), we included 2 RCTs in the meta-analysis [229, 230]. Available studies employed feeding via a nasogastric tube as intervention. This current meta-analysis revealed a trend for a reduction of mortality with early enteral nutrition (RR 0.88 [0.76, 1.02], p=0.09) (Table 12, supplement 8); however, tube feeding was associated with a trend towards more gastrointestinal bleedings (RR 2.00 [0.98, 4.08], p=0.06). This result was mainly driven by the second sub-study of the FOOD (feed or ordinary diet) trial that randomized dysphagic stroke patients to either tube feeding or delayed feeding started later than 7 days from randomization [228, 229]. Allocation to early tube feeding was related to a non-significant reduction of mortality by 5.8% (p=0·09) and a higher

rate of gastrointestinal bleedings, whereas there were no differences with regards to other outcomes including functional status, pneumonia and PEG-placement at follow-up. The third sub-study of the FOOD trial, which was not part of this meta-analysis due to its different focus, compared early feeding via a nasogastric tube with early feeding via a percutaneous endoscopic gastrostomy (PEG) tube [228, 229]. While there was no difference in mortality between both groups, the combined endpoint of death or disability was less frequently seen in patients being started on NG tube-feeding. Additionally, there was an increase in pressure sores in the PEG-group.

Recommendation 11: In unselected stroke patients, we suggest to avoid routine use of oral nutritional supplementation.

Quality of evidence: Moderate ⊕⊕⊕

Strength of recommendation: Weak against intervention ↓?

Recommendation 12: In stroke patients who tolerate an oral diet and present with a risk of malnutrition or with manifest malnutrition, we suggest to consider the use of oral nutritional supplementation.

Quality of evidence: Low ⊕⊕

Strength of recommendation: Weak for intervention ↑?

Recommendation 13: In patients with post-stroke dysphagia and insufficient oral intake we suggest an early enteral nutrition via a nasogastric tube.

Quality of evidence: Moderate ⊕⊕⊕

Strength of recommendation: Weak for intervention ↑?

There were only a small number of high-quality studies available, which mostly did not provide an unequivocal answer to the respective research question. Most studies recruited a limited number of patients and their scientific quality was generally judged to be low with risk of bias. However, since the risks of the interventions, i.e. oral nutritional supplementation and tube feeding, are judged to be low so that its potential benefits outweigh the associated risks, a positive recommendation seems warranted [10].

4d Interventions to improve oral health

In particular in stroke patients and geriatric patient cohorts poor oral health in combination with dysphagia has been identified as a dominant risk factor for aspiration pneumonia [231-234]. In addition to periodontitis, gingivitis, plaque formation and caries, respiratory pathogens such as Staphylococcus aureus, Streptococcus pneumoniae, Haemophilus influenzae, Klebsiella oxytoca, Pseudomonas aeruginosa and Escherichia coli have frequently been detected in the oral cavity of these patients [234, 235]. The aspiration of bacterial contaminated saliva is therefore considered to be the main pathogenic mechanism of pulmonary infections in severely dysphagic stroke patients fed via a gastric tube [128, 236]. In order to avoid aspiration-related respiratory infections, interventions to improve oral health are considered as therapeutic option in this patient cohort.

The working-group formulated one PICO-question.

In patients with post-stroke dysphagia does specific oral health care compared to standard care improve functional outcome and/or survival, reduce aspiration risk, reduce length of hospital stay, reduce adverse events and complications, improve swallowing status/ ability, have an effect on nutritional status, and have an effect on quality of life?

Based on the same search as mentioned above (see 4a), 4 RCTs [237-240] and 4 NRCTs [84, 241-243] were included in the meta-analysis. The interventions to improve oral health mostly consisted of different oral care protocols including mechanical cleaning and mouth rinsing, in part with additional antimicrobial agents added [84, 237]. One study specifically focused on the eradication of oral pathogens using a mixture of different non-absorbable antibiotics and antimycotics ("selective oral decontamination") [238]. Most trials used different oral health scales and pneumonia as key outcome parameters. Our meta-analysis revealed that RCTs dedicated to oral health interventions were associated with a trend towards a reduction of pneumonia (RR 0.14 [0.02, 1.11], p=0.06), a significant reduction in tube feeding (RR 0.43 [0.28, 0.65]) and a significant improvement of oral health conditions (SMD -1.27 [-2.26, -0.28]) (Table 13, supplement 9). Other endpoints pertinent to this meta-analysis, in particular mortality and functional outcome were rarely evaluated and not systematically influenced by this intervention across in RCTs.

Recommendation 14: In stroke patients we suggest to implement oral health care interventions to reduce the risk of pneumonia.

Quality of evidence: Low ⊕⊕

Strength of recommendation: Weak for intervention ↑?

There were only a small number of studies available and the scientific quality of these studies was generally judged to be low with risk of bias. However, since the risk of the intervention, i.e. oral health care, is judged to be very low so that its potential benefits outweighs the associated risks, a positive recommendation seems warranted [10].

4e Pharmacological treatment

Pharmacological treatment options of PSD involve the use of drugs that stimulate the neural pathways of deglutition either on the peripheral sensory level or at different levels of the central nervous system [132]. Classes of pharmacological agents that have been evaluated for their potential to improve disordered swallowing are TRPV1 (transient receptor potential cation channel subfamily V member 1) agonists, angiotensin-converting-enzyme-inhibitors and dopaminergic agents. TRPV1, TRPA1 (transient receptor potential cation channel, subfamily A, member 1), and TRPM8 (transient receptor potential cation channel subfamily M, member 8) agonists, in particular capsaicinoids (TRPV1 agonist), piperine (dual TRPV1 and TRPM8 agonist), and menthol (TRPM8 agonist), stimulate the respective receptors expressed at free nerve endings of the superior laryngeal nerve and the glossopharyngeal nerve [244] and increase salivary substance P levels, a neurotransmitter which is released from sensory nerve terminals in the pharynx and which is intimately involved in the control of deglutition [132]. ACE inhibitors are widely used antihypertensive drugs that can cause a dry cough as a side-effect. One of the mechanisms for this side-effect is the decreased degradation of substance P, which implies that any effect of this drug group on the act of deglutition may be due to a similar mechanism as has been suggested for TRPV1 agonists. With regards to dopaminergic agents the mechanism of action with regards to a potential effect on dysphagia has not been elucidated. However, loss of dopaminergic neurons in the central nervous system because of stroke or neurodegenerative diseases is known to contribute to dysphagia and is associated with a decreased swallow reflex [245].

On the other hand, intravenous application of different broad-spectrum antibiotics has been used to prevent infectious complications, in particular aspiration pneumonia [246]. Finally,

prokinetic drugs have been used in tube-fed dysphagic stroke patients to prevent reflux and concomitant aspiration [60].

The working group formulated one PICO question.

1. In patients with post-stroke dysphagia, does pharmacological treatment compared to no treatment improve functional outcome and/or survival, reduce aspiration risk, reduce length of hospital stay, reduce adverse events and complications, improve swallowing status/ ability, have an effect on nutritional status, and have an effect on quality of life?

Based on the same search as mentioned above (see 4a), we included 24 RCT [121, 247-270] and 9 NRCT in the meta-analysis [271-279] (Table 14, supplement 10). For all three types of pharmacological agents targeting the swallowing network, the meta-analysis revealed significant effects on swallowing physiology, in particular a shortening of the pharyngeal swallow response, that likely contributed to an improved swallowing safety. However, these promising findings have rarely been supported by studies looking for clinical endpoints. Apart from one smaller trial using a combination of ACE-inhibitors and Amantadine in a cohort of geriatric stroke victims with pneumonia our meta-analysis did not show an effect of either of these drugs on mortality. With regards to the endpoint pneumonia, results have been somewhat more promising but remain ambiguous. While in nonrandomized trials a significant reduction of this complication has been observed for ACE inhibitors (RR 0.60 [0.51, 0.70]) and TRPV1 agonists (RR 0.31 [0.15, 0.66]), this was not confirmed by the meta-analysis of RCTs. With regards to dopaminergic drugs, Nakagawa and co-workers showed in a comparatively large RCT (n=163) that treatment with amantadine compared to placebo significantly decreased the rate of pneumonia in patients post stroke over the study period of three years (RR 0.22 [0.09, 0.55]) [259].

Preventive antimicrobial treatment has been evaluated in 7 RCTs recruiting 4301 patients. According to our meta-analysis there is no effect on the key endpoints mortality, functional outcome and pneumonia (Table 14, supplement 10).

The prokinetic drug metoclopramide has been evaluated in a phase II RCT in tube-fed stroke patients. Treatment with metoclopramide was associated with a significant reduction of pneumonia (RR 0.31 [0.17, 0.57]) [265].

Recommendation 15: We recommend that due to the limited evidence available with regards to clinical endpoints, pharmacological treatment of post-stroke dysphagia should be preferably used within clinical trial settings.

Quality of evidence: low ⊕⊕

Strength of recommendation: Strong for intervention ↑↑

Recommendation 16: We recommend that preventive antimicrobial treatment is not used in stroke patients.

Quality of evidence: High ⊕⊕⊕⊕

Strength of recommendation: Strong against intervention ↓↓

Recommendation 17: In stroke patients with post-stroke dysphagia and an impaired swallow response, we suggest to consider TRPV1 agonists and dopaminergic agents to improve swallowing safety. Quality of evidence: Low ⊕⊕

Strength of recommendation: Weak for intervention ↑?

Recommendation 18: In stroke patients fed via a nasogastric tube, we suggest to use metoclopramide to promote gastric emptying and reduce the risk of esophago-pharyngeal regurgitation with subsequent aspiration.

Quality of evidence: Low ⊕⊕

Strength of recommendation: Weak for intervention ↑?

There were only a limited number of studies included in the different meta-analyses pertinent to this topic. In addition, the scientific quality of these studies was generally judged to be low with risk of bias. Since most results point to an effect of treatment a cautious positive recommendation seems warranted that includes the suggestion to preferably use the mentioned pharmacological options within trials.

4f Neurostimulation treatment

Neurostimulation techniques include transcutaneous electrical stimulation (TES), repetitive transcranial magnetic stimulation (rTMS), transcranial direct current stimulation (tDCS) and pharyngeal electrical stimulation (PES). TES is used to activate sensory nerves (SES = sensory transcutaneous electrical stimulation) or muscles (NMES = neuromuscular electrical stimulation) involved in swallowing function through stimulation of axonal motor nerve endings and muscle fibres. Its mechanism of action is thought to include promoting central nervous system recovery and accelerating the development of muscle strength. Non-invasive brain stimulation is based on the principle of neuroplasticity, best defined as changes in neuronal pathways to increase neural functioning via synaptogenesis,

reorganization, and network strengthening and suppression. The two most commonly used techniques to directly target cortical areas are tDCS and rTMS, whereas PES applies stimulation to pharyngeal structures, indirectly targeting the pharyngeal motor and sensory cortices and related brain areas and possibly also working on the peripheral sensory afferent system [60, 280]. All these treatments are usually used as adjunct to a given standard of care. Therefore, in most randomized trials pertinent to this topic a given neurostimulation method or the respective sham stimulation has been added to a specific behavioural swallowing intervention. In addition, in some studies, a three-arm design was adopted, where either two different interventions were compared against a sham condition or a combination of treatments were studied against each single intervention. To account for these differences in trial design, the WG formulated two PICO questions:

1. In patients with post-stroke dysphagia, do neurostimulation techniques compared to no treatment, improve functional outcome and/or survival, reduce aspiration risk, reduce length of hospital stay, reduce adverse events and complications, improve swallowing status/ ability, have an effect on nutritional status, and have an effect on quality of life?

2. In patients with post-stroke dysphagia, do neurostimulation techniques compared to behavioural treatments improve functional outcome and/or survival, reduce aspiration risk, reduce length of hospital stay, reduce adverse events and complications, improve swallowing status/ ability, have an effect on nutritional status, and have an effect on quality of life?

Based on the same search as mentioned above (see 4a), 35 RCTs [173, 281-314] and 6 NRCT [315-320] were included in the meta-analysis (Table 15, supplement 11). All trials reported data on swallowing performance using a variety of different scales and nearly all trials used a local

standard of care, mostly consisting of different behavioural swallow interventions as control. Most studies have been dedicated to different versions of TES, followed by rTMS, tDCS and PES. For most stimulation methods meta-analyses of RCTs revealed a significant improvement of swallowing function compared to sham stimulation (SMD 1.51 [0.60, 2.42] for rTMS, SMD 0.90 [0.60, 1.19] for TES, and SMD 0.75 [0.38, 1.12] for tDCS), for PES the treatment effect just failed to be significant (SMD 0.77 [-0.06, 1.60], p=0.07). Clinically more relevant endpoints, however, have been studied and achieved much rarer. Neurostimulation was associated with a modest impact on functional outcome. Two PES trials including 177 patients showed a significant impact of the intervention on the mRS (MD -0.33 [-0.63, -0.02]) and results from 4 rTMS trials including 86 patients showed an effect of the stimulation on the BI (MD 31.57 [27.75, 35.39]). No significant effect of neurostimulation on mortality, pneumonia and length of stay could be determined, whereas results on quality-of-life indicators, although less frequently studied, have been promising in part, in particular for TES. Finally, two RCTs targeted the subgroup of tracheotomized stroke patients with meta-analysis showing that PES was significantly associated with removal of the tracheal cannula (RR 4.64 [2.00, 10.79]). All these mentioned results of RCTs have generally been supported by non-randomized studies.

Recommendation 19: In patients with post-stroke dysphagia, we recommend that treatment with neurostimulation techniques should preferably be conducted within a clinical trial setting.

Quality of evidence: low ⊕⊕

Strength of recommendation: Strong for intervention ↑↑

Recommendation 20: In patients with post-stroke dysphagia, we suggest treatment with rTMS, TES, tDCS and PES as adjunct to conventional dysphagia treatments to improve swallowing function.

Quality of evidence: Moderate ⊕⊕⊕

Strength of recommendation: Weak for intervention ↑?

Recommendation 21: In tracheotomized stroke patients with severe dysphagia, we suggest treatment with pharyngeal electrical stimulation to accelerate decannulation.

Quality of evidence: High ⊕⊕⊕⊕

Strength of recommendation: Weak for intervention ↑?

The number of trials included into the different meta-analyses pertinent to this topic is, in part, quite high and most results of single trials have a similar trend which in most cases is also in line with results from non-randomized trials. In addition, reports of adverse events were very low, making these treatments safe to apply. The scientific quality of most studies was mostly judged to be low with risk of bias.

Discussion

This ESO and ESSD Guideline on PSD provides an in-depth guide for all members of the multidisciplinary team. This is one of the most rigorous meta-analysis in the field, adding a considerable body of evidence to previous publications and guidance with regards to screening, assessment, management, and factors that will affect PSD health outcomes (Table 16 provides a summary of recommendations). In addition, in two cases where the available

evidence was very limited and the topic in question of considerable clinical importance, recommendations of previously published guidelines were adopted.

It was clearly demonstrated that the presence of PSD impacts on nearly all the different levels of outcomes, ranging from mortality rate to quality-of-life. Acute as well as subacute PSD patients presented higher mortality rates, peaking at 1-month and 3 months post-stroke and endured longer hospital stay. Patients with PSD present a 7-fold higher incidence of pneumonia; the latter being well-documented to be responsible for up to one-third of post-stroke deaths [321]. Pneumonia rates in PSD was one of the most investigated endpoints within this meta-analysis (total of 28 studies and 108056 patients). Approximately half that number appeared in investigations on the effects of formal screening on pneumonia rates. Even though the evidence quality was low, screening for PSD was related to reduced risk of pneumonia (OR 0.55 [0.36, 0.83]) and a trend for reduced mortality in acute stroke patients screened for dysphagia.

Of interest, in the clinical setting in patients who fail the swallow screen, more detailed assessment of dysphagia is performed. We found that there was a small number of studies, judged of low quality with risk-of-bias, for the impact of routinely formal instrumental assessment on outcomes. Nevertheless, a positive recommendation was assigned here, because detailed instrumental studies benefit the decision-making process concerning route of feeding and the optimal therapeutic approach, thus outweighing any associated risks. Evidence shows that specific instrumental assessments, such as FEES performed at the bedside [322] can reduce pneumonia rates and increase functional outcomes [109, 131, 135, 323].

With regards to the management of PSD, evidence concerning the use of thickened liquids and modified diets to reduce pneumonia is weak and remains controversial, in keeping with others [324]. Although there is evidence showing that by increasing levels of viscosity the risk of

airway penetration and aspiration is reduced [143, 147, 148], and recent studies with gum-based thickeners showed the specific range of viscosity values providing this therapeutic effect on safety of swallow [145, 149], long term studies showing the clinical impact of fluid thickening in poststroke patients are clearly required. The heterogeneity in the studies evaluated here showed that there is probably a need for individualized assessment prior to prescription of thickened fluids and modified diet, which again should be monitored. Monitoring is important since there are several studies [155, 156, 159, 160] that showed that modification of food may result in nutritional compromise.

