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Dysphagia and Aspiration Following Stroke

Evidence Tables

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15.2 Pathophysiology of Dysphagia

Table 15.2 Pathophysiology of Dysphagia Post-Stroke

Author, Year Country PEDro Score TPS	Methods	Outcomes
Veis and Logemann (1985) USA No Score TPS<4mo N=38	Intervention: 38 stroke patients consecutively referred for VMBS examination for suspicion of swallowing disorders within 4mo of stroke. Videofluoroscopic studies were used to assess oral and pharyngeal functioning and to identify motility disorders. Three consistencies were tested: liquid, paste and cookie. Outcomes: Videofluoroscopy.	<ol style="list-style-type: none"> 50% of patients demonstrated reduced lingual control, 82% a delayed reflex, 58% reduced pharyngeal peristalsis, 5% reduced laryngeal adduction, 5% cricopharyngeal dysfunction. 76% of patients demonstrated more than one swallowing disorder. 32% of patients aspirated.
Robbins et al. (1993) USA No Score TPS=NA N=60	Intervention: The swallowing patterns of 20 first -ever MCA stroke patients were compared with 40 control subjects. Outcomes: Pharyngeal transit duration; Pharyngeal stage duration; Incidence of laryngeal penetration and aspiration of liquid.	<ol style="list-style-type: none"> Patients with left hemisphere strokes had longer pharyngeal transit duration times compared to controls. Patients with right hemisphere strokes demonstrated longer pharyngeal stage durations and higher incidences of laryngeal penetration and aspiration of liquid. Anterior lesion subjects demonstrated significantly longer swallowing durations on most variables compared to both normal and posterior lesion subjects.
Kimura et al. (2013) Japan Observational No Score TPS _{DG} =35.7d TPS _{ND} =38.2d N _{Start} =30 N _{End} =30	Population: Dysphagia Group (DG; n=10): Mean age=74.1yr; Gender: Male=10, Female=0. No Dysphagia Group (ND; n=20): Mean age=65.7yr; Gender: Male=20, Female=0. Intervention: No intervention. DG and ND groups were also compared to healthy controls (n=10). Outcomes: Degree of penetration aspiration in dysphagia patients; Pulmonary functions: tidal volume, vital capacity, inspiratory reserve volume, expiratory reserve volume and peak cough flow; Brunnstrom's recovery stage; Function Ambulation Categories (FAC).	<ol style="list-style-type: none"> Brunnstrom's recovery stage showed no significant differences between groups (p>0.05). FAC was significantly worse in the DG compared to the ND (median: DG=3, ND=0.5, p<0.05). Peak cough flow was significantly lower in the DG compared to the ND (DG=160.1±68.7, ND=297.2±114.2, p<0.05) and both groups were significantly lower than the healthy control (462.0±84.4, p<0.05). Vital capacity was not significantly different between the DG and ND (DG=2316.0±583.7, ND=2741.0±856.2) but was significantly lower in both groups compared to the healthy control (3565.0±374.5, p<0.05). Inspiratory reserve volume was significantly lower in the DG compared to the healthy control (DG=728.0±477.6, healthy=1645.0±563.8, p<0.05). No significant differences between groups were observed in regards to tidal volume and expiratory reserve volume.

		7. Penetration and aspiration scores were an average of 3.8 for the DG.
<p>Huckabee et al. (2014) New Zealand Pre-Post No Score TPS_{Mean}= 23mo N_{Start}=16 N_{End}=16</p>	<p>Population: Intervention Group (N=16): Mean age=44yr; Gender: Males=8, Females=8. Intervention: All patients were inserted with a 3-channel manometric catheter through the nasal cavity and swallowed into the proximal oesophagus and the sensor positioned at the superior portion of the upper esophageal sphincter. The use of manometric pharyngeal pressure monitoring was then observed as part of a treatment program consisting of 60min sessions, 2/d for a minimum of >1wk. Assessments were conducted at baseline and at post-treatment. Outcomes: Pharyngeal pressure; Peak-to-peak latency.</p>	<ol style="list-style-type: none"> 1. Despite improvement in pharyngeal pressure from baseline to post-treatment, amplitude of pharyngeal pressure generation was lower than the normative mean of healthy participants from a previous study for the proximal and distal pharynx (46.6mmHg and 47.1mmHg vs 114.7mmHg and 114.9mmHg, respectively), and higher for nasal upper esophageal sphincter pressure (-3.5mmHg vs -9.7mmHg, respectively) at post-treatment. 2. Mean peak-to-peak latency between nadir pressures at sensor-1 and sensor-2 was 15ms at baseline with an improvement to 137ms at post-treatment. However, this was still below the normative mean of 239ms. 3. Manometric pharyngeal pressure readings were later used as part of a visual biofeedback intervention resulting in 11 patients able to resume a full oral diet.
<p>Kim et al. (2014) South Korea Observational No Score TPS_{Mean}<3mo N_{Start}=103 N_{End}=103</p>	<p>Population: No characteristics available. Intervention: Patients were divided into groups according to lesion location: territorial anterior circulation infarct (TAI, n=62), territorial posterior circulation infarct (TPI, n=19) and white matter disease (WMD, n=22). Outcomes: Videofluoroscopic swallowing study (VFSS): oral and pharyngeal phase dysfunction, penetration and aspiration.</p>	<ol style="list-style-type: none"> 1. Oral phase dysfunction: <ul style="list-style-type: none"> • Excessive oral residue was most significantly prevalent in the TAI group (TAI=17.7%, TPI=0%, WMD=0%; p=0.017). • Prevalence of incomplete lip closure and inadequate bolus formation was not significantly different between groups (lip closure: TAI=4.8%, TPI=5.3%, WMD=9.1%; bolus formation: TAI=9.7%, TPI=10.5%, WMD=4.5%). • Prevalence of delayed oral transit time was insignificantly different between groups (TAI=38.7%, TPI=36.8%, WMD=27.3%). 2. Pharyngeal phase dysfunction: <ol style="list-style-type: none"> 6. Prevalence of excessive valleculae residue was significantly greater in the WMD group (TAI=74.2%, TPI=52.6%, WMD=100%; p=0.002). 7. Prevalence of excessive pyriform sinus residue was significantly greater in the TPI group (TAI=16.1%, TPI=57.9%, WMD=31.8%; p=0.001). 8. No significant differences between groups were observed in regards to the prevalence of nasal regurgitation

		<p>(TAI=4.8%, TPI=0%, WMD=0%), reduced laryngeal elevation (TAI=59.7%, TPI=63.2%, WMD=77.3%) and delay in pharyngeal swallowing (TAI=71.0%, TPI=78.9%, WMD=77.3%).</p> <p>3. Penetration and aspiration were more frequent for the TPI group with both thin and thick liquids (penetration: thick=52.6%, p=0.018, thin=36.8%, p=0.029; aspiration: thick=57.9%, p=0.033, thin=78.9%, p=0.003).</p>
<p>Li et al. (2014a) China Observational No Score TPS_{Mean}=2-3d N_{Start}=24 N_{End}=24</p>	<p>Population: Dysphagia Group (DG; n=12): Mean age=65.2yr; Gender: Male=6, Female=6. No Dysphagia Group (ND; n=12): Mean age=66.5yr; Gender: Male=7, Female=5. Intervention: No intervention. Patients were also compared to a group of healthy controls (n=12). Outcomes: fMRI data: functional connectivity.</p>	<p>1. In the bilateral sensorimotor-insula-putamen circuits, increased connections in the DG compared to the ND were observed in the right Brodmann area (BA) 3/BA 22, BA 4/BA 22, BA 6/BA 22 and the right BA 32/left putamen. 2. Significant correlations were observed between severity of penetration aspiration scores and the left BA 6 and right BA 3/BA 22, BA 6/BA 22 and the right BA 32/left putamen (p<0.05). 3. No significant differences in the mean fractional anisotropy were observed between the DG and ND.</p>
<p>Li et al. (2014b) China Observational No Score TPS_{Mean}<3d N_{Start}=24 N_{End}=24</p>	<p>Population: Dysphagia Group (DG; n=12): Mean age=65.2yr; Gender: Male=6, Female=6. No Dysphagia Group (ND; n=12): Mean age=66.5yr; Gender: Male=7, Female=5. Intervention: No intervention. Patients were also compared to a group of healthy controls (n=12). Outcomes: fMRI data: functional connectivity.</p>	<p>1. Noticeable increase in the functional connectivity of the posterior cingulate cortex, angular gyrus and bilateral prefrontal cortex in the ND compared to DG. 2. Increased functional connectivity in the bilateral amygdala in ND compared to DG.</p>

15.3 Aspiration Associated with Dysphagia

15.3.2 Incidence of Aspiration Post-Stroke

Table 15.3.2 Incidence of Aspiration and Silent Aspiration Post-Stroke

Author, Year Country PEDro Score TPS	Methods	Outcomes
<p>Horner et al. (1988) USA No Score TPS<1mo N=47</p>	<p>Intervention: 47 stroke patients referred for swallowing evaluation on suspicion of dysphagia. To evaluate the clinical correlates of dysphagia, patients received both a clinical and videofluoroscopic evaluation of swallowing function. Liquid, paste and cookie consistencies were tested. 33 patients were tested within the 1mo post-stroke.</p>	<p>1. 51% of patients aspirated on at least one consistency. 54% of the aspirators were silent aspirators. 2. Aspiration was not limited to brainstem or bilateral lesions. 3. Medical-clinical abnormalities appeared to be more frequent in patients who aspirated</p>

	<p>Outcomes: Clinical evaluation; Videofluoroscopic modified barium swallow study.</p>	<p>although no statistical analysis was performed.</p> <ol style="list-style-type: none"> 4. The presence of a delayed swallow reflex and reduced peristalsis frequently resulted in aspiration. Poor oral motility did not.
<p>Splaingard et al. (1988) USA No Score TPS=NA N=107</p>	<p>Intervention: 107 patients referred for evaluation of possible swallowing dysfunction from a general rehabilitation ward, including 87 stroke patients. The results of a bedside swallowing evaluation were compared with videofluoroscopic modified barium swallow (VMBS) study results by blinded evaluators.</p> <p>Outcomes: Bedside swallowing evaluation; VMBS study.</p>	<ol style="list-style-type: none"> 1. 40% of patients aspirated during VMBS study. 2. Bedside evaluations identified only 42% of proven aspirators. 3. Silent aspiration, not detected on bedside evaluation was noted in 20% of patients. 4. Bedside assessments identified 58/64 (90%) of non-aspirators.
<p>Chen et al. (1990) USA No Score TPS<1mo N=46</p>	<p>Intervention: 46 consecutive patients with clinical symptoms of dysphagia within 1mo post-stroke were referred for videofluoroscopic modified barium swallow (VMBS) examination.</p> <p>Outcomes: VMBS study.</p>	<ol style="list-style-type: none"> 1. Dysphagia was confirmed by VMBS examination in all cases. 2. Mild swallowing impairment was identified in 18 (39%) patients, moderate dysfunction in 23 (50%) patients and severe problems in five (11%) patients. 3. There were 24 episodes of aspiration.
<p>Kidd et al. (1995) UK No Score TPS<72hr N=60</p>	<p>Intervention: 60 consecutive stroke patients admitted to a teaching hospital. Patients received a water swallowing test (WST) and videofluoroscopic modified barium swallow (VMBS) study within 72hr post-stroke and were re-evaluated at 3mo.</p> <p>Outcomes: WST; VMBS study.</p>	<ol style="list-style-type: none"> 1. 42% of patients aspirated on initial VMBS study. 2. 42% of patients were unable to complete the WST. Of these, 80% were aspirators. 3. 32% of patients developed a respiratory tract infection (RTI) within 14d. 89% of RTIs occurred in aspirating patients. 4. 42 patients were re-examined at 3mo. 14% of patients continued to experience impaired pharyngeal sensation. An abnormal WST was reported in 7% of the remaining patients. 5. 8% of patients initially presenting with a positive VMBS study result also had a positive follow-up test. These same patients developed a RTI between 14d and 90d. 6. Five patients were silent aspirators, accounting for 20% of all aspirators.
<p>Smithard et al. (1996) UK No Score TPS<3d N=121</p>	<p>Intervention: 121 stroke patients consecutively admitted to an urban hospital. Patients received both bedside and videofluoroscopic modified barium swallow (VMBS) study evaluations within 3d post-stroke, when feasible.</p> <p>Outcomes: Bedside evaluation; VMBS study.</p>	<ol style="list-style-type: none"> 1. 50% of the patients were considered to have an unsafe swallow based on bedside evaluation alone. 2. 94 patients had a VMBS study. Of these, 20 (16.5%) patients aspirated. 3. Increased mortality, lower Barthel Index scores and increased frequency of discharge to institutionalized care at 6mo were reported more often in patients with an unsafe swallow. 4. However, these outcomes were not associated with a positive VMBS study result. 5. 22 patients did not receive a 6mo follow-up.

<p>Daniels et al. (1998) USA Case Series No Score TPS=NA N=55</p>	<p>Intervention: 55 stroke patients consecutively admitted to a Veterans Affairs Medical Center. All patients received a bedside and videofluoroscopic modified barium swallow (VMBS) study evaluation within 5d of admission. Outcomes: Bedside evaluation; VMBS study.</p>	<ol style="list-style-type: none"> 1. Dysphagia was present in 65% of patients. 2. Aspiration occurred in 21 (38%) patients. Of these, 14 aspirated silently (67% of aspirators). 3. Both abnormal volitional coughing and cough with swallow were highly predictive of aspiration. 4. One patient developed aspiration pneumonia during hospitalization.
<p>Mann et al. (1999) Australia No Score TPS=NA N=128</p>	<p>Intervention: The swallowing function of 128 hospital-referred patients with acute stroke was evaluated clinically and with videofluoroscopic modified barium swallow (VMBS) studies. Patients were followed for 6mo. Outcomes: Clinical evaluation; VMBS study.</p>	<ol style="list-style-type: none"> 1. Using videofluoroscopy a median of 10d following stroke, 82 (64%) of patients were diagnosed with dysphagia and 28 (22%) aspirated. 2. Using a clinical exam administered a median of 3d following stroke, the incidence of dysphagia and aspiration were 51% and 50%, respectively.
<p>Kim et al. (2000) USA No Score TPS<2wk N=23</p>	<p>Intervention: 23 patients with isolated medullary infarctions were assessed using videofluoroscopic modified barium swallow (VMBS) studies within 2wk post-stroke. From the results of the VMBS studies, two patient groups were formed; those with and without aspiration. The clinical variables related to aspiration and outcome measures were also explored. Outcomes: VMBS studies; Clinical evaluation.</p>	<ol style="list-style-type: none"> 1. Ten (44%) of the 23 patients manifested aspiration on swallowing. 2. Criteria including dysphonia, soft palate dysfunction and facial hypesthesia were used to discriminate between those with and without aspiration with 95.7% accuracy.
<p>Bingjie et al. (2010) China Prospective No Score TPS_{Mean}=43±20d N_{Start}=105 N_{End}=105</p>	<p>Population: Stroke group (SG; N=105): Mean age=65.2±8.2 (50-82)yr; Gender: Males=57, Females=48. Control group (CG; N=100): Mean age=62±9 (50-78)yr; Gender: Males=100, Females=0. Intervention: A standardized videofluoroscopic swallow study was conducted while each participant swallowed 1ml and 10ml thin liquid barium, 10ml applesauce mixed barium and 10cm³ biscuit coated with barium, in sequence. Total screening time was below 80s to ensure radiation dose <0.3 m Sv. Stroke group was divided into aspirators and non-aspirators for analysis of the kinematic measures of swallowing. Outcomes: Penetration-Aspiration scale (PAS); Oral transit time (OTT); Pharyngeal delay time (PDT); Pharyngeal transit time (PTT); Vertical laryngeal movement (VLM); Anterior laryngeal movement (ALM); Vertical hyoid movement (VHM); Anterior hyoid movement (AHM).</p>	<ol style="list-style-type: none"> 1. Of 420 swallows among the SG, mild penetrations were found in 63 (15%) patients, moderate penetrations in 47 (11.2%) patients, and 35 (33.3%) patients experienced one or more aspirations according to PAS. 2. Of 420 swallows among the SG, there were 67 (16%) patients who presented aspirations in the SG. 3. 15 (15%) CG participants were classified with mild penetrations according to the PAS. 4. PAS scores were significantly higher for the SG than the CG (p<0.001). 5. Aspirating patients had significantly longer PDT and PTT (p<0.001, both) than non-aspirating patients and the CG. 6. Aspirating patients had significantly reduced maximal extent of VLM and VHM (p<0.001, both) than non-aspirating patients and the CG. 7. OTT of the SG was significantly prolonged (p<0.001) compared to the CG. 8. Maximal extent of ALM (p=0.215) and AHM (p=0.168) showed no significant differences between groups.

15.4 Incidence of Dysphagia Post-Stroke

15.4.1 Incidence of Dysphagia in the Acute Phase of Stroke

Table 15.4.1 Incidence of Dysphagia in the Acute Phase of Stroke

Author, Year Country PEDro Score TPS	Methods	Outcomes
Gordon et al. (1987) UK No Score TPS<4d N=91	Intervention: 91 consecutive stroke patients were evaluated with a standardized swallowing test for the presence of dysphagia. 82/90 (92%) patients were evaluated within 4d of stroke onset. Outcomes: Incidence of dysphagia.	1. 41 (45%) of the patients had evidence of dysphagia.
Wade and Hewer (1987) UK No Score TPS=NA N=452	Intervention: 452 consecutive, conscious acute stroke patients were evaluated within 7d of onset of symptoms. Their ability to swallow water from a cup was evaluated. Outcomes: Incidence of dysphagia.	1. 194 (43%) of patients were considered dysphagic.
Barer (1989) UK No Score TPS=NA N=357	Intervention: 357 stroke patients selected from a stroke registry participating in the "BEST" study with onset of symptoms within 48 hrs, single-hemisphere involvement, able to take oral medications, no pre-stroke impairments and no cardiac conditions were followed. Ability to swallow 10 mL of water from a cup was assessed. Outcomes: Incidence of dysphagia.	1. 105 (29%) patients initially presented with dysphagia. 2. By 1mo, 6/277 (2%) of survivors were still dysphagic. 3. At 6mo, 1/248 (0.4%) of those assessed remained dysphagic.
De Pippo et al. (1994a) USA No Score TPS _{Mean} =5wk N=139	Intervention: 139 consecutive patients admitted to an inpatient rehabilitation unit a mean of 5wk post-stroke. Outcomes: Burke Dysphagia Screening test (a water swallowing test).	1. 82 (59%) of patients failed the screening tests.
Odderson et al. (1995) USA No Score TPS<24hr N=124	Intervention: 124 consecutive, ischemic stroke patients were assessed within 24 hours. Outcomes: Clinical swallowing screen; Voice quality; Ability to handle oral secretions; Ability to swallow ice chips or water briskly.	1. 48 (39%) of patients failed the initial swallow screen. 2. 21 of the patients with dysphagia recovered their swallowing function by discharge.
Gottlieb et al. (1996) Israel No Score TPS _{Mean} =14d N=180	Intervention: 180 consecutive rehab patients assessed an average of 14d post-stroke using a bedside technique, which included a water swallowing test (50 mL). A cough during drinking was considered positive. Outcomes: Incidence of dysphagia.	1. Dysphagia was diagnosed in 28% of patients.
Daniels et al. (1998) USA No Score TPS=NA N=55	Intervention: 55 stroke patients consecutively admitted to a Veterans Affairs Medical Center. All patients received a bedside and videofluoroscopic modified barium swallow (VMBS) evaluation within 5 days of admission.	1. Dysphagia was present in 36 (65%) of patients. 2. Aspiration occurred in 21 (38%) patients.

	Outcomes: Videofluoroscopic Modified Barium Swallow study; Bedside evaluation.	
Nilsson et al. (1998) Sweden No Score TPS=NA N=100	Intervention: 100 consecutive, acute stroke patients were assessed for dysphagia within 24 hours of admission. Outcomes: Swallowing complaints; Repetitive oral suction swallow test.	<ol style="list-style-type: none"> 1. Only 72 patients were able to reliably respond to questions. 2. 14 patients (19%) complained of dysphagia.
Mann et al. (1999) Australia No Score TPS _{Median} =10d N=128	Intervention: The swallowing function of 128 hospital-referred patients with acute stroke was evaluated clinically and with videofluoroscopic modified barium swallow (VMBS) studies. Patients were followed for 6mo. Outcomes: VMBS study; clinical evaluation.	<ol style="list-style-type: none"> 1. Using VMBS a median of 10d following stroke, 82 (64%) of patients were diagnosed with dysphagia and 28 (22%) aspirated. 2. Using a clinical exam administered a median of 3d following stroke, the incidence of dysphagia and aspiration were 51% and 50%, respectively.
Poels et al. (2006) The Netherlands No Score TPS _{Mean} =34d N=69	Intervention: 69 stroke patients without aphasia admitted to stroke rehabilitation an average of 34d following acute stroke. Dysphagia was assessed using structured observations of eating difficulties. Outcomes: Incidence of dysphagia.	<ol style="list-style-type: none"> 1. Eating difficulties (including swallowing difficulties) were present in 30 (43%) of patients.
Terre & Mearin (2006) Spain No Score TPS _{Mean} =3mo N=138	Intervention: 138 consecutive patients admitted to a rehabilitation hospital recovering from a severe, first-ever stroke were evaluated clinically and through videofluoroscopy. Evaluations were conducted a mean of 3mo following stroke. Outcomes: Incidence of dysphagia; Incidence of aspiration.	<ol style="list-style-type: none"> 1. Dysphagia was clinically suspected in 64 (46%) of patients. 2. Clinical examination showed that 44% had impaired gag reflex, 47% coughed during oral feeding, and 13% demonstrated changes in voice after swallowing. 3. 42 (30%) patients demonstrated pharyngeal aspiration on VMBS. Of these, 21 (50%) were episodes of silent aspiration.
Smithard et al. (2007) UK No Score TPS<1wk N=1288	Intervention: A population-based long-term follow-up of 1,288 persons with first time stroke. Dysphagia was assessed by clinical exam within 1wk of stroke. Patients were followed up at 3mo and yearly for 5yr. Outcomes: Clinical examination: incidence of dysphagia.	<ol style="list-style-type: none"> 1. 567 (44%) patients were determined to be dysphagic at first assessment.
Falsetti et al. (2009) Italy No Score TPS _{Mean} =14d N=151	Intervention: 151 consecutively admitted patients to a neurorehabilitation unit an average of 14d following stroke received a three step clinical exam, which included two water swallowing components (bolus of differing amounts) within 1d of admission and a VFS exam for those who failed any portion of the screening test. Outcomes: Incidence of dysphagia; Incidence of aspiration.	<ol style="list-style-type: none"> 1. 62 (41%) of patients were dysphagic, based on the results from the clinical exam. 2. 49/151 patients, 79% of whom were identified as dysphagic based on clinical exam, received a VFS study. 3. Aspiration and silent aspiration were detected in 21 (43%) and 13 (26.5%) patients, respectively.
Remesso et al. (2011) Brazil No Score TPS<14d N=596	Intervention: A review of 596 patient charts of patients who had experienced an ischemic stroke within 14d. Presence of dysphagia was determined by clinical examination. Factors associated with dysphagia were explored. Outcomes: Clinical examination: incidence of dysphagia, factors associated with dysphagia.	<ol style="list-style-type: none"> 1. Dysphagia occurred in 117 (19.7%) of patients. The majority of cases (91.5%) were considered mild. 2. Factors associated with dysphagia included increased age, diabetes and brainstem stroke. Spontaneous recovery occurred in 102 (87.3%) patients within an average of