There is currently moderate level of evidence for the effects of behavioural therapy, including swallowing and non-swallowing tasks, on pneumonia rates and swallowing specific scores. Other strategies included oral health interventions, where a small number of low-quality studies was included. The landscape was similar for the pharmacological therapy, where ACE inhibitors showed a low likelihood for an effect on pneumonia rates following combination of RCTs and non-RCTs [12 studies – 10611 patients: OR 0.60 (0.51, 0.70)]. Yet, the prescription of specific medication should be evaluated in detail on stroke patients and the formulation should be decided upon their swallowing ability. Interestingly, the largest number of included studies was observed with neurostimulation treatment for PSD. Here, the nature of the treatments is shown to be very diverse including muscular stimulation as well as peripheral, central, or combined approaches. The heterogeneity was substantial, given that the outcome measures in the studies were diverse. Some techniques showed greater likelihood to impact on overall dysphagia and QOL scales, while others on overall functional scores (for example Barthel index) and decannulation. Here the recommendation is for the use of the techniques within a research context, in particular controlled trials, until further evidence surfaces.

Concerning early oral nutritional therapy (and supplementation) in PSD, even with the inclusion of 5 RCTs in this meta-analysis, we concluded that there is no evidence to routinely employ this intervention. However, nutritional supplementation could be considered for patients with manifest malnutrition or risk of malnutrition who can tolerate oral diet. The quality of evidence was somewhat stronger for the use of early enteral nutrition in severe PSD, but still there was no specific effect on pneumonia rates or other outcome measures. It was noteworthy that completion of this meta-analysis was particularly difficult given the high heterogeneity and different methodologies in the studies included. Also, there were only a few multicentre trials and few RCTs, indicating that further research is warranted. Inability to reach higher level of evidence in certain PICOs was partially due to the methodological insufficiencies. Moreover, there were different outcome measures utilised in the studies to either capture data or record functional change in PSD (imaging measurements like kinematics and swallowing durations versus functional scales, i.e. FOIS). There are also definition differences, i.e. for pneumonia and differences amongst the screening and assessment tools used. The large number of different screening tools published with varying levels of sensitivities and specificities could potentially impact on the level of evidence. Nonetheless, this extensive meta-analysis was completed with rigor and when there was limited evidence base, recommendation was made based on best available empirical support.

Current barriers for the application of the clinical guidelines in stroke units need to be taken into consideration. Of importance is the appropriate training of specified members of the multidisciplinary team on dysphagia screening and assessment procedures and the means to renew and update their knowledge at specified time points. Training is needed for the inclusion of the instrumental assessments (FEES, VFSS) in the clinics as well as business case

for their availability. Treatment and management procedures could face similar barriers to the above, such as training and availability, in particular in the means of availability on a daily basis for stroke patients.

Finally, future research in this field is warranted and consensus on the outcome and endpoints of the research studies is needed to allow for better clinical recommendations. Better designed studies will surface if the inclusion criteria in the trials are well-characterised, especially the time-window of the recovery phase for PSD, the control groups, and the definition of the usual and standard care. Regarding the outcome measures, functional as well as dysphagia specific measures should be included and consensus should be sought for the comparability of different methodologies and tools where required.

Table 1. Grading of outcomes

Scale	OUTCOME	Same level Outcomes	DEFINITIONS
9	Mortality	MRS	Critical for making a decision (included in evidence profile)
8	Complications (Malnutrition)	Respiratory tract infection	
7	Aspiration risk	Feeding strategy	
6	Swallowing function		
5	Length of stay in hospital	Nutritional measures, Weight loss/muscle loss	important, but not critical for making a decision (included in evidence profile)
4	Quality of life		
3	laboratory parameters linked to malnutrition		
2	Feeding tube failures and adverse events	Withdrawal of tube feeding, Costs	of limited importance for making a decision (not included in evidence profile)
1			

Table 2. Effect of dysphagia compared to no dysphagia on key outcomes

Outcome	Incidence (%)/ Mean±SD		Studies	n (N)	OR [95% CI]/ *MD [95% CI]*	I^2	P value
	Dysphagia	No dysphagia					
Mortality							
• **Mortality, hospital**	19%	1%	17, 30, 37, 41, 48, 49, 52, 55, 56 40, 55, 56	10(682884)	9.77 [5.45, 17.50]	96%	< 0.00001
• **Mortality, 3 months**	16%	1%	15, 17, 19, 32, 49, 51	5(13546)	9.02 [4.50, 18.09]	73%	< 0.00001
• **Mortality, 1 year**	42%	32%	20, 37, 46, 49-51, 54	7(10737)	8.82 [3.56, 21.85]	98%	< 0.00001
Pneumonia	22%	3%	7, 15-18, 21, 22, 24-29, 34, 35, 37-43, 45-50, 52, 56	31(767179)	7.45 [6.01, 9.24]	94%	< 0.00001
Tube feeding							
• **Nasogastric tube**	41%	1%	17, 37	2(8171)	93.74 [24.33, 361.14]	35%	< 0.00001
• **Percutaneous feeding tube**	9%	0.1%	17, 26, 37, 47	4(8446)	71.60 [34.38, 149.11]	0%	< 0.00001
mRS							
• **mRS 0, 1**	6%	30%	17, 37	2(5582)	0.20 [0.11, 0.35]	83%	< 0.00001
• **mRS ≥2**	76%	55%	15, 17, 37, 48	3(17858)	2.34 [1.24, 4.40]	98%	0.08
• **mRS 4,5**	52%	18%	37	1(5012)	5.03 [4.43, 5.72]	NA	< 0.00001
LOS							
• **LOS overall, days**	12.1±9.7	8.4±6.2	7, 15, 17, 20, 23, 26, 30, 37, 40, 46-49, 56, 57, 126	14(697614)	*4.72 [3.53, 5.91]*	99%	< 0.00001
• **LOS stroke unit, days**	4.4±3.0	2.7±2.4	17	1(570)	*1.70 [1.12, 2.28]*	NAs	< 0.00001
Discharge status							
• **Discharged home**	17%	67%	17, 28, 37, 40, 47, 49, 56, 126	8(678519)	0.17 [0.09, 0.35]	100%	< 0.00001
• **Discharged to Institution/ Palliative**	49%	26%	7, 17, 37, 46-48, 51, 56	7(665094)	3.90 [2.93, 5.21]	81%	< 0.00001
• **Discharged to long term care**	15%	5%	37, 56	2(663721)	1.95 [0.71, 5.32]	100%	0.19

• **Readmission, 1 year**	42%	54%	[49]	1(395)	0.62 [0.42, 0.93]	NA	0.02

CI: Confidence intervals; FOIS: Functional oral intake scale; I^2: Heterogeneity; LOS, Length of stay in hospital; MD: Mean difference; n: Number of studies; N: Number of patients; NIHSS: National Institute of Health Stroke Scale; p: Statistical significance value; OR: Odds Ratio; SD: Standard deviation

Table 3. Effect of screening compared to no screening on key outcomes

Outcome	Incidence (%)/ Mean±SD		Studies	n (N)	OR [95% CI]/ *MD [95% CI]*	I^2	P value
	Screening	No Screening					
Mortality							
• **Mortality, hospital**	2%	4%	[40, 71-73]	4(20806)	0.67 [0.45, 1.02]	57%	0.06
• **Mortality, 1 month**	10%	31%	[74, 76, 77]	3(66162)	0.57 [0.12, 2.80]	99%	0.49
Pneumonia	7%	10%	[15, 40, 47, 71-74, 76-80]	11(536650)	0.55 [0.36, 0.83]	99%	0.004
Nasogastric tube, insertion	44%	53%	[47, 71, 73]	3(459)	0.86 [0.51, 1.45]	0%	0.58
Endotracheal tube insertion	7%	9%	[71, 73]	2(260)	0.66 [0.27, 1.63]	0%	0.37
LOS, days	7.2±6.4	6.2±5.3	[40, 47, 71-73]	5(21005)	*0.02 [-2.22, 2.26]*	99%	0.99
Discharge							
• **Discharged home**	29%	33%	[40, 77]	2(20348)	0.84 [0.79, 0.90]	0%	< 0.00001
• **Discharged to Institution**	20%	19%	[77]	1(2334)	1.08 [0.86, 1.35]	NA	0.53
• **Skilled nursing facility**	14%	11%	[77]	1(2334)	1.27 [0.97, 1.66]	NA	0.09
• **Hospice**	2%	3%	[77]	1(2334)	0.78 [0.43, 1.39]	NA	0.39
• **Other hospitals**	6%	5%	[77]	1(2334)	1.28 [0.86, 1.92]	NA	0.23

CI: Confidence intervals; I^2: Heterogeneity; LOS, Length of stay in hospital; MD: Mean difference; n: Number of studies; N: Number of patients; p: Statistical significance value; OR: Odds Ratio; SD: Standard deviation; UTI: Urinary tract infection

Table 4. Effect of early screening compared to late screening on key outcomes

Outcome	Incidence (%)/ Mean±SD		Studies	n (N)	OR [95% CI]/ *MD [95% CI]*	I^2	P value
	Early Screening	Late Screening					
Mortality							
• **Overall**	15%	23%	[74, 81-84]	7(144307)	0.62 [0.43, 0.91]	99%	0.01
• **Mortality, hospital/ 7 days**	5%	6%	[81-83]	4(55969)	0.74 [0.61, 0.89]	75%	0.002
• **Mortality, 1 month**	11%	16%	[74, 83, 84]	5(140614)	0.66 [0.42, 1.02]	99%	0.06
• **Mortality, 1 year**	26%	27%	[83]	2(52276)	0.94 [0.90, 0.97]	0%	0.0009
Pneumonia	9%	15%	[15, 74, 80-82, 84-89]	10(96367)	0.45 [0.35, 0.58]	83%	< 0.00001
LOS, days	23.8±9.5	27.6±9.2	[81-84, 90]	6(56085)	*-2.27 [-3.12, -1.43]*	92%	< 0.00001
Barthel Index Score, discharge	17±43	12±28	[84]	1(116)	*5.00 [-8.21, 18.21]*	NA	0.46
Discharge							
• **Discharged home**	57%	53%	[83]	2(52276)	1.16 [1.08, 1.26]	79%	< 0.0001
• **Readmission**	2%	6%	[85]	1(138)	0.35 [0.06, 2.19]	NA	0.69
mRS							
• **mRS, 4-5**	28%	39%	[81]	1(3309)	0.59 [0.50, 0.71]	NA	0.00001

CI: Confidence intervals; I^2: Heterogeneity; LOS, Length of stay in hospital; MD: Mean difference; n: Number of studies; N: Number of patients; p: Statistical significance value; PEG: Percutaneous endoscopic gastrostomy; OR: Odds Ratio; SD: Standard deviation; LOS: Length of stay

Table 5. Effect of clinical bedside assessment compared to instrumental assessment on key outcomes

Outcome	Incidence (%)		Studies	n (N)	OR [95% CI] / *MD [95% CI]*	I^2	P value
	Clinical bedside assessment	Instrumental assessment					
Mortality	10.5%	7.3%	[135]	1(440)	1.49 [0.76, 2.90]	NA	0.24
Pneumonia	12.3%	6.4%	[135]	1(440)	2.06 [1.05, 4.04]	NA	0.04
Discharge, home	43.6%	46.4%	[135]	1(440)	0.90 [0.62, 1.30]	NA	0.57
Discharge, on standard diet	51.1%	65.6%	[135]	1(378)	0.47 [0.31, 0.71]	NA	0.004
LOS, days	17.3±15.2	23.7±20.2	[135]	1(440)	*-6.33 [-9.67, -2.99]*	NA	0.0002

CI: Confidence intervals; I^2: Heterogeneity; LOS: Length of stay in hospital; n: Number of studies; N: Number of patients; NA: Not applicable; p: Statistical significance value; OR: Odds Ratio

Table 6. Effect of instrumental assessment with FEES compared to instrumental assessment with VFSS on key outcomes.

Outcome	Incidence (%)		Studies	n (N)	OR [95% CI]/ *MD [95% CI]*	I^2	P value
	VFSS	FEES					
Pneumonia	29.2%	4.8%	[140]	1(45)	8.24 [0.92, 73.79]	NA	0.06
PEG	2.6%	23.8%	[140]	1(99)	0.08 [0.01, 0.47]	NA	0.005

CI: Confidence intervals; FEES: fiberoptic endoscopic evaluation of swallowing; I^2: Heterogeneity; n: Number of studies; N: Number of patients; NA: Not applicable; p: Statistical significance value; PEG: Percutaneous endoscopic gastrostomy; OR: Odds Ratio

Table 7. Effect of complementary and standard assessment in patients with acute or subacute stroke

Outcome	Incidence (%)/ Mean±SD		Studies	n (N)	OR [95% CI]/ *MD [95% CI]*	I^2	P value
	Complementary and standard assessment	Standard assessment					
Mortality	13.5%	19.6%	[141]	1(311)	0.64 [0.35, 1.18]	NA	0.15
Pneumonia	25.7%	21.5%	[141]	1(311)	1.26 [0.75, 2.14]	NA	0.38
Independence							
• **At home**	48.6%	44.8%	[141]	1(311)	1.17 [0.75, 1.83]	NA	0.50
• **At residential care**	43.2%	45.4%	[141]	1(311)	0.92 [0.59, 1.43]	NA	0.70
• **At public hospital**	8.1%	9.8%	[141]	1(311)	0.81 [0.37, 1.78]	NA	0.60
Length of stay	7±5.2	6±5.2	[141]	1(311)	*1.00 [-0.16, 2.16]*	NA	0.09
FOIS	6.2±1.2	6±1.3	[141]	1(311)	*0.20 [-0.08, 0.48]*	NA	0.16

CI: Confidence intervals; I^2: Heterogeneity; MD: Mean difference; n: Number of studies; N: Number of patients; NA: Not applicable; p: Statistical significance value; OR: Odds Ratio; SD: Standard deviation; FOIS: Functional oral intake scale

Table 8. Effect of consistency modification on key outcomes

Outcome	Incidence %		Studies	n (N)	RR [95% CI]/ *MD [95% CI]*	$I^{2,}$	P value
	Consistency modification	Control					
Pneumonia							
• RCT	0.0%	20.0%	[154, 156, 158]	4(100)	0.19 [0.03, 1.40]	0%	0.1
Penetration							
• RCT	0.0%	13.1%	[153]	1(122)	0.06 [0.00, 1.00]	NA	0.05
Aspiration							
• RCT	21.3%	45.7%	[153-155]	3(188)	0.51 [0.14, 1.77]	90%	0.29
LOS in hospital (days)							
• RCT	24±9	34±12	[158]	1(64)	*-9.58 [-15.41, -3.76]*	19%	0.001
Fluid intake (ml)							
• Overall	1179±235	1612±455	[156, 157, 160]	3(77)	*-133.22 [-541.90, 275.46]*	94%	0.52
• RCT	745±164	649±172	[156, 157]	2(38)	*140.48 [-41.56, 322.51]*	68%	0.13
• NRCT	1589±302	2575±737	[160]	1(39)	*-986.00 [-1330.71, -641.29]*	NA	<0.0001
• **Energy intake, Kcal/kg/day**							
• NRCT	19.4±6.2	22.3±9.0	[161]	1(52)	*-2.90 [-7.09, 1.29]*	NA	0.18
• **Protein intake, g/kg/day**							
• NRCT	0.71±0.29	0.90±0.31	[161]	1(68)	*-0.19 [-0.34, -0.04]*	NA	0.02

CI: Confidence intervals; I^2: Heterogeneity; MD: Mean difference; n: Number of studies; N: Number of patients; p: Statistical significance value; RR: Risk Ratio; SD: Standard deviation