		2.4mo.
Baroni et al. (2012) Brazil No Score TPS<60d N=212	Intervention: Clinical swallowing evaluations were conducted on 212 patients admitted following stroke. The majority of evaluations were conducted within the first 5 days of stroke post-stroke (81%). The remainder were completed within 11d and 60d days post-of stroke. Outcomes: Clinical swallowing evaluations; Mortality.	<ol style="list-style-type: none"> 134 (63%) patients presented with swallowing difficulties. Of these, 26 (19%) were considered to be mild, 51 (38%), moderate and 57 (43%) severe. 3mo month mortality was higher among patients with any swallowing disorder (OR 6.54; 95% CI 2.23 to 19.21).
Okubo et al. (2012) Brazil No Score TPS=NA N=50	Intervention: Clinical swallowing assessments were performed in 50 patients following acute stroke and the results compared with National Institutes of Health Stroke Scale (NIHSS) score ≥ 12 , the value selected as a cut-off point to indicate dysphagia. Outcomes: Clinical swallowing assessments; NIHSS.	<ol style="list-style-type: none"> Dysphagia was present in 16 (32%) patients. 14 of the patients with dysphagia had NIHSS scores ≥ 12 and 29/34 without dysphagia had NIHSS scores <12, representing a sensitivity and specific of 88% and 85%, respectively.
Baroni et al. (2012) Brazil No Score	Clinical swallowing evaluations were conducted on 212 patients admitted following stroke. The majority of evaluations were conducted within the first 5 days of stroke (81%). The remainder were completed within 11 and 60 days of stroke.	<ol style="list-style-type: none"> 134 (63%) patients presented with swallowing difficulties. Of these, 26 (19%) were considered to be mild, 51 (38%), moderate and 57 (43%) severe. 3 month mortality was higher among patients with any swallowing disorder (OR 6.54; 95% CI 2.23 to 19.21).
Flowers et al. (2013) Canada No Score TPS=NA N=221	Intervention: A review of 221 charts of patients who had experienced an acute stroke or transient ischemic attack was conducted. Presence of dysphagia was defined as diagnosis on clinical examination or as the presence of enteral feeding. Factors associated with the presence of dysphagia were also explored. Outcomes: Incidence of dysphagia; Presence of enteral feeding; Factors associated with dysphagia: Canadian Neurological Scale (CNS), consciousness.	<ol style="list-style-type: none"> 98 (44%) of patients were diagnosed with dysphagia. The time to diagnosis was a median of 2.0 days (ranging from 0-26 days) from stroke onset. The odds of experiencing dysphagia were greater for patients with a lower CNS score and lower level of consciousness (OR 1.4, 1.3 to 1.6; OR 2.6, 1.03 to 6.50 respectively).
Kuptniratsaikul et al. (2013) Thailand Prospective Study No Score TPS _{Mean} =24d N _{Start} =214 N _{End} =214	Population: Mean age=62.1 \pm 12.5yr; Gender: Males=124, Females=90. Intervention: The incidence of morbidities after stroke were prospectively analyzed. Comparisons were made at discharge and at 12mo. Outcomes: Incidence of morbidities: musculoskeletal pain, neuropathic pain, pneumonia, deep vein thrombosis, pressure ulcer, spasticity, shoulder subluxation, joint contracture, dysphagia, urinary incontinence, anxiety and depression.	<ol style="list-style-type: none"> Nearly 60% of patients with complications at discharge still had the same complaints after 1yr. Among the patients with no complications at discharge, 20% developed complication during the first year. The most common complications found during the first year of stroke were musculoskeletal pain (50.7%), shoulder subluxation (29.3%), depression (21.2%), spasticity (18.3%) and joint contracture (15.7%). Among those with musculoskeletal pain, the shoulder was the most common site with an incidence of 33.9%. Joint contracture was not present at discharge but developed during the year post-stroke, with common sites including the shoulder, ankle, and the knee joints. Urinary incontinence was found in 14.4% of

		<p>patients.</p> <p>7. Other complications less than 5% include dysphagia (3.5%), pressure ulcer (2.6%), infection (1.5%) and neuropathic pain (3.0%).</p>
<p>Mourao et al. (2016) Brazil Observational No Score TPS<48hr N_{Start}=100 N_{End}=100</p>	<p>Population: Mean age=62.6yr; Gender: Males=46, Females=54. Intervention: Investigation of the frequency and factors related to dysphagia among patients in the acute phase of stroke. Data was collected in two stages; i. Obtained sociodemographic and clinical data, ii. Clinical evaluation by a speech language pathologist. Outcomes: Structured interview; neurological clinical evaluation (including cranial computed tomography); Gugging Swallowing Screen scale.</p>	<ol style="list-style-type: none"> 1. Frequency of dysphagia was 50% (severe=28%, mild=11%, slight=11%). 2. Previous history of stroke was the only sociodemographic/clinical variable significantly associated with the incidence of dysphagia (p=0.022). 3. Neither location nor physiopathology of stroke were significantly associated with the incidence of dysphagia. 4. Stroke severity was not significantly associated with location or physiopathology.

15.4.2 Prognostic Indicators of Dysphagia Post-Stroke

Table 15.4.2 Prognostic Indicators of Dysphagia Post-Stroke

Author, Year Country PEDro Score TPS	Methods	Outcomes
<p>Daniels et al. (1997) USA No Score TPS=NA N=59</p>	<p>Intervention: 59 consecutively admitted ischemic stroke patients received a clinical and videofluoroscopic modified barium swallowing (VMBS) evaluation within 5d of admission. Outcomes: Clinical examination; VMBS evaluation.</p>	<ol style="list-style-type: none"> 1. 44/59 patients (74.6%) were dysphagic based on VMBS results. 2. Dysphonia, dysarthria, abnormal volitional cough and cough after swallow were all significantly predictive of dysphagia severity.
<p>Kojima et al. (2014) Japan Retrospective No Score TPS_{Mean}=9.5d N_{Start}=123 N_{End}=123</p>	<p>Population: Mean age=81.4yr; Gender: Males=63, Females=60. Intervention: Retrospective review of stroke patients with dysphagia admitted to a hospital between April 2008 and March 2010. Patients had previously received indirect (exercising organs related to swallowing without food intake) and direct (training food intake) swallowing training. Outcomes: Food Intake Level Scale (FILS); Videofluoroscopic swallowing study (VFSS); Video-endoscopy (VE); Clinical Dementia Rating Scale (CDR); Modified Rankin Scale (mRS).</p>	<ol style="list-style-type: none"> 1. Patients were rated as no oral intake (FILS 1-3, n=85), oral intake and alternative nutrition (FILS 4-6, n=14) and oral intake alone (FILS 7-10, n=24) from the initial assessment. 2. 43 patients showed temporary improvement of dysphagia, nine of these patients showed deterioration <2mo. 3. No significant differences in improvement levels between patients 70yr and 80yr. 4. From 52 patients with stroke and dysphagia, 25 improved to oral intake and alternative nutrition or to oral intake alone at 4wk post-initial examination, 27 showed no improvement from no oral intake. 5. 29 patients had stroke and cognitive dysfunction (CDR 2-3), seven showed improvement of dysphagia while 22 showed no change.

		<ol style="list-style-type: none"> 6. 47 patients had disuse syndrome (MRS 4-5), 16 showed improvement to oral intake and alternative nutrition, 31 showed improvement to oral intake alone. 7. 42 patients without disuse syndrome (MRS 0-3) showed improvement of dysphagia, 12 showed no improvement. 8. Of patients that showed improvement in dysphagia, <2mo after initial examination, 12 had a fever, 26 had no fever and eight had no body temperature data. 9. Of patients that showed no improvement in dysphagia, <2mo after initial examination, 20 had a fever, 22 had no fever and one had no data. 10. Of patients that showed improvements of dysphagia, 24 were readmitted for symptoms including fever and malnutrition <1yr, 18 were not readmitted and four died. 11. Of patients who showed no improvement of dysphagia, 14 were readmitted, 17 were not readmitted and 12 died.
<p>Kumar et al. (2014) Israel Retrospective No Score TPS_{Mean}<7d N_{Start}=323 N_{End}=323</p>	<p>Population: Mean age=75.9yr; Gender: Males=134, Females=189. Intervention: Retrospective review of stroke patients with dysphagia admitted to a hospital between June 2005 and June 2010. Outcomes: Persistence of dysphagia.</p>	<ol style="list-style-type: none"> 1. Approximately 70% of patients did not recover enough swallowing function to allow for a full or mildly modified diet at discharge. 2. The presence of dysarthria, aspiration, National Institutes of Health Stroke scale scores ≥ 12, level of consciousness assessment, intubation and bihemispheric infarcts were significantly related to the presence of dysphagia at discharge. 3. Length of hospital stay was significantly inversely related to the presence of dysphagia at discharge (mean stay=10.4\pm6.79d).

15.5 Pneumonia and Aspiration Post-Stroke

15.5.3 Incidence and Development of Pneumonia

Table 15.5.3 Incidence and Development of Pneumonia Post-Stroke

Author, Year Country PEDro Score TPS	Methods	Outcomes
<p>Langdon et al. (2009) Australia No Score TPS=NA</p>	<p>Intervention: A cohort of 330 ischemic stroke survivors were followed for 30d to determine whether the risk of pneumonia was higher in tube fed patients compared with orally fed.</p>	<ol style="list-style-type: none"> 1. Over the study period the number of respiratory infections in tube fed and orally fed patients were 30/51 (59%) and 21/64 (33%), respectively.

<p>N=330</p>	<p>Outcomes: Number of respiratory infections; Risk of pneumonia.</p>	<p>2. The risk of pneumonia was increased in tube fed patients (RR=4.94, 95% CI 3.02-8.10, p<0.001).</p>
<p>Alsumrain et al. (2013) USA Retrospective No Score TPS_{Mean}=NA N_{Start}=290 N_{End}=280</p>	<p>Population: Patients with pneumonia (N=39): Median age=64yr; Gender: Males=22, Females=17. Patients without pneumonia (N=241): Median age=71yr; Gender: Males=137, Females=103. Intervention: None. Examining predictors of the development of pneumonia using retrospective data in stroke patients with and without pneumonia. Outcomes: Pneumonia development.</p>	<p>1. Mechanical ventilation, tube feeding, dysphagia, and tracheostomy are exposures significantly associated with increased likelihood of the development of pneumonia, after adjustment for potential confounders (modified Rankin Scale (mRS), Glasgow Coma Scale (GCS), H2 blockers, angiotensin-converting enzyme inhibitors and proton pump inhibitor).</p> <p>2. After adjusting for potential confounders, the adjusted OR for the effect of mechanical ventilation on the development of pneumonia was 3.72 (95% CI: 1.68-8.26).</p> <p>3. After adjusting for potential confounders, the adjusted OR for the effect of dysphagia and tracheostomy on the development of pneumonia was 7.46 (95% CI: 3.34-10.6) and 16.2 (95% CI: 4.98-52.8), respectively.</p> <p>4. For tube feeding, both GCS and mRS reduced OR; the former to 14.7 (95% CI: 6.16-35.0) and the latter to 15.7 (95% CI: 6.63-37.0).</p> <p>5. Pneumonia was significantly associated with morbidity (p<0.003), length of stay (p<0.0001) and mortality rate (p<0.041) of the patients.</p>
<p>Satou et al. (2013) Japan Descriptive No Score TPS_{Overall}=59±82d N_{Start}=16 N_{End}=16</p>	<p>Population: Mean age=83.2±9.2yr; Gender: Males=7, Females=9. Intervention: Four patients underwent percutaneous endoscopic gastrostomy (PEG) and 12 patients underwent nasogastric tube feeding. Outcomes: Rate of aspiration pneumonia.</p>	<p>1. Nine patients (56%) were diagnosed with gastroesophageal reflux (GER) and 10 (63%) patients developed aspiration pneumonia after enteral feeding.</p> <p>2. The rate of aspiration pneumonia was significantly higher in patients with GER (88.9%) than in those without GER (42.9%, p=0.04).</p> <p>3. There was a higher incidence of acid reflux among patients with left hemispheric lesions than those with right lesions (116±105 vs 13±17; p=0.04).</p> <p>4. There were no significant differences in total time of acid reflux or mean pH values between patients with left and right hemispheric lesions.</p>
<p>Chowdhury et al. (2014) Bangladesh Observational</p>	<p>Population: Mean age=57.42 ±13.63yr; Gender: Male to Female Ratio=3:1. Intervention: None. Goal of study is to identify the incidence of aspiration pneumonia in hospitalized</p>	<p>1. 26% of patients developed aspiration pneumonia.</p> <p>2. Fever, cough and respiratory distress were present in the majority of patients who</p>

<p>No Score TPS_{Mean}=NA N_{Start}=50 N_{End}=50</p>	<p>patients with altered consciousness. Outcomes: Incidence of aspiration pneumonia; Factors involved with aspiration pneumonia; Factors causing altered consciousness.</p>	<p>developed aspiration pneumonia. 3. The main precipitating factors causing altered consciousness were stroke, encephalitis, and encephalopathy due to hepatic encephalopathy and uremia.</p>
<p>Pinto et al. (2014) Brazil Prospective No Score TPS_{Overall}≤72hr N_{Start}=52 N_{End}=52</p>	<p>Population: Mean age=62.05±13.88yr; Gender: Males=29, Females=23. Intervention: None. This study sought to determine the probability of pneumonia on all study patients post-stroke, using software (unspecified). A clinical and flexible endoscopic evaluation of swallowing was performed within 72hr of onset of symptoms. Patients were offered 5mL, 10mL and a free sip of each food consistency. A functional oral intake scale (FOIS) was administered. Outcomes: Incidence of pneumonia: Rosenbeck Scale; Incidence of aspiration.</p>	<ol style="list-style-type: none"> 1. There was no significant difference between the clinical swallow evaluation and FEES for the presence of tracheal aspiration (p=0.42). 2. The Rosenbeck Scale showed no significant relationship between the scale and the presence or absence of pneumonia (p=0.2293). 3. Only three patients (5.7%) had a probability of pneumonia between 80% and 100%, as identified by the software. 4. 32 patients (61.7%) had a probability of pneumonia between 0% and 19%, five (9.5%) between 20% and 49%, three (5.8%) between 50% and 79%, and 12 (23.0%) between 80% and 100%.
<p>Watanabe et al. (2014) Japan Retrospective study No Score TPS_{Overall}<7d N_{Start}=143 N_{End}=143</p>	<p>Population: Age range=43-92yr; Gender: Males=103, Females=40. Intervention: Onset of Aspiration Pneumonia (AP) within 1yr post-stroke was evaluated retrospectively before and after swallowing function assessment. Outcomes: AP incidence.</p>	<ol style="list-style-type: none"> 1. Male gender (OR 6.206; p=0.0199), dysarthria (OR 5.683; p=0.0212), and denture usage (OR 2.843; p=0.0377) were significantly associated with the onset of AP prior to swallowing function assessment. 2. Cerebral atrophy (OR 4.225; p=0.0198), infarcted foci in the basal ganglia (OR 8.914; p=0.0396), and a Barthel Index (BI) < 100 point before admission (OR 5.404; p=0.0042) were significantly associated with the onset of AP after swallowing function assessment.
<p>Goda et al. (2015) Egypt Observational No Score TPS_{Overall}<24hr N_{Start}=50 N_{End}=50</p>	<p>Population: Intervention Group (N=50): Mean age=62±10.4yr; Gender: Males=27, Females=23. Intervention: Patients were observed on a daily basis for the presence of pneumonia. Assessments were conducted at post-treatment in which comparisons were made between those who did and did not develop pneumonia. Outcomes: National Institutes of Health Stroke Scale (NIHSS); Prevalence: facial palsy, aphasia, neglect, hemiparesis, endotracheal insertion, dysarthria, decreased consciousness; Duration of nasogastric tube insertion.</p>	<ol style="list-style-type: none"> 1. Of the patients who developed pneumonia, a significantly higher NIHSS score was reported compared to those who did not develop pneumonia (p<0.000). 2. Prevalence of facial palsy (p=0.02), endotracheal intubation (p=0.04), and decreased consciousness (p=0.002) were all significantly greater amongst those who developed pneumonia compared to those who did not. 3. Patients who developed pneumonia required a significantly longer duration of nasogastric tube insertion (p<0.000) than those who did not develop pneumonia. 4. Prevalence of dysarthria (p=0.4), aphasia (p=0.13), neglect (p=0.35) and hemiparesis (p=0.09) were not

significantly associated with pneumonia.

15.5.4 Dysphagia Screening Protocols and Incidence of Pneumonia

Table 15.5.4 Dysphagia Screening Protocols and Incidence of Pneumonia

Author, Year Country PEDro Score TPS	Methods	Outcomes
Odderson et al. (1995) USA No Score TPS=NA N=NA	Intervention: The incidence of pneumonia was assessed in a single institution before the implementation of a dysphagia screening protocol, during the first year after its implementation and during the second year. Outcomes: Incidence of pneumonia.	1. The percentages of patients who developed pneumonia before the pathway was developed, during the first year of the pathway and during the second year of the pathway were 6.7%, 4.1% and 0%, respectively.
Hinchey et al. (2005) USA No Score TPS=NA N=NA	Intervention: 15 acute care hospital sites were surveyed to determine whether they had an established dysphagia screening protocol in place and to establish the adherence level. The incidence of pneumonia between institutions which had/ did not have formal screening in place was compared. Outcomes: Incidence of pneumonia; Adherence rate to dysphagia screening protocol.	1. Six sites had a formal dysphagia screen. Their adherence rate was 78% compared with 57% at sites with no formal screen. 2. The pneumonia rate at sites with a formal dysphagia screen was 2.4% versus 5.4% (p=0.0016) at sites with no formal screen. 3. There was no difference in median stroke severity (5 versus 4; P=0.84) between the sites with and without a formal screen.
Lakshminarayan et al. (2010) USA No Score TPS=NA N=18017	Intervention: Adherence to guidelines for dysphagia screening was examined in a National Acute Stroke Registry. The incidence of pneumonia among patients who were screened/not screened was assessed prior to initiation of oral intake. Outcomes: Incidence of pneumonia.	1. The sample was composed of 18,017 patients from 222 hospitals. 4,509 (25%) of patients were not screened. 2. Pneumonia rates were 4.2% in patients who were not screened, 2.0% in patients who were screened and passed and 6.8% for patients who were screened but failed.
Yeh et al. (2011) Taiwan No Score TPS=NA N=176	Intervention: 176 consecutive acute stroke patients admitted to the stroke ICU from May 2006 to March 2007 were included. Patients were divided into two groups; those who were admitted before the introduction of standardized dysphagia screening (n=74) and those admitted after the introduction of the 3-Step Swallowing Screen (n=102). A binary logistic regression model was used to determine independent risk factors for stroke associated pneumonia and in-hospital death. Outcomes: Incidence of pneumonia; Risk factors for stroke associated pneumonia and in-hospital death.	1. 100 patients (57%) developed pneumonia although there was no difference in its development between patients who were screened and those who were not (45 vs. 55, p=0.44). 2. Pneumonia was associated with greater stroke severity, older age, nasogastric and endotracheal tube placement and length of tube placement. 3. After adjusting for age, gender, NIHSS score and nasogastric and endotracheal tube insertion, dysphagia screening was associated with a borderline decrease in pneumonia (OR: 0.42; 95% CI, 0.18-1.00; p=0.05). However, dysphagia screening was not associated with reduction of in-hospital deaths.
Sorensen et al. (2013) Canada	Population: Intervention Group (IG; N=58): Mean age=84 (79-88)yr; Gender: Males=22, Females=36.	1. The incidence of x-ray verified pneumonia was four of 58 (7%) patients in the IG

<p>PCT No Score TPS_{Mean}≥3d N_{Start}=146 N_{End}=146</p>	<p>Internal Control Group (ICG; N=58): Mean age=85 (78-89)yr; Gender: Males=21, Females=37. External Control Group (ECG; N=30): Mean age=83 (78-90)yr; Gender: Males=10, Females=20. Intervention: An early screening with the Gugging Swallowing Screen (GUSS) and intensified oral hygiene care plan was offered to three groups of patients: IG, ICG (an internal historic control group), and an ECG (external control group from a neighbouring stroke unit hospitalized). Treatment in the IG included an initial GUSS and a standardized care plan with detailed procedures for mechanical cleaning (tooth brushing), protection and moistening of the oral cavity, and preventative antibacterial cleansing with chlorhexidine 0.12% mouth rinse. Dysphagia treatment in the CGs was dysphagia screening using a clinical screening method within 24hr and before oral administration of nutrition or fluids. Outcomes: GUSS.</p>	<p>compared with 16 of 58 (28%) patients in the ICG (p<0.01) and with eight of 30 (27%) patients in the ECG (p<0.05). 2. Dysphagia screening also took place ≤24hr for 97% of patients in the intervention group, compared to 72% in the historical control group (P<0.01). 3. A greater number of individuals in the intervention group also had a care plan for oral hygiene prepared (71% vs. 10% in the historical control group, P<0.01).</p>
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15.5.5 Prevention of Pneumonia Post-Stroke

Table 15.5.5 Prevention of Pneumonia Post-Stroke

<p>Author, Year Country PEDro Score TPS</p>	<p>Methods</p>	<p>Outcomes</p>
<p>Osawa et al. (2013b) Japan Case Series No Score TPS_{Mean}=1.7±1.7d N_{Start}=189 N_{End}=189</p>	<p>Population: Intervention Group (N=189): Mean age=69.9±12.2yr; Gender: Males=129, Females=60. Intervention: Medical records of patients referred to the rehabilitation department between September 2008 and August 2009 were reviewed retrospectively for the occurrence of aspiration pneumonia and the administration of cilostazol. Outcomes: Functional Independence Measure (FIM); Mini-Mental Status Examination (MMSE); Canadian Neurological Scale (CNS); Length of Stay (LOS); Incidence of pneumonia.</p>	<ol style="list-style-type: none"> 1. The incidence of pneumonia was significantly higher among patients who did not receive cilostazol compared to patients who did (p=0.0476). 2. There were no significant differences between patients who received cilostazol and those who did not on any other measures. 3. Patients who developed pneumonia had significantly lower MMSE (p=0.0050) and CNS scores (p=0.0004) at admission, a longer LOS in hospital (p<0.0001), and significantly lower FIM scores at discharge (p<0.0001). 4. FIM score on admission did not differ significantly between patients who developed pneumonia and patients who did not.
<p>Warusevitane et al. (2014) UK RCT PEDro=8 TPS_{Overall}<7d N_{Start}=60 N_{End}=60</p>	<p>Population: Experimental Group (EG; N=30): Mean age=76.9±6.3yr; Gender: Males=11, Females=19. Control Group (CG; N=30): Mean age=79.2±10.8yr; Gender: Males=11, Females=19. Intervention: The EG received 10mg of metoclopramide, and the CG received 10ml of placebo (i.e. normal saline) 3/d via the nasogastric tubes (NGT). Treatment was conducted until the</p>	<ol style="list-style-type: none"> 1. 26 patients in the CG versus eight patients in the EG developed pneumonia. 2. The mean number of pneumonia episodes was 1.33 in the CG and 0.27 in the EG (rate ratio=5.24; p<0.001). 3. The CG had a higher mean number of days on antibiotic treatment (7.57) than those in the EG (2.2) (rate ratio=3.94; p<0.001).

	<p>NGT was no longer necessary, withdrawal of active treatment as part of end-of-life care, or for a maximum of 21d.</p> <p>Outcomes: Number of episodes of pneumonia; Witnessed aspiration; Highest level of white blood cell count (WBC); C-reactive protein (CRP) during follow-up; Lowest oxygen saturation during follow-up; Number of antibiotic days; Neurological deficits; Final clinical outcome; Mortality.</p>	<ol style="list-style-type: none"> 4. The CG had a mean of 0.7 episodes of aspiration when compared with the mean of 0.03 in the EG (rate ratio=20.54; p=0.003). 5. There was no significant difference in mortality between the groups (OR 1.85; p=0.292). 6. The lowest recorded % oxygen saturation was lower in the CG than in the EG (mean difference=8.54; p<0.001). 7. The highest WBC count was 1.332x greater (p=0.016) and the highest CRP was 1.97x greater (p=0.014) in the CG than in the EG. 8. Regarding the final clinical outcome, more patients in the EG showed improved swallowing compared to those in the CG (N=20 vs. N=11; p=0.031). 9. Number of patients referred for percutaneous endoscopic gastrostomy did not differ between the two groups (p=0.807).
<p>Hirayama et al. (2016) Japan Cohort No Score TPS=Acute N_{Start}=305 N_{End}=305</p>	<p>Population: Post Group (EG; N=173): Mean age=70.1±11.5yr; Gender: Males=110, Females=63. Prior Group (CG; N=132): Mean age=70.0±12.2yr; Gender: Males=86, Females=46.</p> <p>Intervention: Patient outcomes were retrospectively analyzed prior (CG) to and post (EG) implementation of a multidisciplinary swallowing team.</p> <p>Outcomes: Pneumonia Rate.</p>	<ol style="list-style-type: none"> 1. There was a significant decrease in Pneumonia Rate in the EG group compared to the CG group (p=0.01).