Table 9. Effect of behavioural therapy on key outcomes and dysphagia scores

Outcome	Mean±SD/ Incidence (%)		Studies	n (N)	RR [95% CI]/ *MD [95% CI]*	I^2	P value
	Behaviour	Control					
Mortality							
• RCT	15.1%	10.7%	[25, 170, 171]	3(505)	1.47 [0.32, 6.78]	71%	0.62
mRS, RCT							
• mRS ≥3	50.5%	48.0%	[171]	1(306)	1.05 [0.82, 1.34]	NA	0.69
Pneumonia							
• Overall	18.4%	24.5%	[25, 170, 171, 173, 183, 184]	6(677)	0.57 [0.43, 0.75]	0%	< 0.0001
• EMST, RCT	11.6%	19.0%	[173, 183, 184]	3(196)	0.58 [0.24, 1.41]	22%	0.23
• Swallowing exercises, RCT	21.3%	26.6%	[25, 170, 171]	3(481)	0.56 [0.41, 0.76]	0%	0.0002
LOS							
• Swallowing exercise, RCT	19.2±1.2	21.4±12.4	[171]	1(306)	*-2.20 [-4.61, 0.21]*	NA	0.07
Tube feeding							
• Tube removal	63.6%	28.6%	[193, 194]	2(43)	2.16 [0.75, 6.17]	43%	0.15
Improvement in dysphagia scores							
• Overall	6.4±3.6	4.1±3.5	[101, 165, 172, 173, 175-177, 181, 185-190, 192-194]	18(510)	*1.18 [0.78, 1.57]*	70%	<0.00001
• RCT	5.0±2.9	3.0±2.8	[101, 165, 172, 173, 175-177, 181, 185-190, 192]	16(440)	*0.97 [0.64, 1.30]*	68%	<0.00001
• EMST, RCT	1.4±1.3	0.7±1.4	[165, 172, 173, 185]	4(108)	*0.99 [0.51, 1.47]*	16%	< 0.0001
• Swallowing exercises, overall	7.6±4.2	5.1±4.1	[101, 175-177, 181, 186-190, 192-194]	14(402)	*1.01 [0.67, 1.34]*	73%	<0.00001
• Swallowing exercises, RCT	6.1±3.4	3.9±3.3	[101, 175-177, 181, 186-190, 192]	12(332)	*1.19 [0.68, 1.69]*	73%	<0.00001
• Swallowing exercises, NRCT	15.5±8.4	10.5±7.3	[193, 194]	2(70)	*3.11 [-0.12, 6.34]*	40%	0.06

CI: Confidence intervals; I^2, p: Heterogeneity; n: Number of studies; N: Number of patients; NA: Not applicable; NRCT: Non-randomized controlled trial; p: Statistical significance value; SD: Standard

Deviation; MD: Mean Difference; RCT: Randomized controlled trial; RR: Risk Ratio; EMST: Expiratory muscle strength training

Table 10. Effect of acupuncture on key outcomes

Outcome	Mean±SD/ Incidence (%)		Studies	n (N)	RR [95% CI]/ *(S)MD [95% CI]*	I^2	P value
	Acupuncture	Control					
Dysphagia at end	20.0%	39.6%	[196] [198-208, 210-214, 216, 218-222]	23(2177)	0.51 [0.41, 0.63]	58%	< 0.00001
Dysphagia score, overall*							
• Improvement	4.0±0.8	2.8±0.9	[197, 199, 217]	3(292)	*1.05 [0.45, 1.65]*	81%	0.0006
• Post intervention	1.5±0.7	2.1±0.9	[197, 199, 208, 212, 217]	5(443)	*-0.63 [-1.12, -0.14]*	84%	0.01
Pneumonia	3.3%	8.3%	[200]	1(120)	0.40 [0.08, 1.98]	NA	0.26
SQoL	197±19	165±20	[200]	1(120)	*32.0 [24.99, 39.01]*	NA	<0.00001
Nasal feeding tube removal	89.5%	50.0%	[198]	1(74)	1.79 [1.27, 2.53]	NA	0.0009
BI	78±11	63±12	[209, 217]	2(140)	*7.40 [-12.39, 27.19]*	95%	0.46
Adverse effects							
• Pain	1.7%	0.0%	[217]	1(120)	3.00 [0.12, 72.20]	NA	0.5
• Hematoma	3.3%	0.0%	[217]	1(120)	5.00 [0.25, 102.00]	NA	0.3
• Discomfort	11.7%	8.3%	[217]	1(120)	1.40 [0.47, 4.17]	NA	0.55

*: Standard Mean Difference; CI: Confidence intervals; I^2: Heterogeneity; n: Number of studies; N: Number of patients; NA: Not applicable; p: Statistical significance value; SD: Standard Deviation; MD: Mean Difference; SQoL: Swallowing quality of life; RR: Risk ratio; BI: Barthel Index

Table 11. Effect of early compared to late initiation of oral nutritional therapy on key outcomes

Outcome	Incidence (%)		Studies	n (N)	RR [95% CI]/ *MD [95% CI]*	I^2	P value
	Early nutrition	Late nutrition					
Mortality							
• RCT	11.7%	12.6%	[223-226]	4(4337)	0.88 [0.57, 1.37]	26%	0.57
Pneumonia							
• RCT	6.4%	5.8%	[223]	1(4023)	1.12 [0.88, 1.42]	NA	0.38
MRS, RCT							
mRS, 0, 1	23.4%	23.5%	[223]	1(4023)	1.00 [0.89, 1.11]	NA	0.94
mRS, 0-2	40.4%	41.1%	[223]	1(4023)	0.98 [0.91, 1.06]	NA	0.68
Recurrent stroke							
• RCT	2.5%	2.1%	[223]	1(4023)	1.16 [0.77, 1.73]	NA	0.48
Infections							
• RCT	8.5%	10.0%	[223]	1(4023)	0.86 [0.71, 1.04]	NA	0.12
Pressure sores							
• RCT	0.7%	1.3%	[223]	1(4023)	0.57 [0.31, 1.08]	NA	0.09
GIT haemorrhage							
• RCT	1.4%	0.9%	[223]	1(4023)	1.55 [0.86, 2.79]	NA	0.15
Length of stay, days							
• RCT	31.1±46.5	31.4±43.2	[223-226]	4(4289)	*0.93 [-1.05, 2.91]*	0%	0.36
Weight, change, kg							
• RCT	0.0±1.7	-1.1±2.1	[225-227]	4(315)	*1.03 [0.17, 1.89]*	91%	0.02
Energy, kJ/kg							
• RCT	61.6±20.8	49.7±15.0	[225, 227]	5(264)	*8.25 [1.97, 14.53]*	81%	0.01
Protein intake, g/kg							
• RCT	0.9±0.3	0.7±0.3	[225, 227]	5(264)	*0.21 [0.01, 0.41]*	88%	0.04

CI: Confidence intervals; I^2,p: Heterogeneity; n: Number of studies; N: Number of patients; MD: Mean differecne; NA: Not applicable; p: Statistical significance value; RR: Risk Ratio; GIT: Gastrointestinal tract; RR: Risk ratio

Table 12. Effect of early compared to late or restrictive enteral or parenteral nutrition therapy on key outcomes

Outcome	Incidence (%)		Studies	n (N)	RR [95% CI]/ *MD [95% CI]*	I^2	P value
	Early Enteral or Parenteral	Late/ Restrictive Enteral or Parenteral					
Mortality							
• RCT	42.4%	48.1%	[229]	1(859)	0.88 [0.76, 1.02]	NA	0.09
Pneumonia							
• RCT	28.4%	29.5%	[229, 230]	2(1005)	0.97 [0.80, 1.17]	0%	0.75
MRS (RCT)							
• mRS, 0, 1	5.7%	7.0%	[229, 230]	2(981)	0.84 [0.36, 1.94]	65%	0.68
• mRS, 0-2	9.3%	10.2%	[229]	1(859)	0.91 [0.61, 1.37]	NA	0.65
Recurrent stroke							
• RCT	3.5%	5.3%	[229]	1(859)	0.65 [0.35, 1.24]	NA	0.19
Infections							
• RCT	23.8%	27.3%	[229, 230]	2(1005)	0.80 [0.55, 1.18]	65%	0.27
Pressure sores							
• RCT	2.8%	2.3%	[229]	1(859)	1.20 [0.53, 2.75]	NA	0.66
Malnutrition							
• RCT	27.1%	48.3%	[230]	1(128)	0.56 [0.35, 0.90]	NA	0.02
GIT haemorrhage							
• RCT	5.1%	2.6%	[229]	1(859)	2.00 [0.98, 4.08]	NA	0.06
Length of stay, days							
• RCT	45±58	44±50	[229]	1(859)	*1.00 [-6.24, 8.24]*	NA	0.79
BI							
• RCT	46.7±8.8	44.4±9.3	[230]	1(146)	*2.30 [-0.64, 5.24]*	NA	0.13
Living at home							
• RCT	35.7%	31.6%	[229]	1(859)	1.13 [0.93, 1.36]	NA	0.21
Living in Rehabilitation/ institution							
• RCT	21.9%	20.0%	[229]	1(859)	1.10 [0.84, 1.42]	NA	0.49
Nasogastric tube							
• RCT	7.0%	5.3%	[229]	1(859)	1.31 [0.77, 2.21]	NA	0.32
PEG							
• RCT	3.3%	2.3%	[229]	1(859)	1.40 [0.63, 3.12]	NA	0.41

CI: Confidence intervals; I^2,p: Heterogeneity; n: Number of studies; N: Number of patients; MD: Mean difference; NA: Not applicable; p: Statistical significance value; RR: Risk Ratio; BI: Barthel Index

Table 13. Effects of oral health interventions on key outcomes

Outcome	Incidence %		Studies	n (N)	RR [95% CI]/ *(S)MD [95% CI]*	I^2	P value
	Oral health	Control					
Mortality							
• Overall	17.4%	29.8%	[84, 238]	3(349)	0.66 [0.45, 0.96]	0%	**0.03**
• RCT	8.7%	14.0%	[238]	1(203)	0.62 [0.28, 1.38]	NA	0.24
• NRCT	32.8%	47.7%	[84]	2(146)	0.67 [0.44, 1.03]	0%	0.07
In-patients							
• RCT	8.7%	11.0%	[238]	1(203)	0.79 [0.34, 1.83]	NA	0.59
1 month							
• RCT	NR	NR		NR	NR	NR	NR
• NRCT	12.1%	25.0%	[84]	2(146)	0.48 [0.22, 1.05]	0%	0.07
3 months							
• RCT	8.7%	14.0%	[238]	1(203)	0.62 [0.28, 1.38]	NA	0.24
6 months							
• RCT	NR	NR		NR	NR	NR	NR
• NRCT	32.8%	47.7%	[84]	2(146)	0.67 [0.44, 1.03]	0%	0.07
Pneumonia							
• Overall	8.7%	13.9%	[84, 238-242]	7(2110)	0.39 [0.17, 0.91]	53%	0.03
• RCT	0.6%	5.6%	[238-240]	3(284)	0.14 [0.02, 1.11]	NA	0.06
• NRCT	10.0%	15.2%	[84, 241, 242]	4(1826)	0.47 [0.21, 1.06]	51%	0.07
Tube feeding							
• Overall	18.1%	29.1%	[84, 237, 242]	4(1853)	0.62 [0.48, 0.79]	36%	0.0001
• RCT	41.4%	100.0%	[84, 237, 242]	1 (51)	0.43 [0.28, 0.65]	NA	< 0.0001
• NRCT	17.5%	27.2%	[84, 242]	3 (1802)	0.68 [0.57, 0.81]	0%	< 0.0001
Length of stay							
• RCT	NR	NR		NR	NR	NR	NR
• NRCT	11.7±9.7	16.8±7.6	[84, 243]	2(200)	*-3.21 [-5.26, -1.16]*	0%	0.002
• **Oral Health**							
• Overall*	NA	NA	[237, 239-241]	6(235)	*-1.27 [-2.26, -0.28]*	93%	0.01
• **Plaque index**							
• RCT	1.4±1.5	7.4±2.6	[239, 240]	3(175)	*-2.98 [-4.98, -0.98]*	98%	0.003
• **Gingival bleeding index**							
• RCT	8.7±9.3	17.7±21.9	[240]	2(81)	*-8.85 [-17.77, 0.07]*	27%	0.05

I^2: Heterogeneity; MD: Mean difference; n: Number of studies; N: Number of patients; RR: Risk ratio;

p: Statistical significance value

Table 14: Effect of different pharmaceutical agents on key outcomes

Outcome	Incidence %		Studies	n (N)	RR [95% CI], *MD [95% CI]*	I^2	P value
	Drugs	Control					
Mortality							
ACE inhibitors							
• Overall	10.3%	10.5%	[257, 258, 268, 275]	4(6733)	0.96 [0.54, 1.69]	75%	0.88
• RCTs: vs Control	10.6%	11.0%	[257, 258, 268]	3(6244)	0.97 [0.46, 2.04]	83%	0.93
• NRCT: vs Control	4.8%	5.6%	[275]	1(489)	0.86 [0.37, 1.99]	NA	0.72
TRPV-agonists: RCT	0.0%	2.9%	[254]	1(70)	0.33 [0.01, 7.91]	NA	0.5
Dopaminergic drugs: RCT	15.2%	42.9%	[257]	1(68)	0.35 [0.14, 0.86]	NA	0.02
Antibiotics: RCTs	16.1%	15.3%	[250, 252, 255, 256, 263, 264, 266]	7(4301)	1.05 [0.87, 1.26]	16%	0.61
Metoclopramide: RCT	26.7%	40.0%	[265]	1(60)	0.67 [0.32, 1.39]	NA	0.28
Pneumonia							
ACE inhibitors							
• Overall	4.1%	7.6%	[258, 260, 271-275, 278, 279]	12(10611)	0.60 [0.51, 0.70]	61%	< 0.00001
• RCTs vs control (fatal)	4.4% (2.2%)	5.2% (2.2%)	[258, 260]	2(6176) 2(6176)	0.86 [0.69, 1.06] (1.02 [0.74, 1.42])	61% (79%)	0.16 (0.89)
• NRCTs vs control	3.6%	11.4%	[271, 274, 275, 278]	4(1491)	0.41 [0.26, 0.64]	0%	< 0.0001
• NRCTs: vs other antihypertensive drugs	3.9%	10.6%	[271-274, 279]	6(2944)	0.38 [0.28, 0.52]	0%	< 0.00001
TRPV-agonists							
• Overall	9.6%	32.7%	[254, 277]	2(104)	0.31 [0.15, 0.66]	0%	0.002
• RCT: Vs Control	0.0%	2.9%	[254]	1(70)	0.33 [0.01, 7.91]	NA	0.50
• NRCT: Vs Control	29.4%	94.1%	[277]	1(34)	0.31 [0.15, 0.66]	NA	0.002
Dopaminergic drugs: RCT	6.0%	27.5%	[259]	1(163)	0.22 [0.09, 0.55]	NA	0.001
Antibiotics: RCTs	10.3%	11.1%	[252, 255, 256, 263, 264, 266]	6(4201)	0.93 [0.78, 1.10]	17%	0.40

Outcome	Incidence %		Studies	n (N)	RR [95% CI], *MD [95% CI]*	I^2	P value
	Drugs	Control					
Metoclopramide: RCT	26.7%	86.7%	[265]	1(60)	0.31 [0.17, 0.57]	NA	0.0002
mRS							
Antibiotics: RCTs							
• mRS 0-2	46.0%	45.4%	[250, 256, 264, 266]	3(3946)	1.02 [0.83, 1.25]	56%	0.85
• mRS 3-6	43.3%	45.4%	[263, 264, 266]	3(2825)	0.97 [0.91, 1.02]	31%	0.25
Length of stay in hospital, days							
• ACE inhibitor: RCT	37±22	51±36	[257]	1(68)	*-14.00 [-28.09, 0.09]*	NA	0.05
• Dopaminergic: RCT	37±22	51±36	[257]	1(68)	*-14.00 [-28.09, 0.09]*	NA	0.05
• Antibiotics: RCT	12.5±5.9	10.2±5.8	[256, 266]	2(3755)	*3.49 [-3.37, 10.35]*	100%	0.32
Aspiration							
• ACE inhibitors: RCT	26.2%	91.7%	[269]	1(54)	0.29 [0.17, 0.49]	NA	<0.00001
• Dopaminergic drugs: RCT	25.9%	91.7%	[269]	1(39)	0.30 [0.16, 0.58]	0%	0.0003
Latency of swallowing reflex							
• TRPV agonist							
• Change							
• Overall	-7.4±1.2	-0.5±7.2	[253, 254, 276]	3(174)	*-5.14 [-7.86, -2.41]*	100%	0.80
• RCT	-7.9±1.5	-0.6±9.4	[253, 254]	2(134)	*-6.68 [-15.75, 2.39]*	90%	0.15
• NRCT	-5.5±0.0	0.0±0.01	[276]	1(40)	*-5.50 [-5.50, -5.50]*	NA	<0.00001
Upper oesophageal sphincter opening time, sec							
• TRPV agonist	0.9±0.1	1.0±0.0	[262]	2(50)	*-0.08 [-0.13, -0.04]*	41%	0.0002
Laryngeal vestibule closure time, sec							
• TRPV agonist	0.3±0.0	0.4±0.0	[121, 262]	3(116)	*-0.10 [-0.12, -0.08]*	70%	<0.00001
Hyoid bone maximum anterior extension time, sec							

Outcome	Incidence %		Studies	n (N)	RR [95% CI], *MD [95% CI]*	I^2	P value
	Drugs	Control					
• TRPV agonist	0.5±0.0	0.6±0.1	[121, 262]	3(146)	*-0.15 [-0.16, -0.13]*	0%	<0.00001
Latency of Swallowing reflex							
• Dopaminergic drugs: RCT	2.9±0.8	8.3±1.2	[270]	1(54)	*-5.40 [-5.94, -4.86]*	NA	<0.00001
Swallows/min							
• TRPV agonist							
• Change: RCT	3.3±2.5	0.0±0.05	[254]	1(70)	*3.30 [2.47, 4.13]*	NA	<0.00001

ACE: Angiotensin converting enzyme; CI: Confidence intervals; I^2, p: Heterogeneity; n: Number of studies; N: Number of patients; MD: Mean difference;NA: Not applicable; NRCT: Non-Randomized Controlled Trial; p: Statistical significance value; RCT: Randomized Controlled Trial; RR: Risk ratio; TRPV: transient receptor potential vanilloid

Table 15: Effect of different neurostimulation modalities on key outcomes

Outcome	Mean±SD		Studies	n (N)	RR [95% CI]/ *(S)MD [95% CI]*	I^2	P value
	Stimulation	Control					
Imprevement in dysphagia score							
TES							
• Overall	5.8±2.7	3.5±2.6	173, 282, 284, 287, 294-296, 299, 301, 304, 307, 308, 312-317, 319	22(868)	*0.90 [0.62, 1.18]*	69%	<0.00001
• RCT	6.2±2.8	3.7±2.7	173, 282, 284, 287, 294-296, 299, 301, 304, 307, 308, 312-315	19(746)	*0.90 [0.60, 1.19]*	70%	<0.00001
• NRCT	3.7±1.9	1.8±1.9	316, 317, 319	3(122)	*1.14 [-0.13, 2.41]*	78%	0.08
rTMS							
• Overall	9.6±6.1	4.7±5.1		11(236)	*1.33 [0.51, 2.16]*	85%	0.002
• RCT	10.5±6.4	5.3±5.5	285, 289-291, 295, 297, 298, 300	10(212)	*1.51 [0.60, 2.42]*	85%	0.001
• NRCT	0.8±2.6	0.7±2.5	318	1(24)	*0.04 [-0.76, 0.84]*	NA	0.93
tDCS							
• Overall	2.8±2.3	2.0±1.8	281, 292, 293, 303, 306, 310	8(196)	*0.75 [0.38, 1.12]*	26%	<0.0001
• RCT	2.8±2.3	2.0±1.8	281, 292, 293, 303, 306, 310	8(196)	*0.75 [0.38, 1.12]*	26%	<0.0001
PES, Non-tracheostomised							
• Overall	2.3±1.9	1.6±2.2	283, 288, 297, 302, 309	5(204)	*0.77 [-0.06, 1.60]*	80%	0.07
• RCT	2.3±1.9	1.6±2.2	283, 288, 297, 302, 309	5(204)	*0.77 [-0.06, 1.60]*	80%	0.07
PES, tracheostomised							
• Overall	5.6±3.9	5.2±4.3	286, 305	2(83)	*0.25 [-0.19, 0.69]*	0%	0.27
• RCT	5.6±3.9	5.2±4.3	286, 305	2(83)	*0.25 [-0.19, 0.69]*	0%	0.27
Mortality, RCT							
• 2 weeks, PES	3.5%	1.5%	283, 288	2(154)	1.66 [0.22, 12.37]	0%	0.62
• 3 months, PES	13.8%	12.0%	283, 288, 309	3(231)	1.10 [0.55, 2.18]	0%	0.78

mRS, RCT							
• rTMS	1.0±0.7	2.5±1.3	[285]	1(38)	*-1.50 [-2.29, -0.71]*	0%	0.0002
• PES	3.8±1.1	4.2±1.0	[283, 286]	2(177)	*-0.33 [-0.63, -0.02]*	0%	0.04
Pneumonia, RCT							
• TES	5.8%	8.5%	[173, 314]	2(99)	0.75 [0.19, 2.95]	NA	0.68
• tDCS	37.9%	53.3%	[306]	1(59)	0.71 [0.40, 1.26]	NA	0.24
• PES	7.6%	11.5%	[283, 286]	2(209)	0.66 [0.29, 1.52]	0%	0.33
BI							
• rTMS, Overall	76.8±7.9	52.8±14.5	[285, 289, 290, 318]	5(110)	*29.54 [25.82, 33.26]*	87%	< 0.00001
• rTMS, RCT	79.8±5.1	46.9±12.7	[285, 289, 290]	4(86)	*31.57 [27.75, 35.39]*	73%	< 0.00001
• rTMS, NRCT	64.0±20.0	70.0±20.0	[318]	1(24)	*-6.00 [-22.00, 10.00]*	NA	0.46
• PES, RCT	36.1±30.5	27.0±25.7	[283, 288]	2(154)	*-0.34 [-1.19, 0.51]*	74%	0.43
LOS, Hospital (d), RCT							
• tDCS	16.2±6.8	13.4±5.1	[306]	1(59)	*2.80 [-0.28, 5.88]*	NA	0.07
• PES	32.4±20.7	35.3±22.1	[283, 305]	3(192)	*-4.23 [-12.11, 3.66]*	33%	0.29
LOS, ICU (d), RCT							
• tDCS	6.7±4.4	7.0±3.3	[306]	1(59)	*-0.30 [-2.29, 1.69]*	NA	0.77
• PES	38.2±14.9	38.8±19.7	[306]	1(59)	*-0.60 [-14.45, 13.25]*	NA	0.93
Decannulation							
• Tracheotomised patients, PES, Overall	59.0%	7.5%	[286, 305, 320]	3(145)	5.43 [2.42, 12.16]	0%	< 0.0001
• Tracheotomised patients, PES, RCT	58.2%	11.4%	[286, 305]	2(99)	4.64 [2.00, 10.79]	0%	0.004
• Tracheotomised patients, PES, NRCT	60.9%	0.0%	[320]	1(46)	29.00 [1.83, 459.04]	NA	0.02
Feeding Tube removal							
• TES, RCT	50.0%	14.3%	[294]	1(19)	3.50 [0.52, 23.42]	NA	0.2
• PES, RCT	50.0%	28.6%	[309]	1(30)	1.75 [0.67, 4.58]	NA	0.25
Quality of Life, change from baseline, RCT							

• Swallowing QoL, TES	26.2±18.2	7.2±17.1	[304, 312]	3(106)	*18.02 [11.41, 24.63]*	37%	<0.00001

CI: Confidence intervals; tDCS: transcranial Direct Current Stimulation; I^2: Heterogeneity; n: Number of studies; N: Number of patients; TES: Transcutaneous Electrical Stimulation; NRCT: RCT: Non-randomized controlled trial (Cohort, before after, case-control studies); p: Statistical significance value; PES: Pharyngeal Electrical Stimulation; RCT: Randomized controlled trial; RR: Risk ratio SD: Standard Deviation; SMD: Standard Mean Difference; rTMS: repetitive Transcranial Magnetic Stimulation; BI: Barthel Index; LOS: Length of stay; ICU: Intensive care unit

Box 1. Grades of quality of evidence.

Grade	Definition	Symbol
High	Further research is very unlikely to change our confidence in the estimate of effect.	⨁⨁⨁⨁
Moderate	Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.	⨁⨁⨁
Low	Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.	⨁⨁
Very low	We are very uncertain about the estimate.	⨁

Box 2. Definitions and symbols of categories of strength of recommendation.

Strength of recommendation	Criteria	Symbol
Strong for an intervention	The desirable effects of an intervention clearly outweigh its undesirable effects.	↑↑
Weak for an intervention .	The desirable effects of an intervention probably outweigh the undesirable effects	↑?
Weak against an intervention	The undesirable effects of an intervention probably outweigh the desirable effects	↓?
Strong against an intervention	The undesirable effects of an intervention clearly outweigh its desirable effects.	↓↓

References

1. Michou E, Hamdy S. Cortical input in control of swallowing. *Current opinion in otolaryngology & head and neck surgery*. 2009;17:166-171
2. Jean A. Brain stem control of swallowing: Neuronal network and cellular mechanisms. *Physiol Rev*. 2001;81:929-969
3. Cohen DL, Roffe C, Beavan J, Blackett B, Fairfield CA, Hamdy S, et al. Post-stroke dysphagia: A review and design considerations for future trials. *International journal of stroke : official journal of the International Stroke Society*. 2016;11:399-411
4. Hamdy S, Aziz Q, Rothwell JC, Crone R, Hughes D, Tallis RC, et al. Explaining oropharyngeal dysphagia after unilateral hemispheric stroke. *Lancet (London, England)*. 1997;350:686-692
5. Teismann I, Suntrup S, Warnecke T, Steinstraeter O, Fischer M, Floeel A, et al. Cortical swallowing processing in early subacute stroke. *BMC neurology*. 2011;11:34
6. Martino R, Foley N, Bhogal S, Diamant N, Speechley M, Teasell R. Dysphagia after stroke - incidence, diagnosis, and pulmonary complications. *Stroke; a journal of cerebral circulation*. 2005;36:2756-2763
7. Smithard DG, O'Neill PA, Park C, Morris J, Wyatt R, England R, et al. Complications and outcome after acute stroke - does dysphagia matter? *Stroke; a journal of cerebral circulation*. 1996;27:1200-1204
8. Mann G, Hankey GJ, Cameron D. Swallowing disorders following acute stroke: Prevalence and diagnostic accuracy. *Cerebrovascular diseases (Basel, Switzerland)*. 2000;10:380-386
9. Dziewas R, Beck AM, Clave P, Hamdy S, Heppner HJ, Langmore SE, et al. Recognizing the importance of dysphagia: Stumbling blocks and stepping stones in the twenty-first century. *Dysphagia*. 2017;32:78-82
10. Ntaios G, Bornstein NM, Caso V, Christensen H, De Keyser J, Diener HC, et al. The european stroke organisation guidelines: A standard operating procedure. *International journal of stroke : official journal of the International Stroke Society*. 2015;10 Suppl A100:128-135
11. Cebm (centre for evidence-based medicine). 2017
12. Higgins JP, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, et al. *Cochrane handbook for systematic reviews of interventions*. John Wiley & Sons; 2019.
13. Higgins JP, Altman DG, Gøtzsche PC, Jüni P, Moher D, Oxman AD, et al. The cochrane collaboration's tool for assessing risk of bias in randomised trials. *BMJ (Clinical research ed.)*. 2011;343:d5928
14. Group GW. Grade working group. Overview of grade approach. 2018
15. Al-Khaled M, Matthis C, Binder A, Mudter J, Schattschneider J, Pulkowski U, et al. Dysphagia in patients with acute ischemic stroke: Early dysphagia screening may reduce stroke-related pneumonia and improve stroke outcomes. *Cerebrovascular diseases (Basel, Switzerland)*. 2016;42:81-89
16. Alsumrain M, Melillo N, Debari VA, Kirmani J, Moussavi M, Doraiswamy V, et al. Predictors and outcomes of pneumonia in patients with spontaneous intracerebral hemorrhage. *Journal of intensive care medicine*. 2013;28:118-123
17. Arnold M, Liesirova K, Broeg-Morvay A, Meisterernst J, Schlager M, Mono ML, et al. Dysphagia in acute stroke: Incidence, burden and impact on clinical outcome. *PloS one*. 2016;11:e0148424
18. Babi M-A, Gorman M, Commichau C, Kenney S, Boyle L, Comeau M, et al. Failed bedside dysphagia screen predicts pneumonia treatment in acute stroke: A resident quality initiative project in a jc-certified primary stroke center (p3. 124). 2014
19. Baroni AF, Fábio SR, Dantas RO. Risk factors for swallowing dysfunction in stroke patients. *Arquivos de gastroenterologia*. 2012;49:118-124
20. Bonilha HS, Simpson AN, Ellis C, Mauldin P, Martin-Harris B, Simpson K. The one-year attributable cost of post-stroke dysphagia. *Dysphagia*. 2014;29:545-552

21. Brogan E, Langdon C, Brookes K, Budgeon C, Blacker D. Dysphagia and factors associated with respiratory infections in the first week post stroke. *Neuroepidemiology*. 2014;43:140-144
22. Chua KS, Kong KH. Functional outcome in brain stem stroke patients after rehabilitation. *Archives of physical medicine and rehabilitation*. 1996;77:194-197
23. Crary MA, Carnaby GD, Sia I, Khanna A, Waters MF. Spontaneous swallowing frequency has potential to identify dysphagia in acute stroke. *Stroke; a journal of cerebral circulation*. 2013;44:3452-3457
24. De Castillo LLC, Sumalapao DEP, Pascual JLR. Risk factors for pneumonia in acute stroke patients admitted to the emergency department of a tertiary government hospital. *National Journal of Physiology, Pharmacy and Pharmacology*. 2017;7:855
25. DePippo K, Holas MA, Reding MJ, Mandel F, Lesser M. Dysphagia therapy following stroke: A controlled trial. *Neurology*. 1994;44:1655-1660
26. Falsetti P, Acciai C, Palilla R, Bosi M, Carpinteri F, Zingarelli A, et al. Oropharyngeal dysphagia after stroke: Incidence, diagnosis, and clinical predictors in patients admitted to a neurorehabilitation unit. *Journal of stroke and cerebrovascular diseases : the official journal of National Stroke Association*. 2009;18:329-335
27. Finlayson O, Kapral M, Hall R, Asllani E, Selchen D, Saposnik G. Risk factors, inpatient care, and outcomes of pneumonia after ischemic stroke. *Neurology*. 2011;77:1338-1345
28. Gordon C, Hewer RL, Wade DT. Dysphagia in acute stroke. *Brit Med J*. 1987;295:411-414
29. Gottlieb D, Kipnis M, Sister E, Vardi Y, Brill S. Validation of the 50 ml3 drinking test for evaluation of post-stroke dysphagia. *Disability and rehabilitation*. 1996;18:529-532
30. Guyomard V, Fulcher RA, Redmayne O, Metcalf AK, Potter JF, Myint PK. Effect of dysphasia and dysphagia on inpatient mortality and hospital length of stay: A database study. *Journal of the American Geriatrics Society*. 2009;57:2101-2106
31. Hamidon BB, Nabil I, Raymond AA. Risk factors and outcome of dysphagia after an acute ischaemic stroke. *The Medical journal of Malaysia*. 2006;61:553-557
32. Hinds NP, Wiles CM. Assessment of swallowing and referral to speech and language therapists in acute stroke. *QJM : monthly journal of the Association of Physicians*. 1998;91:829-835
33. Hoffmann S, Harms H, Ulm L, Nabavi DG, Mackert BM, Schmehl I, et al. Stroke-induced immunodepression and dysphagia independently predict stroke-associated pneumonia - the predict study. *Journal of cerebral blood flow and metabolism : official journal of the International Society of Cerebral Blood Flow and Metabolism*. 2017;37:3671-3682
34. Hoffmann S, Malzahn U, Harms H, Koennecke HC, Berger K, Kalic M, et al. Development of a clinical score (a2ds2) to predict pneumonia in acute ischemic stroke. *Stroke; a journal of cerebral circulation*. 2012;43:2617-2623
35. Holas MA, DePippo K, Reding MJ. Aspiration and relative risk of medical complications following stroke. *Archives of neurology*. 1994;51:1051-1053
36. Jeyaseelan RD, Vargo MM, Chae J. National institutes of health stroke scale (nihss) as an early predictor of poststroke dysphagia. *PM & R : the journal of injury, function, and rehabilitation*. 2015;7:593-598
37. Joundi RA, Martino R, Saposnik G, Giannakeas V, Fang J, Kapral MK. Predictors and outcomes of dysphagia screening after acute ischemic stroke. *Stroke; a journal of cerebral circulation*. 2017;48:900-906
38. Kidd D, Lawson J, Nesbitt R, MacMahon J. The natural history and clinical consequences of aspiration in acute stroke. *Q J Med*. 1995;88:409-413
39. Kumar S, Massaro J, Marchina S, Lahoti S, Feng W, Selim M, et al. Acd2d4 scale for predicting stroke related pneumonia. *INTERNATIONAL JOURNAL OF STROKE*. 2016;11:101-101
40. Lakshminarayan K, Tsai AW, Tong X, Vazquez G, Peacock JM, George MG, et al. Utility of dysphagia screening results in predicting poststroke pneumonia. *Stroke; a journal of cerebral circulation*. 2010;41:2849-2854