15.6 Non-Instrumental Methods for Screening and Assessment of Dysphagia

15.6.1 Clinical Screening Methods

Table 15.6.1 Clinical Screening Methods

Author, Year Name of Test	Components of test Details of validation study	Outcomes
<p>Daniels et al. (1997) “Any Two”</p>	<p>59 acute stroke survivors were studied. Six clinical features-dysphonia, dysarthria, abnormal volitional cough (includes water-swallowing test), abnormal gag reflex, cough after swallow and voice change after swallow were assessed. All subjects received a VMBS study in addition to a clinical exam and water swallowing test.</p>	<p>44/59 patients (74.6%) were dysphagic based on VMBS results. The presence of 2 clinical features correctly distinguished between subjects with normal swallow of mild dysphagia from those with moderate or severe dysphagia as determined by VMBS examination: Sensitivity: 92% Specificity: 67%</p>
<p>Hinds & Wiles (1998) “Timed test”</p>	<p>Standardized questionnaire (11 questions) Timed test of swallowing: subject is given small amount of water from a teaspoon. If successful, 100-150 mL of water is given with the instruction to drink as quickly as possible. A test is considered</p>	<p>The ability of the 11 questions to predict the need for a SLP referral: Sensitivity: 0% - 69% Specificity: 62%- 94% The ability of the water swallowing test to</p>

	<p>abnormal if wet hoarse voice or coughing are noted, or if volume of water consumed are below population norms.</p> <p>115 consecutive subjects with acute stroke. The tool was used to predict the need for SLP intervention.</p>	<p>predict the need for a SLP referral:</p> <p>Sensitivity: 100%</p> <p>Specificity: 52%</p>
<p>Logemann et al. (1999)</p> <p>28-Item Screening Test (28 patient variables considered during identification of dysphagia and referral for diagnostic assessment)</p>	<p>28 items divided into 5 categories:</p> <ul style="list-style-type: none"> i) 4 medical history variables ii) 6 behavioural variables iii) 2 gross motor variables iv) 9 observations from oromotor testing v) 7 observations during trial swallows <p>The tool was designed to identify the presence or absence of aspiration, oral stage disorder, pharyngeal delay, pharyngeal stage disorder.</p> <p>202 consecutive patients (34% stroke) were examined. The results were of the screening tool were compared with a VMBS exam.</p>	<p>Aspiration: Throat clearing was best single predictor.</p> <p>Sensitivity: 78%</p> <p>Specificity: 58%</p> <p>Oral stage disorder: dysarthria was the best single predictor.</p> <p>Sensitivity: 64%</p> <p>Specificity: 75%</p> <p>Presence of pharyngeal delay: being rated as unsafe on at least 8/28 swallowing trials was the best predictor.</p> <p>Sensitivity: 69%</p> <p>Specificity: 71%</p> <p>Pharyngeal stage swallow disorder: reduced laryngeal elevation was the best single predictor.</p> <p>Sensitivity: 72%</p> <p>Specificity: 67%</p>
<p>Trapl et al. (2007)</p> <p>The Gugging Swallowing Screen (GUSS)</p>	<p>Preliminary Assessment (vigilance, throat clearing, saliva swallow)</p> <p>Direct swallow (semisolid, liquid, solid swallow trials)</p> <p>Score: 0 (worst) - 20 (no dysphagia)</p> <p>80 acute stroke patients were included. Results were compared with fibertopic endoscopic evaluation.</p>	<p>First group of 50 patients: using a cut-off score of 14, the sensitivity of GUSS to identify subjects at risk of aspiration: Sensitivity: 100%</p> <p>Specificity: 50%</p> <p>Second group of 30 patients:</p> <p>Sensitivity: 100%</p> <p>Specificity: 69%</p>
<p>Edmiaston et al. (2010)</p> <p>USA</p> <p>Acute Stroke Dysphagia Screen</p>	<p>300 acute stroke patients screened by nurses within 8 to 32 hours following admission.</p> <p>Items included: Glasgow Coma Scale score <13, presence of facial, tongue or palatal asymmetry/weakness. If no to all 3 items, then proceed to 3 oz water swallowing test. If no evidence of swallowing problems on water swallowing test, then the patient passes the screen.</p> <p>Scoring: pass-4/4 items; fail \geq1/4 items</p> <p>Results were compared with the results of the Mann Assessment of Swallowing Ability, performed by a SPL.</p>	<p>Prevalence of Dysphagia identified using MASA: 29%</p> <p>Sensitivity (Dysphagia): 91%</p> <p>Specificity: 74%</p> <p>Sensitivity (aspiration risk): 95%</p> <p>Specificity: 68%</p> <p>Inter-rater reliability: 94%</p> <p>Test-retest reliability: 92.5%</p>

<p>Turner-Lawrence et al. (2009)</p> <p>Emergency Physician Dysphagia Screen</p>	<p>A convenience sample of 84 stroke patients (ischemic/hemorrhagic) was included. Examinations were conducted by 45 ER MDs.</p> <p>The two-tiered bedside tool was developed by SLPs. Tier 1 items included: voice quality, swallowing complaints, facial asymmetry, and aphasia. Tier 2 items included a water swallow test, with evaluation for swallowing difficulty, voice quality compromise, and pulse oximetry desaturation (>or=2%).</p> <p>Patients failing tier 1 did not move forward to tier 2.</p> <p>Patients who passed both tiers were considered to be low-risk. These results were compared with those from a formal assessment by an SLP. Reliability was assessed using a convenience sample of 32 patients.</p>	<p>Prevalence of Dysphagia identified by SLPs: 48 (57%)</p> <p>Sensitivity: 96%</p> <p>Specificity: 56%</p> <p>+Likelihood ratio: 2.2</p> <p>Reliability: Kappa=0.90</p>
<p>Antonios et al. (2010)</p> <p>Modified Mann Assessment of Swallowing Ability (MMASA)</p>	<p>150 consecutive patients with acute ischemic stroke were assessed by 2 neurologists shortly after admission to hospital. The results were compared with the assessments conducted by SLPs using the full MASA.</p> <p>12 of the 24 MASA items were retained including: alertness, co-operation, respiration, expressive dysphasia, auditory comprehension, dysarthria, saliva, tongue movement, tongue strength, gag, volitional cough and palate movement. Maximum score is 100.</p>	<p>Prevalence of Dysphagia identified by SLP using MASA: 54 (36.2%)</p> <p>Sensitivity: 87% & 93%</p> <p>Specificity: 86% & 84%</p> <p>+ Predictive Value: 79 & 76%</p> <p>+ Likelihood Ratio: 5.5 & 6.8</p> <p>Reliability: Kappa=0.76</p>
<p>Schrock et al. (2011)</p> <p>MetroHealth Dysphagia Screen</p>	<p>283 patients admitted to the Emergency department with acute stroke and screened for the presence of dysphagia by nurses using a 5-item questionnaire. Those results were compared with: an abnormal VMBS study, the placement of a NG/PEG or need for a dysphagia diet at 30 days.</p> <p>Focus of the items:</p> <ol style="list-style-type: none"> 1. Alert and able to sit upright for 10 minutes. 2. Weak, wet or abnormal voice. 3. Drooling 4. Slurred speech 5. Weak, or inaudible cough. 	<p>Incidence of true dysphagia at 30 days was 32% (n=91). VMBS was performed in 77 patients and was abnormal on 64 (83%) patients.</p> <p>Sensitivity: 95%</p> <p>Specificity: 55%</p> <p>+ Likelihood Ratio: 2.1</p> <p>Likelihood ratio: 0.1</p> <p>Reliability: Kappa=0.69</p>
<p>Edmiaston et al. (2013)</p> <p>Barnes-Jewish Hospital Stroke Dysphagia Screen</p>	<p>225 patients admitted to a stroke unit were assessed for dysphagia and aspiration by a nurse using the BJH-SDS. Results of this test were compared to results of the videofluoroscopic swallow study (VFSS) test which was conducted by a (blinded) SLP.</p>	<p>Prevalence of dysphagia as diagnosed by an SLP using the VFSS was 47%.</p> <p>Sensitivity: 94% (95% CI 88% - 98%)</p> <p>Specificity: 66% (95% CI 57% - 75%)</p> <p>PPV: 71% (95% CI 63% - 79%)</p>

<p>(BJH-SDS) <i>(formerly Acute Stroke Dysphagia Screen – Edmiaston et al. 2010)</i></p>	<p>Items of the BJH-SDS included: Glasgow Coma Scale score <13, presence of facial, tongue or palatal asymmetry/weakness. If no to all 3 items, then proceed to 3 oz water swallowing test. If no evidence of swallowing problems on water swallowing test, then the patient passes the screen.</p> <p>Scoring: pass-4/4 items; fail ≥1/4 items</p>	<p>NPV: 93% (95% CI 85% - 97%)</p> <p>Prevalence of aspiration as diagnosed by an SLP using the VFSS was 27%.</p> <p>Sensitivity: 95% (95% CI 86% - 99%) Specificity: 50% (95% CI 42% - 58%) PPV: 41% (95% CI 33% - 50%) NPV: 96% (95% CI 90% - 99%)</p>
<p>Harms et al. (2013) Germany Observational No Score TPS_{Overall}<24hr N_{Start}=335 N_{End}=335</p>	<p>Population: Age<60yr=52, Age 60-70yr=82, Age 71-80yr=101, Age>80yr=100; Gender: Males=176, Females=159.</p> <p>Intervention: This study developed a score to identify patients at high risk of developing stroke-associated-pneumonia (SAP). Demographic and clinical data was obtained from acute stroke patients treated in an intensive care unit. Patients were divided into a derivation group and a validation group for data analysis purposes.</p> <p>Outcomes: Diagnosis of pneumonia within the first 7d after admission.</p>	<ol style="list-style-type: none"> The frequency of SAP was 31.3%. A 12-point scoring system (PANTHERIS) was developed based on the Glasgow Coma Scale (CGS) (GCS<9=5, GCS 9-12=2, GCS>12=0), age (<60yr=0, 60-80yr=1, >80yr=2), increase in systolic arterial blood pressure >200mmHg within the first 24hr after admission (no=0, yes=2), and white blood cell count >11.000/μl (no=2, yes=3). A score of ≥5 point predicted SAP with a sensitivity of 77.6%, a specificity of 84%, a positive predictive value of 67.5%, and a negative predictive value of 89.7% in the derivation group. PANTHERIS score showed excellent discrimination (AUC 0.85, 95% CI 0.80,0.91) and calibration properties (Nagelkerke's R²=0.46) in the derivation group. All predictive properties were reproduced in the validation group.
<p>Guillen-Sola et al. (2013) Spain Observational No Score TPS_{Mean}=13. 8±8.86d N_{Start}=52 N_{End}=52</p>	<p>Population: Intervention group (N=52): Median age=66±11yr; Gender: Males=28, Females=24.</p> <p>Intervention: All patients were evaluated using the Volume Viscosity Swallow Test (V-VST) followed by Videofluoroscopy (VFS). The results of the V-VST were then evaluated in comparison with the VFS results to ascertain the screening capacity of the V-VST.</p> <p>Outcomes: V-VST: specificity, sensitivity, positive predictive value (PPV), Negative predictive value (NPV), diagnostic accuracy index (DAI), likelihood ratio (LR).</p>	<ol style="list-style-type: none"> Sensitivity of the V-VST to assess the efficacy signs during the oral phase was 93.7% and 40% during the pharyngeal phase. Specificity of the V-VST to assess the efficacy signs during the oral phase was 65% and 70.8% during the pharyngeal phase. PPV was 81.1% during the oral phase and 55.5% during the pharyngeal phase. NPV was 86.6% during the oral phase and 55.9% during the pharyngeal phase. DIA during the oral phase was 79.6% and 43.3% during the pharyngeal phase. <ol style="list-style-type: none"> LR was 2.67 during the oral phase and 1.35 during the pharyngeal phase.
<p>Rofes et al. (2014) Spain Pre-Post No Score TPS_{Overall}=NA N_{Start}=120 N_{End}=120</p>	<p>Population: Mean age=74.4±12.4yr; Gender: Males=65, Females=55.</p> <p>Note: 55% of the population are stroke patients. A separate population of 14 healthy controls also underwent the same assessments.</p> <p>Intervention: Patients were evaluated for oropharyngeal dysphagia (OD) using the eating assessment tool (EAT-10) and the bedside method,</p>	<ol style="list-style-type: none"> The prevalence of OD according to VFS was 87% (n=114). 75.6% (n=99) of patients presented VFS signs of impaired efficacy, and 80.9% (n=106) presented signs of impaired safety of swallow. EAT-10 showed an area under the receiver operating characteristic curve of 0.89 for OD with an optimal cut-off at 2 (0.89