41. Langdon PC, Lee AH, Binns CW. Dysphagia in acute ischaemic stroke: Severity, recovery and relationship to stroke subtype. *Journal of clinical neuroscience : official journal of the Neurosurgical Society of Australasia*. 2007;14:630-634
42. Lim SHB, Lieu PK, Phua SY, Seshadri R, Venketasubramanian N, Lee SH, et al. Accuracy of bedside clinical methods compared with fiberoptic endoscopic examination of swallowing (fees) in determing the risk of aspiration in acute stroke patients. *Dysphagia*. 2001;16:1-6
43. Lord AS, Langefeld CD, Sekar P, Moomaw CJ, Badjatia N, Vashkevich A, et al. Infection after intracerebral hemorrhage: Risk factors and association with outcomes in the ethnic/racial variations of intracerebral hemorrhage study. *Stroke; a journal of cerebral circulation*. 2014;45:3535-3542
44. Maeshima S, Osawa A, Yamane F, Ishihara S, Tanahashi N. Dysphagia following acute thalamic haemorrhage: Clinical correlates and outcomes. *European neurology*. 2014;71:165-172
45. Mann G, Hankey GJ, Cameron D. Swallowing function after stroke: Prognosis and prognostic factors at 6 months. *Stroke; a journal of cerebral circulation*. 1999;30:744-748
46. Muriana D, Palomeras E, Rofes L. Incidence, risk factors and complications of oropharyngeal dysphagia one year after stroke. *Eur. Stroke J*. 2016;1:186
47. Odderson IR, Keaton JC, McKenna BS. Swallow management in patients with on an acute stroke pathway: Quality is cost effective. *Archives of physical medicine and rehabilitation*. 1995;76:1130-1133
48. Palomeras E, Muriana D, Rofes L, Alvarez D, Casado V, Vilardeli N, et al. Dysphagia in stroke patients. Risk factors and impact on prognosis. *CEREBROVASCULAR DISEASES*. 2014;37:702-702
49. Rofes L, Muriana D, Palomeras E, Vilardell N, Palomera E, Alvarez-Berdugo D, et al. Prevalence, risk factors and complications of oropharyngeal dysphagia in stroke patients: A cohort study. *Neurogastroenterology & Motility*. 2018;30:e13338
50. Sala R, Muntó MJ, de la Calle J, Preciado I, Miralles T, Cortés A, et al. [swallowing changes in cerebrovascular accidents: Incidence, natural history, and repercussions on the nutritional status, morbidity, and mortality]. *Revista de neurologia*. 1998;27:759-766
51. Smithard DG, Smeeton NC, Wolfe CD. Long-term outcome after stroke: Does dysphagia matter? *Age and ageing*. 2007;36:90-94
52. Sundar U, Mehetre R. Etiopathogenesis and predictors of in-hospital morbidity and mortality in posterior circulation strokes--a 2 year registry with concordant comparison with anterior circulation strokes. *The Journal of the Association of Physicians of India*. 2007;55:846-850
53. Wade DT, Hewer RL. Motor loss and swallowing difficulty after stroke: Frequency, recovery, and prognosis. *Acta neurologica Scandinavica*. 1987;76:50-54
54. Wang Y, Lim LL, Levi C, Heller RF, Fischer J. A prognostic index for 30-day mortality after stroke. *Journal of clinical epidemiology*. 2001;54:766-773
55. Zhang X, Yu S, Wei L, Ye R, Lin M, Li X, et al. The a2ds2 score as a predictor of pneumonia and in-hospital death after acute ischemic stroke in chinese populations. *PloS one*. 2016;11:e0150298
56. Suntrup-Krueger S, Minnerup J, Muhle P, Claus I, Schroder JB, Marian T, et al. The effect of improved dysphagia care on outcome in patients with acute stroke: Trends from 8-year data of a large stroke register. *Cerebrovascular diseases (Basel, Switzerland)*. 2018;45:101-108
57. Bijani B, Mozhdehipanah H, Jahanihashemi H, Azizi S. The impact of pneumonia on hospital stay among patients hospitalized for acute stroke. *Neurosciences (Riyadh, Saudi Arabia)*. 2014;19:118-123
58. Jauch EC, Saver JL, Adams HP, Jr., Bruno A, Connors JJ, Demaerschalk BM, et al. Guidelines for the early management of patients with acute ischemic stroke: A guideline for healthcare professionals from the american heart association/american stroke association. *Stroke; a journal of cerebral circulation*. 2013;44:870-947
59. Wirth R, Smoliner C, Jager M, Warnecke T, Leischker AH, Dziewas R. Guideline clinical nutrition in patients with stroke. *Experimental & translational stroke medicine*. 2013;5:14

60. Burgos R, Breton I, Cereda E, Desport JC, Dziewas R, Genton L, et al. Espen guideline clinical nutrition in neurology. *Clinical nutrition (Edinburgh, Scotland)*. 2018;37:354-396
61. Hebert D, Lindsay MP, McIntyre A, Kirton A, Rumney PG, Bagg S, et al. Canadian stroke best practice recommendations: Stroke rehabilitation practice guidelines, update 2015. *International journal of stroke : official journal of the International Stroke Society*. 2016;11:459-484
62. Party ISW. National clinical guideline for stroke, 5th edn. London: Royal college of physicians. 2016
63. Nabavi DG, Ossenbrink M, Schinkel M, Koennecke HC, Hamann G, Busse O. [revised certification criteria for regional and national stroke units in germany]. *Der Nervenarzt*. 2015;86:978-988
64. Fedder WN. Review of evidenced-based nursing protocols for dysphagia assessment. *Stroke; a journal of cerebral circulation*. 2017;48:e99-e101
65. Virvidaki IE, Nasios G, Kosmidou M, Giannopoulos S, Milionis H. Swallowing and aspiration risk: A critical review of non instrumental bedside screening tests. *Journal of clinical neurology (Seoul, Korea)*. 2018
66. Chen PC, Chuang CH, Leong CP, Guo SE, Hsin YJ. Systematic review and meta-analysis of the diagnostic accuracy of the water swallow test for screening aspiration in stroke patients. *Journal of advanced nursing*. 2016;72:2575-2586
67. Poorjavad M, Jalaie S. Systemic review on highly qualified screening tests for swallowing disorders following stroke: Validity and reliability issues. *Journal of research in medical sciences : the official journal of Isfahan University of Medical Sciences*. 2014;19:776-785
68. Kertscher B, Speyer R, Palmieri M, Plant C. Bedside screening to detect oropharyngeal dysphagia in patients with neurological disorders: An updated systematic review. *Dysphagia*. 2014;29:204-212
69. Bours GJ, Speyer R, Lemmens J, Limburg M, de Wit R. Bedside screening tests vs. Videofluoroscopy or fibreoptic endoscopic evaluation of swallowing to detect dysphagia in patients with neurological disorders: Systematic review. *Journal of advanced nursing*. 2009;65:477-493
70. Daniels SK, Anderson JA, Willson PC. Valid items for screening dysphagia risk in patients with stroke: A systematic review. *Stroke; a journal of cerebral circulation*. 2012;43:892-897
71. Gandolfi M, Smania N, Bisoffi G, Squaquara T, Zuccher P, Mazzucco S. Improving post-stroke dysphagia outcomes through a standardized and multidisciplinary protocol: An exploratory cohort study. *Dysphagia*. 2014;29:704-712
72. Hinchey JA, Shephard T, Furie K, Smith D, Wang D, Tonn S. Formal dysphagia screening protocols prevent pneumonia. *Stroke; a journal of cerebral circulation*. 2005;36:1972-1976
73. Yeh SJ, Huang KY, Wang TG, Chen YC, Chen CH, Tang SC, et al. Dysphagia screening decreases pneumonia in acute stroke patients admitted to the stroke intensive care unit. *Journal of the neurological sciences*. 2011;306:38-41
74. Bray BD, Smith CJ, Cloud GC, Enderby P, James M, Paley L, et al. The association between delays in screening for and assessing dysphagia after acute stroke, and the risk of stroke-associated pneumonia. *Journal of neurology, neurosurgery, and psychiatry*. 2017;88:25-30
75. Grimley R, Andrew N, Grabsch B, Coccetti A, Cornwell P, O'Connell C, et al. Dysphagia screening/assessment is associated with reduced 30 day mortality after acute stroke. *International Journal of Stroke*. 2015;10:15-15
76. Guillan M, Fernandez-Ferro J, Martin-Gil L, Barbero N, Garcia-Botran B, Gutierrez-Fonseca R, et al. The importance of a multidisciplinar approach to dysphagia in acute stroke. *Age (years)*. 2015;72:73.71-13
77. Titsworth WL, Abram J, Fullerton A, Hester J, Guin P, Waters MF, et al. Prospective quality initiative to maximize dysphagia screening reduces hospital-acquired pneumonia prevalence in patients with stroke. *Stroke; a journal of cerebral circulation*. 2013;44:3154-3160

78. Clements AM, Ralston L, Rke-Martindale CB, Bouchard E, Iyengar P. An interdisciplinary approach to the prevention of aspiration pneumonia in patients with a diagnosis of stroke. *STROKE*. 2009;40:E279-E279
79. Masrur S, Smith EE, Saver JL, Reeves MJ, Bhatt DL, Zhao X, et al. Dysphagia screening and hospital-acquired pneumonia in patients with acute ischemic stroke: Findings from get with the guidelines--stroke. *Journal of stroke and cerebrovascular diseases : the official journal of National Stroke Association*. 2013;22:e301-309
80. McCormack J, McElwaine P, Brennan C, Coetzee H, Cotter P, Doyle R, et al. Poor levels of swallow screening associated with increased rates of pneumonia. . *European Stroke Journal* 2016;1:217
81. Han TS, Lean ME, Fluck D, Affley B, Gulli G, Patel T, et al. Impact of delay in early swallow screening on pneumonia, length of stay in hospital, disability and mortality in acute stroke patients. *European journal of clinical nutrition*. 2018;72:1548-1554
82. Palli C, Fandler S, Doppelhofer K, Niederkorn K, Enzinger C, Vetta C, et al. Early dysphagia screening by trained nurses reduces pneumonia rate in stroke patients: A clinical intervention study. *Stroke; a journal of cerebral circulation*. 2017;48:2583-2585
83. Turner M, Barber M, Dodds H, Dennis M, Langhorne P, Macleod MJ. Stroke patients admitted within normal working hours are more likely to achieve process standards and to have better outcomes. *Journal of neurology, neurosurgery, and psychiatry*. 2016;87:138-143
84. Sorensen RT, Rasmussen RS, Overgaard K, Lerche A, Johansen AM, Lindhardt T. Dysphagia screening and intensified oral hygiene reduce pneumonia after stroke. *The Journal of neuroscience nursing : journal of the American Association of Neuroscience Nurses*. 2013;45:139-146
85. Dhufaigh N, Hayes M. 128the sooner the better: Does early speech and language therapy involvement in stroke management result in better dysphagia outcomes? *Age and ageing*. 2017;46
86. Perry L, McLaren S. An evaluation of implementation of evidence-based guidelines for dysphagia screening and assessment following acute stroke: Phase 2 of an evidence-based practice project. *Journal of Clinical Excellence*. 2000;2:147-156
87. Schrock JW, Lou L, Ball BAW, Van Etten J. The use of an emergency department dysphagia screen is associated with decreased pneumonia in acute strokes. *The American journal of emergency medicine*. 2018;36:2152-2154
88. Schrock J, Ball B. Abstract tmp70: The emergency department screen is associated with lower rates of pneumonia in acute hemorrhagic stroke patients. *Stroke; a journal of cerebral circulation*. 2017;48:ATMP70-ATMP70
89. Schrock JW, Lou L. Abstract tp255: The emergency department dysphagia screen is associated with lower rates of pneumonia in acute ischemic stroke patients. *Stroke; a journal of cerebral circulation*. 2016;47:ATP255-ATP255
90. Svendsen ML, Ehlers LH, Andersen G, Johnsen SP. Quality of care and length of hospital stay among patients with stroke. *Medical care*. 2009;47:575-582
91. Trapl M, Enderle P, Nowotny M, Teuschl Y, Matz K, Dachenhausen A, et al. Dysphagia bedside screening for acute-stroke patients: The gugging swallowing screen. *Stroke; a journal of cerebral circulation*. 2007;38:2948-2952
92. Warnecke T, Im S, Kaiser C, Hamacher C, Oelenberg S, Dziewas R. Aspiration and dysphagia screening in acute stroke - the gugging swallowing screen revisited. *European journal of neurology*. 2017;24:594-601
93. Clave P, Arreola V, Romea M, Medina L, Palomera E, Serra-Prat M. Accuracy of the volume-viscosity swallow test for clinical screening of oropharyngeal dysphagia and aspiration. *Clinical nutrition (Edinburgh, Scotland)*. 2008;27:806-815
94. Rofes L, Arreola V, Mukherjee R, Clave P. Sensitivity and specificity of the eating assessment tool and the volume-viscosity swallow test for clinical evaluation of oropharyngeal dysphagia. *Neurogastroenterology and motility : the official journal of the European Gastrointestinal Motility Society*. 2014;26:1256-1265

95. Guillen-Sola A, Marco E, Martinez-Orfila J, Donaire Mejias MF, Depolo Passalacqua M, Duarte E, et al. Usefulness of the volume-viscosity swallow test for screening dysphagia in subacute stroke patients in rehabilitation income. *NeuroRehabilitation*. 2013;33:631-638
96. Sabbouh T, Torbey MT. Malnutrition in stroke patients: Risk factors, assessment, and management. *Neurocritical care*. 2018;29:374-384
97. Lamb CA, Parr J, Lamb EI, Warren MD. Adult malnutrition screening, prevalence and management in a united kingdom hospital: Cross-sectional study. *The British journal of nutrition*. 2009;102:571-575
98. Foley NC, Martin RE, Salter KL, Teasell RW. A review of the relationship between dysphagia and malnutrition following stroke. *Journal of rehabilitation medicine*. 2009;41:707-713
99. Chai J, Chu FC, Chow TW, Shum NC. Prevalence of malnutrition and its risk factors in stroke patients residing in an infirmary. *Singapore medical journal*. 2008;49:290-296
100. Gomes F, Emery PW, Weekes CE. Risk of malnutrition is an independent predictor of mortality, length of hospital stay, and hospitalization costs in stroke patients. *Journal of stroke and cerebrovascular diseases : the official journal of National Stroke Association*. 2016;25:799-806
101. Kim Y, Kim CK, Jung S, Ko SB, Lee SH, Yoon BW. Prognostic importance of weight change on short-term functional outcome in acute ischemic stroke. *International journal of stroke : official journal of the International Stroke Society*. 2015;10 Suppl A100:62-68
102. Maruyama K, Nakagawa N, Koyama S, Maruyama JI, Hasebe N. Malnutrition increases the incidence of death, cardiovascular events, and infections in patients with stroke after rehabilitation. *Journal of stroke and cerebrovascular diseases : the official journal of National Stroke Association*. 2018;27:716-723
103. Stratton RJ, Green CJ, Elia M. *Disease-related malnutrition: An evidence-based approach to treatment*. Cabi; 2003.
104. Kondrup J, Rasmussen HH, Hamberg O, Stanga Z. Nutritional risk screening (nrs 2002): A new method based on an analysis of controlled clinical trials. *Clinical nutrition (Edinburgh, Scotland)*. 2003;22:321-336
105. Elia M. The 'must'report. *Nutritional screening for adults: a multidisciplinary responsibility. Development and use of the 'Malnutrition Universal Screening Tool'('MUST') for adults. A report by the Malnutrition Advisory Group of the British Association for Parenteral and Enteral Nutrition*. 2003:127
106. Cai ZM, Wu YZ, Chen HM, Feng RQ, Liao CW, Ye SL, et al. Being at risk of malnutrition predicts poor outcomes at 3 months in acute ischemic stroke patients. *European journal of clinical nutrition*. 2020
107. Sremanakova J, Burden S, Kama Y, Gittins M, Lal S, Smith CJ, et al. An observational cohort study investigating risk of malnutrition using the malnutrition universal screening tool in patients with stroke. *Journal of stroke and cerebrovascular diseases : the official journal of National Stroke Association*. 2019;28:104405
108. Mann G. *Masa: The mann assessment of swallowing ability*. Clifton, New York: Thomson Learning Inc; 2002.
109. Logemann JA, Veis S, Colangelo L. A screening procedure for oropharyngeal dysphagia. *Dysphagia*. 1999;14:44-51
110. Leder SB, Espinosa JF. Aspiration risk after acute stroke: Comparison of clinical examination and fiberoptic endoscopic evaluation of swallowing. *Dysphagia*. 2002;17:214-218
111. McCullough GH, Rosenbek JC, Wertz RT, McCoy S, Mann G, McCullough K. Utility of clinical swallowing examination measures for detecting aspiration post-stroke. *Journal of speech, language, and hearing research : JSLHR*. 2005;48:1280-1293
112. Langmore SE. Evaluation of oropharyngeal dysphagia: Which diagnostic tool is superior? *Current opinion in otolaryngology & head and neck surgery*. 2003;11:485-489
113. Splaingard ML, Hutchins B, Sulton LD, Chaudhuri G. Aspiration in rehabilitation patients: Videofluoroscopy vs bedside clinical assessment. *Archives of physical medicine and rehabilitation*. 1988;69:637-640

114. Addington WR, Stephens RE, Gilliland KA. Assessing the laryngeal cough reflex and the risk of developing pneumonia after stroke: An interhospital comparison. *Stroke; a journal of cerebral circulation*. 1999;30:1203-1207
115. Bianchi C, Baiardi P, Khirani S, Cantarella G. Cough peak flow as a predictor of pulmonary morbidity in patients with dysphagia. *American journal of physical medicine & rehabilitation*. 2012;91:783-788
116. Nakajoh K, Nakagawa T, Sekizawa K, Matsui T, Arai H, Sasaki H. Relation between the incidence of pneumoniae and protective reflexes in post-stroke patients with oral or tube feeding. *J Int Med*. 2000;247:39-42
117. Smith Hammond CA, Goldstein LB, Horner RD, Ying J, Gray L, Gonzalez-Rothi L, et al. Predicting aspiration in patients with ischemic stroke: Comparison of clinical signs and aerodynamic measures of voluntary cough. *Chest*. 2009;135:769-777
118. Logemann JA. *Manual for the videofluorographic study of swallowing*. Austin, Texas: Pro-Ed; 1993.
119. Vilardell N, Rofes L, Arreola V, Martin A, Muriana D, Palomeras E, et al. Videofluoroscopic assessment of the pathophysiology of chronic poststroke oropharyngeal dysphagia. *Neurogastroenterology and motility : the official journal of the European Gastrointestinal Motility Society*. 2017;29:1-8
120. Clave P, de Kraa M, Arreola V, Girvent M, Farre R, Palomera E, et al. The effect of bolus viscosity on swallowing function in neurogenic dysphagia. *Alimentary pharmacology & therapeutics*. 2006;24:1385-1394
121. Rofes L, Arreola V, Martin A, Clavé P. Natural capsaicinoids improve swallow response in older patients with oropharyngeal dysphagia. *Gut*. 2013;62:1280-1287
122. Martin-Harris B, Brodsky MB, Michel Y, Castell DO, Schleicher M, Sandidge J, et al. Mbs measurement tool for swallow impairment--mbsimp: Establishing a standard. *Dysphagia*. 2008;23:392-405
123. Garand KL, Strange C, Paoletti L, Hopkins-Rossabi T, Martin-Harris B. Oropharyngeal swallow physiology and swallowing-related quality of life in underweight patients with concomitant advanced chronic obstructive pulmonary disease. *International journal of chronic obstructive pulmonary disease*. 2018;13:2663-2671
124. Langmore SE, Aviv JE. Endoscopic procedures to evaluate oropharyngeal swallowing. In: Langmore SE, ed. *Endoscopic evaluation and treatment of swallowing disorders*. New York, Stuttgart: Thieme; 2001:73-100.
125. Langmore SE. History of fiberoptic endoscopic evaluation of swallowing for evaluation and management of pharyngeal dysphagia: Changes over the years. *Dysphagia*. 2017;32:27-38
126. Maeshima S, Osawa A, Hayashi T, Tanahashi N. Elderly age, bilateral lesions, and severe neurological deficit are correlated with stroke-associated pneumonia. *Journal of stroke and cerebrovascular diseases : the official journal of National Stroke Association*. 2014;23:484-489
127. Sellars C, Bowie L, Bagg J, Sweeney MP, Miller H, Tilston J, et al. Risk factors for chest infection in acute stroke: A prospective cohort study. *Stroke; a journal of cerebral circulation*. 2007;38:2284-2291
128. Dziewas R, Ritter M, Schilling M, Konrad C, Oelenberg S, Nabavi DG, et al. Pneumonia in acute stroke patients fed by nasogastric tubes. *Journal of neurology, neurosurgery, and psychiatry*. 2004;75:852-856
129. Lin WC, Huang CY, Lee LF, Chen YW, Ho CH, Sun YT. Initial national institute of health stroke scale to early predict the improvement of swallowing in patients with acute ischemic stroke. *Journal of stroke and cerebrovascular diseases : the official journal of National Stroke Association*. 2019;28:104297
130. Labeit B, Mueller H, Muhle P, Claus I, Warnecke T, Dziewas R, et al. Predicting dysphagia with national institute of health stroke scale: Distinction between infra- and supratentorial region is essential. *Cerebrovascular diseases (Basel, Switzerland)*. 2018;46:152-160

131. Okubo PC, Fabio SR, Domenis DR, Takayanagui OM. Using the national institute of health stroke scale to predict dysphagia in acute ischemic stroke. *Cerebrovascular diseases (Basel, Switzerland)*. 2012;33:501-507
132. Wirth R, Dziewas R. Dysphagia and pharmacotherapy in older adults. *Current opinion in clinical nutrition and metabolic care*. 2019;22:25-29
133. Dziewas R, Pflug C. Neurogene dysphagie, s1-leitliniein. In: DGN, ed. *Leitlinien für diagnostik und therapie in der neurologie*. 2020.
134. Masilamoney M, Dowse R. Knowledge and practice of healthcare professionals relating to oral medicine use in swallowing-impaired patients: A scoping review. *The International journal of pharmacy practice*. 2018;26:199-209
135. Bax L, McFarlane M, Green E, Miles A. Speech-language pathologist-led fiberoptic endoscopic evaluation of swallowing: Functional outcomes for patients after stroke. *Journal of stroke and cerebrovascular diseases : the official journal of National Stroke Association*. 2014;23:e195-200
136. Radhakrishnan S, Menon UK, Anandakuttan A. A combined approach of bedside clinical examination and flexible endoscopic evaluation of swallowing in poststroke dysphagia: A pilot study. *Annals of Indian Academy of Neurology*. 2013;16:388-393
137. Braun T, Juenemann M, Viard M, Meyer M, Reuter I, Prosiegel M, et al. Adjustment of oral diet based on flexible endoscopic evaluation of swallowing (fees) in acute stroke patients: A cross-sectional hospital-based registry study. *BMC neurology*. 2019;19:282
138. Dziewas R, auf dem Brinke M, Birkmann U, Bräuer G, Busch K, Cerra F, et al. Safety and clinical impact of fees – results of the fees-registry *Neurological Practice and Research*. 2019;1:1-8
139. Hwang JM, Cheong YS, Kang MG, Chun SM, Min YS, Lee YS, et al. Recommendation of nasogastric tube removal in acute stroke patients based on videofluoroscopic swallow study. *Annals of rehabilitation medicine*. 2017;41:9-15
140. Aviv JE. Prospective, randomized outcome study of endoscopy versus modified barium swallow in patients with dysphagia. *The Laryngoscope*. 2000;110:563-574
141. Miles A, Zeng IS, McLauchlan H, Huckabee ML. Cough reflex testing in dysphagia following stroke: A randomized controlled trial. *Journal of clinical medicine research*. 2013;5:222-233
142. Bath PM, Lee HS, Everton LF. Swallowing therapy for dysphagia in acute and subacute stroke. *The Cochrane database of systematic reviews*. 2018;10:Cd000323
143. Steele CM, Alsanei WA, Ayanikalath S, Barbon CE, Chen J, Cichero JA, et al. The influence of food texture and liquid consistency modification on swallowing physiology and function: A systematic review. *Dysphagia*. 2015;30:2-26
144. Vilardell N, Rofes L, Arreola V, Speyer R, Clave P. A comparative study between modified starch and xanthan gum thickeners in post-stroke oropharyngeal dysphagia. *Dysphagia*. 2016;31:169-179
145. Bolivar-Prados M, Rofes L, Arreola V, Guida S, Nascimento WV, Martin A, et al. Effect of a gum-based thickener on the safety of swallowing in patients with poststroke oropharyngeal dysphagia. *Neurogastroenterology and motility : the official journal of the European Gastrointestinal Motility Society*. 2019;31:e13695
146. Rofes L, Arreola V, Mukherjee R, Swanson J, Clavé P. The effects of a xanthan gum-based thickener on the swallowing function of patients with dysphagia. *Alimentary pharmacology & therapeutics*. 2014;39:1169-1179
147. Andersen UT, Beck AM, Kjaersgaard A, Hansen T, I P. Systematic review and evidence based recommendations on texture modified foods and thickened fluids for adults with oropharyngeal dysphagia. *e-SPEN Journal*. 2013;8:e127-e134
148. Newman R, Vilardell N, Clave P, Speyer R. Effect of bolus viscosity on the safety and efficacy of swallowing and the kinematics of the swallow response in patients with oropharyngeal dysphagia: White paper by the european society for swallowing disorders (essd). *Dysphagia*. 2016;31:232-249

149. Ortega O, Bolívar-Prados M, Arreola V, Nascimento WV, Tomsen N, Gallegos C, et al. Therapeutic effect, rheological properties and α-amylase resistance of a new mixed starch and xanthan gum thickener on four different phenotypes of patients with oropharyngeal dysphagia. *Nutrients*. 2020;12
150. Hanson B. A review of diet standardization and bolus rheology in the management of dysphagia. *Current opinion in otolaryngology & head and neck surgery*. 2016;24:183-190
151. Cichero JA, Lam P, Steele CM, Hanson B, Chen J, Dantas RO, et al. Development of international terminology and definitions for texture-modified foods and thickened fluids used in dysphagia management: The iddsi framework. *Dysphagia*. 2017;32:293-314
152. Martínez-Guillén M, Carrión-Bolorino S, Bolívar-Prados M, Arreola V, Costa A, Clavé P. Oropharyngeal dysphagia☆. In: Kuipers EJ, ed. *Encyclopedia of gastroenterology (second edition)*. Oxford: Academic Press; 2020:757-773.
153. Diniz PB, Vanin G, Xavier R, Parente MA. Reduced incidence of aspiration with spoon-thick consistency in stroke patients. *Nutrition in clinical practice : official publication of the American Society for Parenteral and Enteral Nutrition*. 2009;24:414-418
154. Garon BR, Engle M, Ormiston C. A randomized control study to determine the effects of unlimited oral intake of water in patients with identified aspiration. *Journal of Neurologic Rehabilitation*. 1997;11:139-148
155. Goulding R, Bakheit AM. Evaluation of the benefits of monitoring fluid thickness in the dietary management of dysphagic stroke patients. *Clinical rehabilitation*. 2000;14:119-124
156. Murray J, Doeltgen S, Miller M, Scholten I. Does a water protocol improve the hydration and health status of individuals with thin liquid aspiration following stroke? A randomized controlled trial. *Dysphagia*. 2016;31:424-433
157. Whelan K. Inadequate fluid intakes in dysphagic acute stroke. *Clinical nutrition (Edinburgh, Scotland)*. 2001;20:423-428
158. Yuan Z, Huang L, Chen Z. Coagulant and enteral nutrition agent in the rehabilitation of deglutition disorders for patients with acute stroke. *Chinese Journal of Clinical Rehabilitation*. 2003;7:3834-3835
159. Finestone HM, Foley NC, Woodbury MG, Greene-Finestone L. Quantifying fluid intake in dysphagic stroke patients: A preliminary comparison of oral and nonoral strategies. *Archives of physical medicine and rehabilitation*. 2001;82:1744-1746
160. McGrail A, Kelchner L. Barriers to oral fluid intake: Beyond thickened liquids. *The Journal of neuroscience nursing : journal of the American Association of Neuroscience Nurses*. 2015;47:58-63
161. Foley N, Finestone H, Woodbury MG, Teasell R, Greene Finestone L. Energy and protein intakes of acute stroke patients. *The journal of nutrition, health & aging*. 2006;10:171-175
162. Robbins J, Gensler G, Hind J, Logemann JA, Lindblad AS, Brandt D, et al. Comparison of 2 interventions for liquid aspiration on pneumonia incidence: A randomized trial. *Annals of internal medicine*. 2008;148:509-518
163. Shaker R, Kern M, Bardan E, Taylor A, Stewart ET, Hoffmann RG, et al. Augmentation of deglutitive upper esophageal sphincter opening in the elderly by exercise. *The American journal of physiology*. 1997;272:G1518-1522
164. Byeon H. Effect of the masako maneuver and neuromuscular electrical stimulation on the improvement of swallowing function in patients with dysphagia caused by stroke. *Journal of physical therapy science*. 2016;28:2069-2071
165. Park JS, Oh DH, Chang MY, Kim KM. Effects of expiratory muscle strength training on oropharyngeal dysphagia in subacute stroke patients: A randomised controlled trial. *Journal of oral rehabilitation*. 2016;43:364-372
166. Shanahan TK, Logemann JA, Rademaker AW, Pauloski BR, Kahrilas PJ. Chin-down posture effect on aspiration in dysphagic patients. *Archives of physical medicine and rehabilitation*. 1993;74:736-739

167. Ding R, Larson CR, Logemann JA, Rademaker AW. Surface electromyographic and electroglottographic studies in normal subjects under two swallow conditions: Normal and during the mendelsohn manuever. *Dysphagia*. 2002;17:1-12
168. Langmore SE, Pisegna JM. Efficacy of exercises to rehabilitate dysphagia: A critique of the literature. *International journal of speech-language pathology*. 2015;17:222-229
169. Mao LY, Li LL, Mao ZN, Han YP, Zhang XL, Yao JX, et al. Therapeutic effect of acupuncture combining standard swallowing training for post-stroke dysphagia: A prospective cohort study. *Chinese journal of integrative medicine*. 2016;22:525-531
170. Bakhtiyari J, Sarraf P, Nakhostin-Ansari N, Tafakhori A, Logemann J, Faghihzadeh S, et al. Effects of early intervention of swallowing therapy on recovery from dysphagia following stroke. *Iranian journal of neurology*. 2015;14:119-124
171. Carnaby G, Hankey GJ, Pizzi J. Behavioural intervention for dysphagia in acute stroke: A randomised controlled trial. *The Lancet. Neurology*. 2006;5:31-37
172. Eom MJ, Chang MY, Oh DH, Kim HD, Han NM, Park JS. Effects of resistance expiratory muscle strength training in elderly patients with dysphagic stroke. *NeuroRehabilitation*. 2017;41:747-752
173. Guillén-Solà A, Messagi Sartor M, Bofill Soler N, Duarte E, Barrera MC, Marco E. Respiratory muscle strength training and neuromuscular electrical stimulation in subacute dysphagic stroke patients: A randomized controlled trial. *Clinical rehabilitation*. 2017;31:761-771
174. Park JS, Oh DH, Chang MY. Effect of expiratory muscle strength training on swallowing-related muscle strength in community-dwelling elderly individuals: A randomized controlled trial. *Gerodontology*. 2016
175. Choi JB, Shim SH, Yang JE, Kim HD, Lee DH, Park JS. Effects of shaker exercise in stroke survivors with oropharyngeal dysphagia. *NeuroRehabilitation*. 2017;41:753-757
176. Fraga BF, Almeida ST, Santana MG, Cassol M. Efficacy of myofunctional therapy associated with voice therapy in the rehabilitation of neurogenic oropharyngeal dysphagia: A pilot study. *International archives of otorhinolaryngology*. 2018;22:225-230
177. Gao J, Zhang HJ. Effects of chin tuck against resistance exercise versus shaker exercise on dysphagia and psychological state after cerebral infarction. *European journal of physical and rehabilitation medicine*. 2017;53:426-432
178. Heo SY, Kim KM. Immediate effects of kinesio taping on the movement of the hyoid bone and epiglottis during swallowing by stroke patients with dysphagia. *Journal of physical therapy science*. 2015;27:3355-3357
179. Kim HD, Choi JB, Yoo SJ, Chang MY, Lee SW, Park JS. Tongue-to-palate resistance training improves tongue strength and oropharyngeal swallowing function in subacute stroke survivors with dysphagia. *Journal of oral rehabilitation*. 2017;44:59-64
180. Don Kim K, Lee HJ, Lee MH, Ryu HJ. Effects of neck exercises on swallowing function of patients with stroke. *Journal of physical therapy science*. 2015;27:1005-1008
181. Kim YK, Lee KY, Lee SH. Efficacy of a 4-week swallowing rehabilitation program combined with pyriform sinus ballooning in patients with post-stroke dysphagia. *Annals of rehabilitation medicine*. 2018;42:542-550
182. Koyama Y, Sugimoto A, Hamano T, Kasahara T, Toyokura M, Masakado Y. Proposal for a modified jaw opening exercise for dysphagia: A randomized, controlled trial. *The Tokai journal of experimental and clinical medicine*. 2017;42:71-78
183. Kulnik ST, Birring SS, Moxham J, Rafferty GF, Kalra L. Does respiratory muscle training improve cough flow in acute stroke? Pilot randomized controlled trial. *Stroke; a journal of cerebral circulation*. 2015;46:447-453
184. Messaggi-Sartor M, Guillen-Solà A, Depolo M, Duarte E, Rodríguez DA, Barrera MC, et al. Inspiratory and expiratory muscle training in subacute stroke: A randomized clinical trial. *Neurology*. 2015;85:564-572
185. Moon JH, Jung JH, Won YS, Cho HY, Cho K. Effects of expiratory muscle strength training on swallowing function in acute stroke patients with dysphagia. *Journal of physical therapy science*. 2017;29:609-612