	<p>Volume-Viscosity Swallow Test (V-VST). These two index tests were compared to videofluoroscopy (VFS) measurements. Three different bolus viscosities were used during V-VST and VFS in the following viscosity ranges: 1-50mPa s for thin liquids, 51-350 mPa s for nectar-like, and >1750mPa s for extreme spoon-thick (EST).</p> <p>Outcomes: EAT-10; V-VST; VFS.</p>	<p>sensitivity and 0.82 specificity).</p> <p>3. V-VST showed 0.94 sensitivity and 0.88 specificity for OD, 0.79 sensitivity and 0.75 specificity for impaired efficacy, 0.87 sensitivity and 0.81 specificity for impaired safety, and 0.91 sensitivity and 0.28 specificity for aspirations.</p>
<p>Bergstrom et al. (2014) Sweden Prospective No Score TPS_{Mean}=NA N_{Start}=12 N_{End}=12</p>	<p>Population: Intervention Group (N=12): Mean age=72.5±13.94yr; Gender: Males=7, Females=5. Intervention: Twelve participants provided 18 swallows samples to test the validity and reliability of cervical auscultation (CA) under two conditions: 1) CA-only, using isolated swallow-sound clips, 2) clinical swallow examination and swallow-sound clips (CSE+CA). The two conditions were compared against a fiberoptic endoscopic evaluation of swallowing (FEES) reference test. Outcomes: Sensitivity; Specificity.</p>	<p>1. Dysphagia</p> <ul style="list-style-type: none"> • Sensitivity <ul style="list-style-type: none"> a. CA-only: 88% b. CSE+CA: 83% • Specificity <ul style="list-style-type: none"> a. CA-only: 50% b. CAE+CA: 60% <p>2. Safe</p> <ul style="list-style-type: none"> • Sensitivity <ul style="list-style-type: none"> a. CA-only: 87% b. CSE+CA: 95% • Specificity <ul style="list-style-type: none"> a. CA-only: 89% b. CSE+CA: 92%
<p>Lee et al. (2014) South Korea Observational No Score TPS_{Mean}=NA N_{Start}=101 N_{End}=101</p>	<p>Population: Mean age=72.95yr; Gender: Male=0, Female=101. Intervention: No intervention. All patients were administered the simplified cough test (SCT) in addition to the videofluoroscopic swallowing study (VFSS). SCT involved patients breathing in a mist of a 1% citric acid solution until the first cough was elicited (cough latency). Based on the VFSS results, patients were divided into the subgroups of non-aspirator, silent aspirator and apparent aspirator. Patients were also compared to a young healthy control group (n=29) and an elderly healthy control group (n=30). Outcomes: SCT; VFSS.</p>	<p>1. Cough latency was significantly longer in the dysphagia group compared to the healthy control groups (dysphagia=29.61±22.23s, elderly=14.91±16.62s, young=3.96±3.92).</p> <p>2. Cough latency was significantly longer in the silent aspiration group (46.90±18.28s, p<0.001) compared to no aspiration (17.99±19.57s) and apparent aspiration (27.24±18.22s).</p> <p>3. Cough latency was significantly longer in the apparent aspiration group compared to the no aspiration group (p<0.001).</p> <p>4. Sensitivity and specificity of SCT (73.8% and 72.5%, respectively) for detecting aspiration in dysphagic patients and 87.1% and 66.7%, respectively for detecting silent aspiration in the aspirated patients.</p>
<p>Crary et al. (2014a) USA Prospective Study No Score TPS_{Mean}=4.6±4.23d N_{Start}=62 N_{End}=62</p>	<p>Population: Mean age=60.1±15.2yr; Gender: Males=32, Females=30. Intervention: Participants were evaluated using the spontaneous swallowing frequency analysis (SFA) and a nurse-administered clinical screening tool. Outcomes: Mann Assessment of Swallowing Ability: sensitivity, specificity negative predictive value (NPV), positive predictive value (PPV), negative likelihood ratio (-LR), positive likelihood ratio (+LR), classification accuracy.</p>	<p>1. The SFA generated a sensitivity of 96%, specificity of 67%, NPV of 96%, PPV of 68%, +LR of 2.9, -LR of 0.06, and a classification accuracy of 79%.</p> <p>2. The nurse-administered clinical screening tool generated a sensitivity of 88%, specificity of 58%, NPV of 88%, PPV of 61%, +LR of 2.1, -LR of 0.20, and a classification accuracy of 71%.</p> <p>3. SFA was superior to a nurse-administered dysphagia screening tool in the accurate identification of patients at risk for</p>

		dysphagia.
<p>Crary et al. (2014b) USA Prospective Study No Score TPS_{Mean}=4.6±4.1d N_{Start}=63 N_{End}=63</p>	<p>Population: Mean age=59.2±15.2yr; Gender: Males=33, Females=30. Intervention: The study cohort (patients with dysphagia and without dysphagia) were assessed on the swallow frequency rates (swallows per minutes (SPM)) and were compared with various criteria such as stroke and swallow severity indices, age, time from stroke to assessment, and conscious level. Outcomes: Specificity; Sensitivity; Negative Predictive Value (NPV); Positive Predictive Values (PPV); Positive Likelihood Ratio (PLR); Overall Classification Accuracy (OCA); Spontaneous Swallowing Frequency Rate via Swallows/min (SPM); Mann Assessment of Swallowing Ability (MASA); National Institute of Health Stroke Scale (NIHSS); modified Rankin Scale (mRS); Barthel Index (BI); Functional Oral Intake Scale (FOIS).</p>	<ol style="list-style-type: none"> 1. SPM significantly correlated with all stroke and dysphagia measures: NIHSS ($r=-0.39$, $p<0.005$), mRS ($r=-0.51$, $p<0.0001$), BI ($r=0.4$, $p<0.0001$), MASA ($r=0.52$, $p<0.0001$), and FOIS ($r=0.51$, $p<0.0001$). 2. Psychometric properties of swallow frequency rate to identify dysphagia was calculated in comparison with the criterion referent MASA (≤ 178). The swallow frequency rate (≤ 0.40 SPM) was 96% sensitive, 68% specific in the identification of clinically significant dysphagia, the NPV was 96%, the PPV was 68%, the (PLR) was 2.96, and the OCA was 79.4%. 3. A sampling period between 5-10min was adequate to represent a total spontaneous swallow frequency analysis on the basis of a 30min sample.
<p>Edmiaston et al. (2014) USA Prospective study No Score TPS_{Mean}=NA N_{Start}=225 N_{End}=225</p>	<p>Population: Mean age=64±15yr; Gender: Males=172, Females=53. Intervention: Acute stroke patients were assessed using the Barnes-Jewish Hospital Stroke Dysphagia Screen (BJH-SDS) and using videofluoroscopic swallow study (VFSS) to test for dysphagia. The BJH-SDS was evaluated against the VFSS. Outcomes: Specificity; Sensitivity; Positive Predictive Values (PPV); Negative Predictive Values (NPV).</p>	<ol style="list-style-type: none"> 1. No increase in pneumonia was identified during the implementation of the BJH-SDS screening tool over the 5yr period ($p=0.33$). <p>Prevalence of dysphagia as diagnosed by an SLP using the VFSS was 47%.</p> <p>Sensitivity: 94% (95% CI 88% - 98%) Specificity: 66% (95% CI 57% - 75%) PPV: 71% (95% CI 63% - 79%) NPV: 93% (95% CI 85% - 97%)</p> <p>Prevalence of aspiration as diagnosed by an SLP using the VFSS was 27%.</p> <p>Sensitivity: 95% (95% CI 86% - 99%) Specificity: 50% (95% CI 42% - 58%) PPV: 41% (95% CI 33% - 50%) NPV: 96% (95% CI 90% - 99%)</p>
<p>Jeyaseelan et al. (2015) USA Retrospective No Score TPS_{Mean}=NA N_{Start}=290 N_{End}=290</p>	<p>Population: Dysphagia Group (DG; n=88): Mean age=67.1yr; No Dysphagia Group (ND; n=202): Mean age=63.2yr. Intervention: Retrospective review of stroke patients admitted to a hospital. Outcomes: National Institutes of Health Stroke Scale (NIHSS); Functional Independence Measure (FIM): motor and cognition; Modified Brain Swallow (MBS) study.</p>	<ol style="list-style-type: none"> 1. 30.6% of patients in the ND group were administered the MBS test. 2. FIM motor was significantly lower in the DG (DG=26.8±11.9, ND=40.1±11.3, $p<0.001$). 3. FIM cognition was significantly lower in the DG (DG=15.0±7.4, ND=22.7±7.9, $p<0.001$). 4. NIHSS was significantly greater in the DG (DG=12.3±5.9, ND=8.4±5.5, $p<0.001$).
<p>Cheney et al. (2015) USA Retrospective No Score TPS_{Mean}=NA</p>	<p>Population: Mean age=64.40±14.75yr; Gender: Males=195, Females=165. Intervention: Data from individuals with dysphagia undergoing a videofluoroscopic swallow study were obtained from a clinical database to evaluate the</p>	<ol style="list-style-type: none"> 2. The mean EAT-10 of patients who aspirated (PAS>5) was 23.16±10.88 and the mean EAT-10 of patients who did not aspirate (PAS<6) was 16.08±10.25 ($p<0.001$). 3. There was a significant linear correlation of

<p>N_{Start}=360 N_{End}=360</p>	<p>ability of the assessment tools to screen for aspiration risk. Outcomes: Eating Assessment Tool (EAT-10); Penetration Aspiration Scale (PAS); Total Pharyngeal Transit (TPT) time.</p>	<p>EAT-10 and PAS scores for the entire cohort ($r=0.273$, $p<0.001$).</p> <ol style="list-style-type: none"> 4. Individuals with EAT-10>15 were 2.2 times more likely to aspirate (95% CI 1.39,3.62). 5. The mean TPT times for aspirators and non-aspirators were 2.03 ± 1.81 and 1.38 ± 1.04 ($p<0.001$). 6. There was a linear correlation between the TPT time and PAS ($r=0.22$, $p<0.001$) and between TPT time and EAT-10 scores ($r=0.14$, $p<0.05$). 7. The sensitivity of an EAT-10 greater than 15 in predicting aspiration was 70.6% and the specificity was 52.7%. 8. An EAT-10 score >15 had a positive predictive value of 26% and a negative predictive value of 89%.
<p>Guillen-Sola et al. (2015) Spain Observational No Score TPS=$12.7\pm 9.8d$ N_{Start}=134 N_{End}=134</p>	<p>Population: Mean age=$62.2\pm 11.9yr$; Gender: Males=74, Females=60. Intervention: All patients were observed after administration of a citric acid cough test and undergoing a videofluoroscopic swallowing test (VFS). Outcomes: Penetration Rate; Aspiration Rate; Silent Aspiration Rate; Normality Rate.</p>	<ol style="list-style-type: none"> 1. There were 36 patients with a positive citric acid cough test, of which the VFS revealed penetration in 14 cases (38.9%), aspiration in 5 (13.9%), silent aspiration in 5 (13.9%), and normality in 12 patients (33.3%). 2. The sensitivity and specificity indexes for the reliability of citric acid cough test as a screening method for silent aspiration in comparison with the VFSS were .19 and .71, respectively.
<p>Oh et al. (2016) South Korea Observational No Score TPS_{Mean}=10.9mo N_{Start}=54 N_{End}=54</p>	<p>Population: Mean age=$58.6\pm 15.1yr$; Gender: Males=36, Females=18. Intervention: The test-re-test and inter-rater reliability of the Korean Mann Assessment of Swallowing Ability (K-MASA) was assessed and correlated to the Videofluoroscopic Dysphagia Scale (VDS). Outcomes: K-MASA; VDS.</p>	<ol style="list-style-type: none"> 1. The total score of the K-MASA was significantly negatively correlated to the total score of the VDS ($r=-0.509$) ($p=0.000$). 2. Swallowing domains of the K-MASA (oral preparatory phase, bolus clearance, oral transit, pharyngeal phase and pharyngeal response) were significantly negatively correlated to VDS scores ($r=-0.546$) ($p=0.000$). 3. The intra-class correlation coefficient for the test-re-test reliability of the K-MASA was determined to be 0.98; ranging from 0.76 to 1.00. 4. The intra-class correlation coefficient for the inter-rater reliability of the K-MASA was determined to be 0.99; ranging from 0.79 to 1.00.

15.6.1.1 Water Swallowing Test (WST)

Table 15.6.1.1 Water Swallowing Test

<p>Author, Year Country PEDro Score</p>	<p>Methods</p>	<p>Outcomes</p>
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TPS		
<p>DePippo et al. (1992) 3-oz water swallow test</p>	<p>44 consecutive patients on a stroke rehabilitation unit with suspected dysphagia were studied. Patients were given 3oz of water from a cup and asked to drink without interruption. Coughing for up to 1 minute after the test or a wet-horse voice was considered abnormal. Patients also received a VMBS study and the results from the 2 tests were compared.</p>	<ol style="list-style-type: none"> 1. The sensitivity and specificity of the WST to detect aspiration were 76% and 59%, respectively
<p>Garon et al. (1995) USA No Score TPS=NA N=100</p>	<p>Intervention: 100 patients (50% stroke) with confirmed or suspected dysphagia that required a VMBS study as part of clinical management were included. All patients were asked to drink 3oz of water from a cup without interruption. Any coughing or throat clearing was indicative of an abnormal water-swallowing test (WST). The results of the two methods were compared.</p>	<ol style="list-style-type: none"> 1. The sensitivity and specificity of the tool to identify confirmed aspirators were 54% and 79%, respectively.
<p>Lim et al. (2001) Singapore No Score TPS=NA N=50</p>	<p>Intervention: 50 acute stroke patients received a 50mL water swallowing test (in 10mL aliquots) and a flexible endoscopic evaluation of swallowing (FEES) examination. Patients also received an oxygen desaturation test (ODT). Outcomes: FEES; ODT.</p>	<ol style="list-style-type: none"> 1. The 50ml water swallow test had a sensitivity of 84.6% and specificity of 75.0%. 2. The oxygen desaturation test had a sensitivity of 76.9% and specificity of 83.3%. 3. When the two tests were combined into one test called "bedside aspiration," the sensitivity rose to 100% with a specificity of 70.8%. 4. Five (10%) patients developed pneumonia during their inpatient stay. The relative risk of developing pneumonia, if there was evidence of aspiration on FEES, was 1.24 (95% CI 1.03, 1.49).
<p>Chong et al. (2003) Singapore No Score TPS=NA N=50</p>	<p>Intervention: 50 patients with suspected dysphagia ≥65yr who had suffered either a recent or remote stroke. Patients received a clinical evaluation of swallowing which included a water swallowing test (WST), where patients were asked to drink 50mL of water in 10mL aliquots, and an oxygen desaturation test (ODT) (desaturation of ≥2% was considered clinically significant) and fiberoptic endoscopic evaluation of swallowing (FEES) where episodes of aspiration or penetration of various food consistencies were noted. The consistency or results between the tests were compared. Outcomes: WST; ODT; FEES.</p>	<ol style="list-style-type: none"> 1. The WST had a sensitivity of 79.4% and specificity of 62.5% for the detection of aspiration, with a positive predictive value (PPV) of 81.8% and a negative predictive value (NPV) of 58.8%. 2. The oxygen desaturation test had a sensitivity of 55.9% and a specificity of 100% with PPV of 100% and NPV of 51.6%. 3. When both tests were combined, a sensitivity of 94.1% and a specificity of 62.5% were attained, with a PPV of 84.2% and NPV of 83.3%. 4. Using this clinical assessment test, three aspirators were detected who would otherwise have been missed if they were assessed with the water swallow test using thin fluids alone.
<p>Tohara et al. (2003) USA & Japan No Score</p>	<p>Intervention: 63 nursing home patients (57% stroke) with clinical evidence of dysphagia were studied to assess the accuracy of three non-</p>	<ol style="list-style-type: none"> 1. 29 patients aspirated on the VFSS. 2. The summed scores of all three non-VFG tests had a sensitivity and specificity of 90%

<p>TPS=NA N=63</p>	<p>videofluorographic (VFG) tests for risk of aspiration: (1) the water swallowing test (3ml of water are placed under the tongue and the patient is asked to swallow); (2) the food test (4g of pudding are placed on the dorsum of the tongue and the patient asked to swallow); and (3) the X-ray test (static radiographs of the pharynx are taken before and after swallowing liquid barium). The results of these tests were compared with those of a videofluorographic swallowing study (VFSS) conducted within 1wk after the water and food tests. Outcomes: Non-VFG; VFSS.</p>	<p>and 71%. The summed scores of the water and food tests (without X-ray) had a sensitivity of 90% and specificity of 56%.</p>
<p>Wu et al. (2004) Taiwan No Score TPS=NA N=59</p>	<p>Intervention: 59 stroke outpatients with suspected dysphagia underwent a 100mL water swallowing test (WST). Signs of choking or a wet sounding voice within 1min of completing the test were considered evidence of an abnormal swallow. Swallowing speed (<10mL/s or ≥10mL/s) was also recorded. The results were compared to a videofluoroscopic modified barium swallow (VMBS) study. Outcomes: WST; VMBS.</p>	<ol style="list-style-type: none"> 1. 55 patients were identified as having some form of swallowing dysfunction on VMBS examination. 2. An abnormal swallowing speed was detected in 47/55 patients. 3. Two patients with a normal VMBS result demonstrated abnormal swallowing speed on the WST. 4. The sensitivity and specificity of swallowing speed in detecting swallowing dysfunction was 85.5% and 50%, respectively. 5. 33 patients either aspirated or demonstrated penetration on VMBS study. Of these, 11 choked on the WST, while three patients with a normal VMBS result, choked on the WST. 6. The sensitivity and specificity of using choking or wet-horse voice in the WST for the prediction of aspiration was 47.8% and 91.7%, respectively.
<p>Nishiwaki et al. (2005) Japan No Score TPS=NA N=61</p>	<p>Intervention: 61 consecutive stroke patients admitted to four hospitals were assessed for dysphagia. Symptoms of oromotor functions were evaluated (lip closure, tongue movement, palatal elevation, gag reflex, voice quality and motor speech function). The water swallowing test (using 30mL of water), saliva swallowing test (SST) and a videofluoroscopic modified barium swallow (VMBS) study examination were also conducted. Factor analysis was used to predict dysphagia in patients post-stroke. Outcomes: WST; VMBS; SST.</p>	<ol style="list-style-type: none"> 1. Cough/voice change in the water swallowing test was the only variable that was significantly associated with aspiration on VMBS examination with a sensitivity of 72% and a specificity of 67%.
<p>Kopey et al. (2010) USA Retrospective No Score TPS=NA N=223</p>	<p>Intervention: A retrospective review of 223 patients admitted to an acute rehabilitation unit who were alert, and non-dysarthric. These patients received a 3-sip test on day two following admission. A portion of the patients underwent additional videofluoroscopic modified barium swallow (VMBS) study due to continued suspicion of dysphagia. The</p>	<ol style="list-style-type: none"> 1. 206 patients passed the 3-sip test. 2. 67 (32.5%) patients had clinically significant dysphagia. 3. The reported SN and SP were 20.8% and 98.7%, and the PPV and NPV were 88.2% and 72.3%, respectively. 4. A low (<60) FIM score was also predictive

	sensitivity (SN), specificity (SP), positive and negative predictive values (PPV, NPV) of the sip test compared with clinically relevant dysphagia, defined as VMBS findings that precipitated a diet change (i.e. minced or pureed solids) were calculated. Outcomes: 3-sip test; VMBS; Functional Independence Measure (FIM).	of clinically relevant dysphagia.
Osawa et al. (2013c) Japan Observational No Score TPS _{Mean} =16.6±10.3d N _{Start} =111 N _{End} =111	Population: Intervention group (N=111): Mean age=65.6±13.4yr; Gender: Males=65, Females=46. Intervention: All patients were evaluated using the water swallow test (WST) after a videofluoroscopy (VFS) examination. The results of the WST were then evaluated in comparison with the VFS results to ascertain the reliability of the WST. Outcomes: WST: specificity, sensitivity, positive predictive value (PPV), negative predictive value (NPV), accuracy percentage; Number of swallows; Swallowing speed; Time for one swallow.	<ol style="list-style-type: none"> 1. After 5ml of water swallowed, the sensitivity, specificity, PPV, NPV and accuracy of the WST were 52.9%, 90.4%, 50.0%, 91.4% and 84.7%, respectively. 2. After 10ml of water swallowed, the sensitivity, specificity, PPV, NPV and accuracy of the WST were 34.8%, 93.2%, 81.1%, 57.1% and 81.1%, respectively. 3. After 30ml of water swallowed, the sensitivity, specificity, PPV, NPV and accuracy of the WST were 51.4%, 78.9%, 52.9%, 77.9% and 70.3%, respectively. 4. After 60ml of water swallowed, the sensitivity, specificity, PPV, NPV and accuracy of the WST were 55.7%, 85.4%, 86.7%, 53.0% and 66.7%, respectively. 5. There was a positive correlation between the time for one swallow and age but there was no correlation between clinical findings of the WST or the presence of aspiration with swallow speed, number of swallows or time for one swallow.
Momosaki et al. (2013a) Japan Pre-Post No Score TPS _{Mean} =36±34d N _{Start} =110 N _{End} =110	Population: Mean age=73±10yr; Gender: Males=53, Females=57. Intervention: The Two-Step Thickened Water Test (TTWT), which includes a pretest and a swallowing test. For comparison purposes, the Two-Step Water Test (TWT) was used and followed the same procedure as TTWT. Outcomes: Fiberoptic Endoscopic Evaluation of Swallowing (FEES); Penetration-Aspiration Scale (PAS).	<ol style="list-style-type: none"> 1. The sensitivity, specificity, positive predictive value, and negative predictive value of the TTWT were 93.3%, 87.7%, 84%, 95%, respectively. 2. Overall, the study found that the TTWT is a reliable and useful tool for detection of paste food dysphagia. The low inter-rater reliability of the TTWT supports its usefulness as an assessment tool. 3. Compared with the TTWT, the sensitivity of the TWT for the diagnosis of paste food aspiration was similar (93.3%), but the specificity was lower (78.5%).

15.6.1.3 Swallowing Provocation Test (SPT)

Table 15.6.1.3 Swallowing Provocation Test

Author, Year Country PEDro Score TPS	Methods	Outcomes
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<p>Teramoto & Fukuchi (2000) Japan Retrospective No Score TPS=NA N=26</p>	<p>Intervention: A retrospective comparative trial of 26 stroke patients with aspiration pneumonia and 26 age-matched controls without pneumonia were selected to assess the properties of a swallowing provocation test (SPT) and a water swallowing test (WST) in detecting aspiration pneumonia in elderly patients. The normal response to SPT was determined by inducing swallowing reflex within 3s after water injection into the suprapharynx. In WST, subjects drank quantities of 10 and 30mL of water from a cup within 10s. A test was considered normal if the subject drank water without interruption and without evidence of aspiration.</p>	<ol style="list-style-type: none"> 1. The sensitivity and specificity of first-step SPT for the detection of aspiration pneumonia were 100% and 83.8%, respectively. Those of the second-step SPT were 76.4% and 100%, respectively. 2. The sensitivity and specificity of first-step WST using 10mL of water for the detection of aspiration pneumonia were 71.4% and 70.8%, respectively. Those of the second-step WST using 30mL of water were 72% and 70.3%, respectively.
<p>Warnecke et al. (2008) Germany No Score TPS≤72hr N=100</p>	<p>Intervention: 100 patients with first-ever stroke were examined by a speech language pathologist and fiberoptic endoscopic evaluation of swallowing (FEES) within 72hr of stroke onset. A two-step swallowing provocation test was used. In the first step 0.4ml of distilled water was used. In step two, 2.0ml was used.</p>	<ol style="list-style-type: none"> 1. The incidence of endoscopically proven aspiration risk was 81%. 2. The 1st-step SPT had a sensitivity of 74% and a specificity of 100%. The 2nd-step SPT had 49% sensitivity and 100% specificity.
<p>Kagaya et al. (2010) Japan No Score TPS=NA N=45</p>	<p>Intervention: The sensitivity (SN) and specificity (SP) of the 2-step swallowing provocation test (SPT) compared with videofluoroscopic modified barium swallow (VMBS) study results to detect aspiration, silent aspiration and penetration was evaluated among 45 rehabilitation inpatients, 27% with stroke.</p>	<ol style="list-style-type: none"> 1. The SNs and SPs of the first-step SPT for the detection of aspiration, silent aspiration, or penetration were 72-75% and 38-44%, respectively. The SNs and SPs of the second-step of the SPT were 13-17% and 80-89%, respectively.