186. Moon JH, Hahm SC, Won YS, Cho HY. The effects of tongue pressure strength and accuracy training on tongue pressure strength, swallowing function, and quality of life in subacute stroke patients with dysphagia: A preliminary randomized clinical trial. *International journal of rehabilitation research. Internationale Zeitschrift fur Rehabilitationsforschung. Revue internationale de recherches de readaptation*. 2018;41:204-210
187. Park JS, Kim HJ, Oh DH. Effect of tongue strength training using the iowa oral performance instrument in stroke patients with dysphagia. *Journal of physical therapy science*. 2015;27:3631-3634
188. Park JS, Hwang NK, Oh DH, Chang MY. Effect of head lift exercise on kinematic motion of the hyolaryngeal complex and aspiration in patients with dysphagic stroke. *Journal of oral rehabilitation*. 2017;44:385-391
189. Park JS, An DH, Oh DH, Chang MY. Effect of chin tuck against resistance exercise on patients with dysphagia following stroke: A randomized pilot study. *NeuroRehabilitation*. 2018;42:191-197
190. Power ML, Fraser C, Hobson A, Singh S, Tyrell P, Nicholson DA, et al. Evaluating oral stimulation as a treatment for dysphagia after stroke. *Dysphagia*. 2006;21:49-55
191. Steele CM, Bayley MT, Peladeau-Pigeon M, Nagy A, Namasivayam AM, Stokely SL, et al. A randomized trial comparing two tongue-pressure resistance training protocols for post-stroke dysphagia. *Dysphagia*. 2016;31:452-461
192. Kim JH, Kim YA, Lee HJ, Kim KS, Kim ST, Kim TS, et al. Effect of the combination of mendelsohn maneuver and effortful swallowing on aspiration in patients with dysphagia after stroke. *Journal of physical therapy science*. 2017;29:1967-1969
193. Kang JH, Park RY, Lee SJ, Kim JY, Yoon SR, Jung KI. The effect of bedside exercise program on stroke patients with dysphagia. *Annals of rehabilitation medicine*. 2012;36:512-520
194. Li CM, Wang TG, Lee HY, Wang HP, Hsieh SH, Chou M, et al. Swallowing training combined with game-based biofeedback in poststroke dysphagia. *PM & R : the journal of injury, function, and rehabilitation*. 2016;8:773-779
195. Lin LC, Wang SC, H CS, Wang TG, Chen MY, Wu SC. Efficacy of swallowing training for residents following stroke. *Journal of advanced nursing*. 2003;44:469-478
196. Jing B, Bao-dong L, Zhi-yong W, Wei-bin G, Wang LC. [the role of different needling manipulation in adjusting swallow-period obstacle of dysphagia after stroke]. *Zhongguo zhen jiu = Chinese acupuncture & moxibustion*. 2007;27:35-37
197. Chan SL, Or KH, Sun WZ, Ng KY, Lo SK, Lee YS. Therapeutic effects of acupuncture for neurogenic dysphagia--a randomized controlled trial. *Journal of traditional Chinese medicine = Chung i tsa chih ying wen pan*. 2012;32:25-30
198. Chang L, He PL, Zhou ZZ, Li YH. [efficacy observation of dysphagia after acute stroke treated with acupuncture and functional electric stimulation]. *Zhongguo zhen jiu = Chinese acupuncture & moxibustion*. 2014;34:737-740
199. Chen L, Fang J, Ma R, Gu X, Chen L, Li J, et al. Additional effects of acupuncture on early comprehensive rehabilitation in patients with mild to moderate acute ischemic stroke: A multicenter randomized controlled trial. *BMC complementary and alternative medicine*. 2016;16:226
200. Cheng FX, Chen T. [efficacy observation of post-stroke dysphagia treated with acupuncture at lianquan (cv 23)]. *Zhongguo zhen jiu = Chinese acupuncture & moxibustion*. 2014;34:627-630
201. Chu J, Liu X, Chen F, Hong F, Bao Y. [effects of gao's neck acupuncture on swallowing function and quality of life in patients with post-stroke pseudobulbar palsy:A randomized controlled trial]. *Zhongguo zhen jiu = Chinese acupuncture & moxibustion*. 2017;37:691-695
202. Fan C, Jiang H, Wu L. Clinical observations on acupuncture treatment of postapoplectic dysphagia. *Shanghai J Acupunct Moxibust*. 2007;26:6-7
203. Feng S, Cao S, Du S, Yin T, Mai F, Chen X, et al. [acuuncture combined with swallowing training for post-stroke dysphagia: A randomized controlled trial]. *Zhongguo zhen jiu = Chinese acupuncture & moxibustion*. 2016;36:347-350

204. Han J. An observation on the therapeutic effect of acupuncture for bulbar palsy after acute stroke. *Henan J Pract Nerv Dis*. 2004;7:81-82
205. Huang YL, Liang FR, Chang HS. [effect of acupuncture on quality of life in post-ischemic stroke patients with dysphagia]. *Zhongguo Zhong xi yi jie he za zhi Zhongguo Zhongxiyi jiehe zazhi = Chinese journal of integrated traditional and Western medicine*. 2008;28:505-508
206. Huang Z, Huang F, Yan HX, Min Y, Gao Y, Tan BD, et al. [dysphagia after stroke treated with acupuncture or electric stimulation: A randomized controlled trial]. *Zhongguo zhen jiu = Chinese acupuncture & moxibustion*. 2010;30:969-973
207. Jia H-l, Zhang Y-c. Treatment of 40 cases of post-apoplectic dysphagia by acupuncture plus rehabilitation exercise. *Journal of Acupuncture and Tuina Science*. 2006;4:336-338
208. Jin Z, Chen J, Wang Y-l. Clinical study on puncturing renying (st 9) to treat poststroke dysphagia. *Journal of Acupuncture and Tuina Science*. 2010;8:246-248
209. Kikuchi A, Seki T, Takayama S, Iwasaki K, Ishizuka S, Yaegashi N. Effect of press needles on swallowing reflex in older adults with cerebrovascular disease: A randomized double-blind controlled trial. *Journal of the American Geriatrics Society*. 2014;62:2438-2440
210. Liu Y. Treatment of pseudobulbar paralysis by scalp acupuncture and sublingual needling. *Journal of traditional Chinese medicine = Chung i tsa chih ying wen pan*. 2004;24:26-27
211. Liu D-d, Tong X, Kou J-y, Wei Y, Yang T-s. Influence of acupuncture on remodeling of swallowing functions for patients with pseudobulbar palsy after cerebral infarction. *Journal of Acupuncture and Tuina Science*. 2012;10:44-48
212. Ma FX, Cao GP, Li WL. [post-stroke dysphagia treated with acupoint injection combined with neural electrical stimulation]. *Zhongguo zhen jiu = Chinese acupuncture & moxibustion*. 2014;34:1169-1173
213. Ma JN, Wang ZL, Ning LN, Yang H, Xiong J. [observation on therapeutic effects of acupuncture combined with cutaneous electrical stimulation for dysphagia in patients with cerebral 1nfarction]. *Zhen ci yan jiu = Acupuncture research*. 2015;40:238-241
214. Meng Y, Wang C, Shang S, Ning L, Zhou L, Han K. [effects of different acupuncture depths of lianquan (cv 23) for dysphagia after stroke: A randomized controlled trial]. *Zhongguo zhen jiu = Chinese acupuncture & moxibustion*. 2015;35:990-994
215. Seki T, Iwasaki K, Arai H, Sasaki H, Hayashi H, Yamada S, et al. Acupuncture for dysphagia in poststroke patients: A videofluoroscopic study. *Journal of the American Geriatrics Society*. 2005;53:1083-1084
216. Wu P, Liang F, Li Y, Yang L, Huang Y, Li A, et al. Clinical observation on acupuncture plus rehabilitation training for dysphagia after stroke—a multi-centered random-controlled trial. *Journal of traditional Chinese medicine*. 2011;1
217. Xia W, Zheng C, Zhu S, Tang Z. Does the addition of specific acupuncture to standard swallowing training improve outcomes in patients with dysphagia after stroke? A randomized controlled trial. *Clinical rehabilitation*. 2016;30:237-246
218. Lili Y. A clinical study on acupuncture combined with rehabilitation therapy for 57 cases of swallowing disorders after stroke [j]. *Journal of Traditional Chinese Medicine*. 2013;9
219. Zheng H, Zhu S-W, Yang F, Huang X-M, Wang Z, Cui F-F, et al. Efficacy observation of thoroughfare vessel theory in acupuncture for post-stroke dysphasia. *Zhongguo zhen jiu= Chinese acupuncture & moxibustion*. 2011;31:1067-1070
220. Zhou Z, Y.L. Z, H. Y. The clinical observation of 60 cases of scalp and body acupuncture treatment for dysphagia after stroke. *Lishizhen Medicine and Materia Medica Research*. 2014;24:2160-2162
221. Liu L. Acupuncture treatment of bulbar palsy--a report of 54 cases. *Journal of traditional Chinese medicine = Chung i tsa chih ying wen pan*. 2000;20:30-32
222. Liu X-p, Chen F-y, Chu J-m, Bao Y-h. Therapeutic observation of gao's nape acupuncture plus swallowing training for pharyngeal deglutition disorder after stroke. *Journal of Acupuncture and Tuina Science*. 2019;17:37-43

223. Dennis MS, Lewis SC, Warlow C. Routine oral nutritional supplementation for stroke patients in hospital (food): A multicentre randomised controlled trial. *Lancet (London, England)*. 2005;365:755-763
224. Gariballa SE, Parker SG, Taub N, Castleden CM. A randomized, controlled, a single-blind trial of nutritional supplementation after acute stroke. *JPEN. Journal of parenteral and enteral nutrition*. 1998;22:315-319
225. Ha L, Hauge T, Spenning AB, Iversen PO. Individual, nutritional support prevents undernutrition, increases muscle strength and improves qol among elderly at nutritional risk hospitalized for acute stroke: A randomized, controlled trial. *Clinical nutrition (Edinburgh, Scotland)*. 2010;29:567-573
226. Rabadi MH, Coar PL, Lukin M, Lesser M, Blass JP. Intensive nutritional supplements can improve outcomes in stroke rehabilitation. *Neurology*. 2008;71:1856-1861
227. Aquilani R, Scocchi M, Iadarola P, Franciscone P, Verri M, Boschi F, et al. Protein supplementation may enhance the spontaneous recovery of neurological alterations in patients with ischaemic stroke. *Clinical rehabilitation*. 2008;22:1042-1050
228. Dennis M, Lewis S, Cranswick G, Forbes J. Food: A multicentre randomised trial evaluating feeding policies in patients admitted to hospital with a recent stroke. *Health technology assessment (Winchester, England)*. 2006;10:iii-iv, ix-x, 1-120
229. Dennis MS, Lewis SC, Warlow C. Effect of timing and method of enteral tube feeding for dysphagic stroke patients (food): A multicentre randomised controlled trial. *Lancet (London, England)*. 2005;365:764-772
230. Zheng T, Zhu X, Liang H, Huang H, Yang J, Wang S. Impact of early enteral nutrition on short term prognosis after acute stroke. *Journal of clinical neuroscience : official journal of the Neurosurgical Society of Australasia*. 2015;22:1473-1476
231. Dai R, Lam OL, Lo EC, Li LS, Wen Y, McGrath C. A systematic review and meta-analysis of clinical, microbiological, and behavioural aspects of oral health among patients with stroke. *Journal of dentistry*. 2015;43:171-180
232. Nishizawa T, Niikura Y, Akasaka K, Watanabe M, Kurai D, Amano M, et al. Pilot study for risk assessment of aspiration pneumonia based on oral bacteria levels and serum biomarkers. *BMC infectious diseases*. 2019;19:761
233. Huang ST, Chiou CC, Liu HY. Risk factors of aspiration pneumonia related to improper oral hygiene behavior in community dysphagia persons with nasogastric tube feeding. *Journal of dental sciences*. 2017;12:375-381
234. Perry SE, Huckabee ML, Tompkins G, Milne T. The association between oral bacteria, the cough reflex and pneumonia in patients with acute stroke and suspected dysphagia. *Journal of oral rehabilitation*. 2020;47:386-394
235. Ortega O, Sakwinska O, Combremont S, Berger B, Sauser J, Parra C, et al. High prevalence of colonization of oral cavity by respiratory pathogens in frail older patients with oropharyngeal dysphagia. *Neurogastroenterology and motility : the official journal of the European Gastrointestinal Motility Society*. 2015;27:1804-1816
236. Kalra L, Hodsoll J, Irshad S, Smithard D, Manawadu D. Association between nasogastric tubes, pneumonia, and clinical outcomes in acute stroke patients. *Neurology*. 2016;87:1352-1359
237. Chipps E, Gatens C, Genter L, Musto M, Dubis-Bohn A, Gliemmo M, et al. Pilot study of an oral care protocol on poststroke survivors. *Rehabilitation nursing : the official journal of the Association of Rehabilitation Nurses*. 2014;39:294-304
238. Gosney M, Martin MV, Wright AE. The role of selective decontamination of the digestive tract in acute stroke. *Age and ageing*. 2006;35:42-47
239. Kuo YW, Yen M, Fetzer S, Lee JD, Chiang LC. Effect of family caregiver oral care training on stroke survivor oral and respiratory health in taiwan: A randomised controlled trial. *Community dental health*. 2015;32:137-142
240. Lam OL, McMillan AS, Samaranayake LP, Li LS, McGrath C. Effect of oral hygiene interventions on opportunistic pathogens in patients after stroke. *American journal of infection control*. 2013;41:149-154

241. Murray J, Scholten I. An oral hygiene protocol improves oral health for patients in inpatient stroke rehabilitation. *Gerodontology*. 2018;35:18-24
242. Wagner C, Marchina S, Deveau JA, Frayne C, Sulmonte K, Kumar S. Risk of stroke-associated pneumonia and oral hygiene. *Cerebrovascular diseases (Basel, Switzerland)*. 2016;41:35-39
243. Talley LK, Harl J, Lamb J, Green L, Lorenz H. Oral care program decreases length of stay (los) and length of time oral foods and fluids are withheld (npo) in stroke patients. *STROKE*. 2015;46
244. Alvarez-Berdugo D, Rofes L, Farre R, Casamitjana JF, Enrique A, Chamizo J, et al. Localization and expression of trpv1 and trpa1 in the human oropharynx and larynx. *Neurogastroenterology and motility : the official journal of the European Gastrointestinal Motility Society*. 2016;28:91-100
245. Nakazawa H, Sekizawa K, Ujiie Y, Sasaki H, Takishima T. Risk of aspiration pneumonia in the elderly. *Chest*. 1993;103:1636-1637
246. Vermeij JD, Westendorp WF, Dippel DW, van de Beek D, Nederkoorn PJ. Antibiotic therapy for preventing infections in people with acute stroke. *The Cochrane database of systematic reviews*. 2018;1:Cd008530
247. Arai T, Yasuda Y, Takaya T, Toshima S, Kashiki Y, Yoshimi N, et al. Ace inhibitors and symptomless dysphagia. *Lancet (London, England)*. 1998;352:115-116
248. Arai T, Sekizawa K, Yoshimi N, Toshima S, Fujiwara H. Cabergoline and silent aspiration in elderly patients with stroke. *Journal of the American Geriatrics Society*. 2003;51:1815-1816
249. Arai T, Yoshimi N, Fujiwara H, Sekizawa K. Serum substance p concentrations and silent aspiration in elderly patients with stroke. *Neurology*. 2003;61:1625-1626
250. Chamorro A, Horcajada JP, Obach V, Vargas M, Revilla M, Torres F, et al. The early systemic prophylaxis of infection after stroke study: A randomized clinical trial. *Stroke; a journal of cerebral circulation*. 2005;36:1495-1500
251. Chen D, Xing H, Jiang Q, Xiang Y, Hu W, Guo H. Role of levetiracetam in the rehabilitation of dysphagia due to stroke. *International Journal of Pharmacology*. 2017;13:603-611
252. DeFalco F, Majello L, Angelone P. Antimicrobial prophylaxis in the management of ischemic stroke. *Rivista di neurobiologia*. 1998;44:5
253. Ebihara T, Takahashi H, Ebihara S, Okazaki T, Sasaki T, Watando A, et al. Capsaicin troche for swallowing dysfunction in older people. *Journal of the American Geriatrics Society*. 2005;53:824-828
254. Ebihara T, Ebihara S, Maruyama M, Kobayashi M, Itou A, Arai H, et al. A randomized trial of olfactory stimulation using black pepper oil in older people with swallowing dysfunction. *Journal of the American Geriatrics Society*. 2006;54:1401-1406
255. Harms H, Prass K, Meisel C, Klehmet J, Rogge W, Drenckhahn C, et al. Preventive antibacterial therapy in acute ischemic stroke: A randomized controlled trial. *PloS one*. 2008;3:e2158
256. Kalra L, Irshad S, Hodsoll J, Simpson M, Gulliford M, Smithard D, et al. Prophylactic antibiotics after acute stroke for reducing pneumonia in patients with dysphagia (stroke-inf): A prospective, cluster-randomised, open-label, masked endpoint, controlled clinical trial. *Lancet (London, England)*. 2015;386:1835-1844
257. Kanda A, Ebihara S, Yasuda H, Takashi O, Sasaki T, Sasaki H. A combinatorial therapy for pneumonia in elderly people. *Journal of the American Geriatrics Society*. 2004;52:846-847
258. Lee JS, Chui PY, Ma HM, Auyeung TW, Kng C, Law T, et al. Does low dose angiotensin converting enzyme inhibitor prevent pneumonia in older people with neurologic dysphagia--a randomized placebo-controlled trial. *Journal of the American Medical Directors Association*. 2015;16:702-707
259. Nakagawa T, Wada H, Sekizawa K, Arai H, Sasaki H. Amantadine and pneumonia. *Lancet (London, England)*. 1999;353:1157
260. Ohkubo T, Chapman N, Neal B, Woodward M, Omae J, Chalmers J. Effects of an angiotensin-converting enzyme inhibitor-based regime on pneumonia risk. *American journal of respiratory and critical care medicine*. 2004;169:1041-1045

261. Perez I, Smithard DG, Davies H, Kalra L. Pharmacological treatment of dysphagia in stroke. *Dysphagia*. 1998;13:12-16
262. Rofes L, Arreola V, Martin A, Clave P. Effect of oral piperine on the swallow response of patients with oropharyngeal dysphagia. *Journal of gastroenterology*. 2014;49:1517-1523
263. Schwarz S, Al-Shajlawi F, Sick C, Meairs S, Hennerici MG. Effects of prophylactic antibiotic therapy with mezlocillin plus sulbactam on the incidence and height of fever after severe acute ischemic stroke: The mannheim infection in stroke study (miss). *Stroke; a journal of cerebral circulation*. 2008;39:1220-1227
264. Ulm L, Hoffmann S, Nabavi D, Hermans M, Mackert BM, Hamilton F, et al. The randomized controlled strawinski trial: Procalcitonin-guided antibiotic therapy after stroke. *Frontiers in neurology*. 2017;8:153
265. Warusevitane A, Karunatilake D, Sim J, Lally F, Roffe C. Safety and effect of metoclopramide to prevent pneumonia in patients with stroke fed via nasogastric tubes trial. *Stroke; a journal of cerebral circulation*. 2015;46:454-460
266. Westendorp WF, Vermeij JD, Zock E, Hooijenga IJ, Kruyt ND, Bosboom HJ, et al. The preventive antibiotics in stroke study (pass): A pragmatic randomised open-label masked endpoint clinical trial. *Lancet (London, England)*. 2015;385:1519-1526
267. Yusuf S, Diener HC, Sacco RL, Cotton D, Ounpuu S, Lawton WA, et al. Telmisartan to prevent recurrent stroke and cardiovascular events. *The New England journal of medicine*. 2008;359:1225-1237
268. Group PC. Randomised trial of a perindopril-based blood-pressure-lowering regimen among 6105 individuals with previous stroke or transient ischaemic attack. *The Lancet*. 2001;358:1033-1041
269. Arai T, Sekizawa K. Cabergoline and silent aspiration in elderly patients with stroke. *Journal of the American Geriatrics Society*. 2003;51:1815-1816
270. Kobayashi H, Nakagawa T, Sekizawa K, Arai H, Sasaki H. Levodopa and swallowing reflex. *Lancet (London, England)*. 1996;348:1320-1321
271. Arai T, Yasuda Y, Toshima S, Yoshimi N, Kashiki Y. Ace inhibitors and pneumonia in elderly people. *Lancet (London, England)*. 1998;352:1937-1938
272. Arai T, Yasuda Y, Takaya T, Toshima S, Kashiki Y, Yoshimi N, et al. Ace inhibitors and reduction of the risk of pneumonia in elderly people. *American journal of hypertension*. 2000;13:1050-1051
273. Arai T, Yasuda Y, Takaya T, Toshima S, Kashiki Y, Shibayama M, et al. Angiotensin-converting enzyme inhibitors, angiotensin-ii receptor antagonists, and pneumonia in elderly hypertensive patients with stroke. *Chest*. 2001;119:660-661
274. Arai T, Sekizawa K, Ohrui T, Fujiwara H, Yoshimi N, Matsuoka H, et al. Ace inhibitors and protection against pneumonia in elderly patients with stroke. *Neurology*. 2005;64:573-574
275. Cuifang S. The effects of angiotensin-converting-enzyme inhibitor on pneumonia in older stroke patients. *CIRCULATION*. 2010;122:E348-E348
276. Ebihara T, Sekizawa K, Nakazawa H, Sasaki H. Capsaicin and swallowing reflex. *Lancet (London, England)*. 1993;341:432
277. Ebihara T, Ebihara S, Yamazaki M, Asada M, Yamanda S, Arai H. Intensive stepwise method for oral intake using a combination of transient receptor potential stimulation and olfactory stimulation inhibits the incidence of pneumonia in dysphagic older adults. *Journal of the American Geriatrics Society*. 2010;58:196-198
278. Harada J, Sekizawa K. Angiotensin-converting enzyme inhibitors and pneumonia in elderly patients with intracerebral hemorrhage. *Journal of the American Geriatrics Society*. 2006;54:175-176
279. Sekizawa K, Matsui T, Nakagawa T, Nakayama K, Sasaki H. Ace inhibitors and pneumonia. *Lancet (London, England)*. 1998;352:1069
280. Muhle P, Suntrup-Krueger S, Dziewas R. Neurophysiological adaptation and neuromodulatory treatment approaches in patients suffering from post-stroke dysphagia. *Current physical medicine and rehabilitation reports*. 2018;6:227-238

281. Ahn YH, Sohn HJ, Park JS, Ahn TG, Shin YB, Park M, et al. Effect of bihemispheric anodal transcranial direct current stimulation for dysphagia in chronic stroke patients: A randomized clinical trial. *Journal of rehabilitation medicine*. 2017;49:30-35
282. Arreola V, Rofes L, Vilardel N, Tomsen N, Alvarez-Berdugo D, Ortega O, et al. Therapeutic effect of transcutaneous electrical stimulation on chronic post-stroke oropharyngeal dysphagia: A randomized controlled trial with two stimulation intensities. *Dysphagia*. 2018;33:519-520
283. Bath PM, Scutt P, Love J, Clave P, Cohen D, Dziewas R, et al. Pharyngeal electrical stimulation for treatment of dysphagia in subacute stroke: A randomized controlled trial. *Stroke; a journal of cerebral circulation*. 2016;47:1562-1570
284. Bülow M, Speyer R, Baijens L, Woisard V, Ekberg O. Neuromuscular electrical stimulation (nmes) in stroke patients with oral and pharyngeal dysfunction. *Dysphagia*. 2008;23:302-309
285. Du J, Yang F, Liu L, Hu J, Cai B, Liu W, et al. Repetitive transcranial magnetic stimulation for rehabilitation of poststroke dysphagia: A randomized, double-blind clinical trial. *Clinical neurophysiology : official journal of the International Federation of Clinical Neurophysiology*. 2016;127:1907-1913
286. Dziewas R, Stellato R, van der Tweel I, Walther E, Werner CJ, Braun T, et al. Pharyngeal electrical stimulation for early decannulation in tracheotomised patients with neurogenic dysphagia after stroke (phast-trac): A prospective, single-blinded, randomised trial. *The Lancet. Neurology*. 2018;17:849-859
287. Huang KL, Liu TY, Huang YC, Leong CP, Lin WC, Pong YP. Functional outcome in acute stroke patients with oropharyngeal dysphagia after swallowing therapy. *Journal of stroke and cerebrovascular diseases : the official journal of National Stroke Association*. 2014;23:2547-2553
288. Jayasekeran V, Singh S, Tyrell P, Michou E, Jefferson S, Mistry S, et al. Adjunctive functional pharyngeal electrical stimulation reverses swallowing disability after brain lesions. *Gastroenterology*. 2010;138:1737-1746
289. Khedr EM, Abo-Elfetoh N, Rothwell JC. Treatment of post-stroke dysphagia with repetitive transcranial magnetic stimulation. *Acta neurologica Scandinavica*. 2009;119:155-161
290. Khedr EM, Abo-Elfetoh N. Therapeutic role of rtms on recovery of dysphagia in patients with lateral medullary syndrome and brainstem infarction. *Journal of neurology, neurosurgery, and psychiatry*. 2010;81:495-499
291. Kim L, Chun MH, Kim BR, Lee SJ. Effect of repetitive transcranial magnetic stimulation on patients with brain injury and dysphagia. *Annals of rehabilitation medicine*. 2011;35:765-771
292. Ko S-H, Kim S-Y, Park M, Yang J-H, Shin Y-I. Effect of tanscranial direct current stimulation for swallowing function in the stroke patients. *Archives of physical medicine and rehabilitation*. 2016;97:e104
293. Kumar S, Wagner CW, Frayne C, Zhu L, Selim M, Feng W, et al. Noninvasive brain stimulation may improve stroke-related dysphagia: A pilot study. *Stroke; a journal of cerebral circulation*. 2011;42:1035-1040
294. Lim KB, Lee HJ, Lim SS, Choi YI. Neuromuscular electrical and thermal-tactile stimulation for dysphagia caused by stroke: A randomized controlled trial. *Journal of rehabilitation medicine*. 2009;41:174-178
295. Lim KB, Lee HJ, Yoo J, Kwon YG. Effect of low-frequency rtms and nmes on subacute unilateral hemispheric stroke with dysphagia. *Annals of rehabilitation medicine*. 2014;38:592-602
296. Meng P, Zhang S, Wang Q, Wang P, Han C, Gao J, et al. The effect of surface neuromuscular electrical stimulation on patients with post-stroke dysphagia. *Journal of back and musculoskeletal rehabilitation*. 2018;31:363-370
297. Michou E, Mistry S, Jefferson S, Tyrrell P, Hamdy S. Characterizing the mechanisms of central and peripheral forms of neurostimulation in chronic dysphagic stroke patients. *Brain stimulation*. 2014;7:66-73

298. Park E, Kim MS, Chang WH, Oh SM, Kim YK, Lee A, et al. Effects of bilateral repetitive transcranial magnetic stimulation on post-stroke dysphagia. *Brain stimulation*. 2017;10:75-82
299. Park JS, Oh DH, Hwang NK, Lee JH. Effects of neuromuscular electrical stimulation combined with effortful swallowing on post-stroke oropharyngeal dysphagia: A randomised controlled trial. *Journal of oral rehabilitation*. 2016;43:426-434
300. Park JW, Oh JC, Lee JW, Yeo JS, Ryu KH. The effect of 5hz high-frequency rtms over contralesional pharyngeal motor cortex in post-stroke oropharyngeal dysphagia: A randomized controlled study. *Neurogastroenterology and motility : the official journal of the European Gastrointestinal Motility Society*. 2013;25:324-e250
301. Permsirivanich W, Tipchatyotin S, Wongchai M, Leelamanit V, Setthawatcharawanich S, Sathirapanya P, et al. Comparing the effects of rehabilitation swallowing therapy vs. Neuromuscular electrical stimulation therapy among stroke patients with persistent pharyngeal dysphagia: A randomized controlled study. *Journal of the Medical Association of Thailand = Chotmaihet thangphaet*. 2009;92:259-265
302. Singh SAtopesft, Stroke todpsHT, Association. A trial of pharyngeal electrical stimulation for the treatment of dysphagia post stroke. *Proceedings of the UK Stroke Forum Conference*. 2006:31
303. Shigematsu T, Fujishima I, Ohno K. Transcranial direct current stimulation improves swallowing function in stroke patients. *Neurorehabilitation and neural repair*. 2013;27:363-369
304. Sproson L, Pownall S, Enderby P, Freeman J. Combined electrical stimulation and exercise for swallow rehabilitation post-stroke: A pilot randomized control trial. *International journal of language & communication disorders*. 2018;53:405-417
305. Suntrup S, Marian T, Schroder JB, Suttrup I, Muhle P, Oelenberg S, et al. Electrical pharyngeal stimulation for dysphagia treatment in tracheotomized stroke patients: A randomized controlled trial. *Intensive care medicine*. 2015;41:1629-1637
306. Suntrup-Krueger S, Ringmaier C, Muhle P, Wollbrink A, Kemmling A, Hanning U, et al. Randomized trial of transcranial direct current stimulation for poststroke dysphagia. *Annals of neurology*. 2018;83:328-340
307. Terré R, Mearin F. A randomized controlled study of neuromuscular electrical stimulation in oropharyngeal dysphagia secondary to acquired brain injury. *European journal of neurology*. 2015;22:687-e644
308. Umay EK, Yaylaci A, Saylam G, Gundogdu I, Gurcay E, Akcapinar D, et al. The effect of sensory level electrical stimulation of the masseter muscle in early stroke patients with dysphagia: A randomized controlled study. *Neurology India*. 2017;65:734-742
309. Vasant DH, Michou E, O'Leary N, Vail A, Mistry S, Hamdy S. Pharyngeal electrical stimulation in dysphagia poststroke: A prospective, randomized single-blinded interventional study. *Neurorehabilitation and neural repair*. 2016;30:866-875
310. Yang EJ, Baek SR, Shin J, Lim JY, Jang HJ, Kim YK, et al. Effects of transcranial direct current stimulation (tdcs) on post-stroke dysphagia. *Restorative neurology and neuroscience*. 2012;30:303-311
311. Zeng Y, Yip J, Cui H, Guan L, Zhu H, Zhang W, et al. Efficacy of neuromuscular electrical stimulation in improving the negative psychological state in patients with cerebral infarction and dysphagia. *Neurological research*. 2018;40:473-479
312. Zhang M, Tao T, Zhang ZB, Zhu X, Fan WG, Pu LJ, et al. Effectiveness of neuromuscular electrical stimulation on patients with dysphagia with medullary infarction. *Archives of physical medicine and rehabilitation*. 2016;97:355-362
313. Xia W, Zheng C, Lei Q, Tang Z, Hua Q, Zhang Y, et al. Treatment of post-stroke dysphagia by vitalstim therapy coupled with conventional swallowing training. *Journal of Huazhong University of Science and Technology. Medical sciences = Hua zhong ke ji da xue xue bao. Yi xue Ying De wen ban = Huazhong keji daxue xuebao. Yixue Yingdewen ban*. 2011;31:73-76

314. Lee KW, Kim SB, Lee JH, Lee SJ, Ri JW, Park JG. The effect of early neuromuscular electrical stimulation therapy in acute/subacute ischemic stroke patients with dysphagia. *Annals of rehabilitation medicine*. 2014;38:153-159
315. Byeon H, Koh HW. Comparison of treatment effect of neuromuscular electrical stimulation and thermal-tactile stimulation on patients with sub-acute dysphagia caused by stroke. *Journal of physical therapy science*. 2016;28:1809-1812
316. Ko KR, Park HJ, Hyun JK, Seo IH, Kim TU. Effect of laryngopharyngeal neuromuscular electrical stimulation on dysphonia accompanied by dysphagia in post-stroke and traumatic brain injury patients: A pilot study. *Annals of rehabilitation medicine*. 2016;40:600-610
317. Kushner DS, Peters K, Eroglu ST, Perless-Carroll M, Johnson-Greene D. Neuromuscular electrical stimulation efficacy in acute stroke feeding tube-dependent dysphagia during inpatient rehabilitation. *American journal of physical medicine & rehabilitation*. 2013;92:486-495
318. Lee JH, Kim SB, Lee KW, Lee SJ, Lee JU. Effect of repetitive transcranial magnetic stimulation according to the stimulation site in stroke patients with dysphagia. *Annals of rehabilitation medicine*. 2015;39:432-439
319. Michou E, Mistry S, Jefferson S, Singh S, Rothwell J, Hamdy S. Targeting unlesioned pharyngeal motor cortex improves swallowing in healthy individuals and after dysphagic stroke. *Gastroenterology*. 2012;142:29-38
320. Muhle P, Suntrup-Krueger S, Bittner S, Ruck T, Claus I, Marian T, et al. Increase of substance p concentration in saliva after pharyngeal electrical stimulation in severely dysphagic stroke patients - an indicator of decannulation success? *Neuro-Signals*. 2017;25:74-87
321. Armstrong JR, Mosher BD. Aspiration pneumonia after stroke: Intervention and prevention. *The Neurohospitalist*. 2011;1:85-93
322. Dziewas R, Baijens L, Schindler A, Verin E, Michou E, Clave P. European society for swallowing disorders fees accreditation program for neurogenic and geriatric oropharyngeal dysphagia. *Dysphagia*. 2017;32:725-733
323. Warnecke T, Ritter MA, Kroger B, Oelenberg S, Teismann I, Heuschmann PU, et al. Fiberoptic endoscopic dysphagia severity scale predicts outcome after acute stroke. *Cerebrovascular diseases (Basel, Switzerland)*. 2009;28:283-289
324. McCurtin A, Boland P, Kavanagh M, Lisiecka D, Roche C, Galvin R. Do stroke clinical practice guideline recommendations for the intervention of thickened liquids for aspiration support evidence based decision making? A systematic review and narrative synthesis. *Journal of evaluation in clinical practice*. 2020