15.6.2 Bedside Clinical Examinations

Table 15.6.2 Bedside Clinical Examinations

Author, Year Name of test	Components of test Details of validation study	Results
<p>Smithard et al. (1997) Bedside Swallowing Assessment</p>	<p>121 stroke patients consecutively admitted to an urban hospital. Patients were given an assessment of conscious level, head and trunk control, breathing pattern, lip closure, palate movement, laryngeal function, gag and voluntary cough (includes water-swallow test). Patients received both bedside and VMBS (n=94) evaluations within 3 days of stroke. Both an MD and a SLP each conducted the bedside exam.</p>	<p>50% of the patients were considered to have an unsafe swallow based on bedside evaluation alone. Of these, 20 (16.5%) patients aspirated on VMBS. Sensitivity of bedside exam to detect aspiration on VMBS: 47% (SLP); 68% (MD). Specificity: 86% (SLP); 67% (MD)</p>
<p>Mann et al. (2002) Mann Assessment of Swallowing Ability</p>	<p>128 acute first-ever stroke patients received both a bedside and VMBS exam. General examination: Consciousness, cooperation, language function, verbal/oral praxis, articulation</p> <p>24 items including- Oral preparation: Control of saliva, lip seal, tongue movement/strength, oral preparation, assessment of respiration Oral phase: Gag reflex, palatal movement, oral</p>	<p>65 (51%) subjects demonstrated evidence of dysphagia on bedside exam and 28 (21.9%) demonstrated evidence of aspiration on VMBS exam.</p> <p>Using a cut-off score of <180 the sensitivity and specificity of bedside assessment to detect dysphagia were 71% and 72%.</p> <p>The sensitivity and specificity of bedside</p>

	<p>transit time, bolus clearance Pharyngeal phase: Pharyngeal control/pooling, laryngeal elevation, reflex/voluntary cough, voice quality Includes water swallowing test</p> <p>Scoring for dysphagia: No abnormality $\leq 178-200$ Mild $\leq 168-177$ Moderate $\leq 139-167$ Severe ≤ 138</p>	<p>assessment to detect aspiration were 93% and 53%.</p>
<p>Martino et al. (2009) The Toronto Bedside Swallowing Screening Test (TOR-BSST)</p>	<p>311 stroke patients (103 acute, 208 rehabilitation) were studied. The tool was designed to identify the presence/absence of dysphagia.</p> <p>Items included: voice before, tongue movement, water swallow and voice after. The results of the screening tool were compared with a subset of subjects who also received a VMBS exam.</p> <p>Scoring: pass-4/4 items; fail $\geq 1/4$ items</p>	<p>Prevalence of dysphagia identified using VMBS: 39%</p> <p>Sensitivity: 91% Specificity: 67%</p> <p>Reliability (based on observations from 50 subjects) ICC =0.92 (95% CI: 0.85-0.96)</p>
<p>Maeshima et al. (2014) Japan Retrospective No Score TPS_{Mean}=NA N_{Start}=113 N_{End}=113</p>	<p>Population: Mean age=68.3\pm10.7yr; Gender: Males=72, Females=47. Intervention: Bedside swallowing assessment (BSA) by using the repetitive saliva swallowing test and modified water swallowing test. Outcomes: BSA; Oral intake (regular food); Swallow function at discharge.</p>	<ol style="list-style-type: none"> 1. Abnormal BSA was found in 55% of the subjects with thalamic haemorrhage. 2. Existence of a swallowing disorder was related to haematoma type and haematoma volume. 3. A regular diet was possible in 41% of the subjects (n = 46). 4. Age, haematoma volume, initial BSA evaluation and cognitive function had the greatest influence on a subject's ability to eat a general diet at the time of hospital discharge. Of those subjects in whom the initial BSA evaluation was normal, 70% were able to eat a regular diet at discharge. However, of those in whom the BSA evaluation was abnormal, >70% were discharged with enteral feeding. <p>The rates of discharge to home were 95% in patients who could eat a regular diet and 30% in patients who needed enteral feeding.</p>
<p>Somasundaram et al. (2014) Japan Prospective No Score TPS_{Mean}=NA N_{Start}=67 N_{End}=67</p>	<p>Population: Mean age=68\pm13yr; Gender: Unspecified. All patients had evidence of acute left middle cerebral artery (MCA) stroke. Intervention: Predictive value of common bedside screening tests and two items of cortical dysfunction (aphasia and bucofacial apraxia (BFA)) were analyzed for their predictive value in the detection of dysphagia. Clinical and imaging evidence of acute (<72 hr) left MCA stroke. Dysphonia, dysarthria, abnormal volitional cough</p>	<ol style="list-style-type: none"> 1. Multivariable logistic regression included predictors of dysphasia, however, did not point towards a single independent predictor. The following statistically significant OR's resulted: <ul style="list-style-type: none"> • Abnormal gag reflex (OR=5.449, 95%CI: 0.84-35.21) • Cough after swallow (OR=4.072, 95% CI 0.99– 16.68) • BFA (OR=3.978, 95% CI 0.95–16.59)

	and abnormal gag reflex were assessed by a standardized 50-ml water-swallowing test determining symptoms cough and voice change after swallow. Outcomes: Penetration-Aspiration Scale (PAS).	2. Aphasia and BFA had the highest sensitivity (97% and 78%, respectively) and high negative predictive values (89% and 68%, respectively) for dysphagia.
Martino et al. (2014) Canada Observational No Score TPS _{Acute} =6.1d TPS _{Rehab} =31.6d N _{Start} =311 N _{End} =311	Population: Acute patients (N=103): Mean age=67.7yr; Gender: Males=58, Females=45. Rehab patients (N=208): Mean age=69.0yr; Gender: Males=123, Females= 85. Intervention: None. Only administration of the Toronto Bedside Swallowing Screening Test (TOR-BSST). Outcomes: Teaspoon of water.	1. The proportion of positive first screenings was 45.3% across all patients, and more specifically, 59.2% in acute and 38.5% in rehabilitation patients. 2. Of all four items that form the TOR-BSST, the water swallow item contributed to the identification of dysphagia in 42.7% in acute and 29.0% in rehabilitation patients. 3. Across all patients, dysphagia accuracy was that five teaspoons resulted in a sensitivity of 79% (95% CI 70,86), eight a sensitivity of 92% (95% CI 85,96) and 10 a sensitivity of 96% (95% CI 90,99). The water swallow item is a primary contributor but it alone does not identify all patients with dysphagia. For a water swallow to accurately identify dysphagia, it is critical to administer 10 teaspoons.

15.7 Instrumental Methods Used in the Detection of Dysphagia/Aspiration

15.7.2 Flexible Endoscopic Evaluation of Swallowing (FEES)

Table 15.7.2 Flexible Endoscopic Evaluation of Swallowing

Author, Year Country PEDro Score TPS	Methods	Outcomes
Aviv (2000) USA Cohort No Score TPS=NA N=78	Intervention: 78 outpatients referred for dysphagia evaluation were assigned to a videofluoroscopic modified barium swallowing (VMBS) study group to guide swallowing management, while 61 patients received a flexible endoscopic evaluation of swallowing (FEES) with sensory testing. The incidence of pneumonia over a 1yr period between groups was compared. Patients received feeding tubes, therapy from a speech-language pathologist based on the results obtained from the VMBS/FEES test results. Outcomes: Incidence of pneumonia.	1. There was no difference in the incidence of pneumonia between the groups. 2. At the end of 1yr, 14 (18.4%) patients whose management had been guided by VMBS developed pneumonia, compared with six (12%) patients in the FEES group (p=0.33). 3. However, among 45 stroke patients, the incidence of pneumonia was lower among FEES group patients (1/21 vs. 7/24, p<0.05).
Leder & Espinosa (2002) No Score TPS=NA N=53	Intervention: 53 consecutive stroke patients referred for swallowing assessment were evaluated for the presence of aspiration using a bedside evaluation which was immediately followed by a flexible endoscopic evaluation of swallowing (FEES)	1. The clinical exam correctly identified 19/22 patients considered at risk for aspiration. 2. The clinical exam incorrectly identified 8/27 patients to be at risk of aspiration. 3. The sensitivity and specificity of the clinical

	<p>examination. FEES was used as the diagnostic standard.</p> <p>Outcomes: Risk of aspiration; Bedside evaluation.</p>	<p>assessment were 86% and 30%, respectively. The corresponding positive and negative predictive values were 50% and 73%.</p>
<p>Bax et al. (2014) UK Retrospective No Score TPS_{Mean}=NA N_{Start}=440 N_{End}=440</p>	<p>Population: Pre-FEES group (N=220): Mean age=76.5±12.8yr; Gender: Males=95, Females=125. FEES group (N=220): Mean age=76.3±13.3yr; Gender: Males=93, Females=127.</p> <p>Intervention: A retrospective file audit was carried out on 220 patients before flexible endoscopic evaluation of swallowing (FEES) was introduced (pre-FEES group) and 220 patients after the implementation of a speech-language pathologist-led (SLP-led) FEES service (FEES group). Each audit group spanned 12mo of hospital admissions with a 6mo gap between audits while FEES was introduced.</p> <p>Outcomes: Occurrence of pneumonia; Mortality; Diet on discharge; Discharge destination; Length of stay (LOS); Days kept nil-by-mouth (NBM); Non-oral feeding.</p>	<ol style="list-style-type: none"> 1. In the pre-FEES group, instrumental assessment was significantly associated with developing pneumonia (p=0.033, OR=5.7, 95% CI 1.15,28.35). 2. In the FEES group, instrumental assessment was significantly associated with not developing pneumonia (p=0.026, OR=3.5, 95% CI 1.166,10.75). 3. Non-oral feeding was significantly associated with not developing pneumonia in both groups (pre-FEES: p=0.024, OR=2.9, 95% CI 1.15,7.35; FEES: p=0.010, OR=6.88, 95% CI 1.58,29.88). 4. There was no significant difference between groups in the duration of NBM status (p=0.195), number of patients non-orally fed (p=0.105). 5. If patients left hospital on an oral diet, they were statistically more likely to leave hospital on standard rather than modified diet in the FEES group compared with the pre-FEES group (p=0.005). 6. Patients in the pre-FEES group had significantly shorter LOS in the hospital admission (p<0.001). 7. No statistical difference between groups was found regarding discharge destination (p=0.459) or mortality (p=0.314). 8. Patients in the FEES group were significantly more likely to receive an instrumental assessment than pre-FEES group (p<0.001). 9. Patients in the FEES group waited significantly fewer days between admission and instrumental assessment taking place compared to pre-FEES (p=0.008).
<p>Kjaersgaard et al. (2014) Denmark RCT PEDro=7 TPS_{Exp}=35d TPS_{Con}=36d N_{Start}=138 N_{End}=119</p>	<p>Population: Experimental group (EG; N=57): Median age=59 (18-76)yr; Gender: Males=41, Females=16. Control Group (CG; N=20): Median age=61 (30-78)yr; Gender: Males=38, Females=24.</p> <p>Intervention: The decision to initiate oral intake and to change the texture of food and liquids in patients was based on either a flexible endoscopic evaluation of swallowing (experimental) or the facial oral tract therapy (control). The experimental evaluation consisted of inserting an endoscope into the hypopharynx and observing characteristics including the timing of physiological movements of the bolus, management of saliva and residue of</p>	<ol style="list-style-type: none"> 1. Total number of infections during rehabilitation stay was 93 (excluding pneumonia) with no significant differences between groups. 2. 16/119 (13.5%) patients experienced pneumonia with 4/62 (6.4%) patients being in the CG and 12/57 (21.1%) patients being in the EG. 3. 10 patients developed aspiration pneumonia after initiation of oral intake (3-10d: 5 patients, 32-49d: 5 patients).

	<p>material. Oral intake and textures were altered in the facial oral tract therapy according to the patient's ability to swallow saliva safely and/or eat and drink safely. The median length of stay was 78d for the experimental group and 65d in the control group.</p> <p>Outcomes: Occurrence of pneumonia; Number of infections.</p>	
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15.7.3 Pulse Oximetry

Table 15.7.3 Pulse Oximetry

Author, Year Country PEDro Score TPS	Methods	Outcomes
<p>Collins & Bakheit (1997) UK No Score TPS=NA N=54</p>	<p>Intervention: 54 consecutive stroke patients with swallowing difficulties were studied. Patients received a videofluoroscopic modified barium swallow (VMBS) study and simultaneously had their arterial oxygen saturation measured. The barium meal consisted of 150mL liquid, 3oz mousse and biscuit. A drop of $\geq 2\%$ in the arterial oxygen saturation was considered clinically significant. Oxygen saturation was measured during swallowing, 2min after the test meal and 10min after the VMBS study was completed.</p> <p>Outcomes:</p>	<ol style="list-style-type: none"> 22 patients demonstrated aspiration on VMBS evaluation. Correlation of the pulse oximetry results with VMBS findings showed that 12 (55%) of the patients who aspirated had a significant degree of oxygen desaturation at the point of swallow/aspiration, but none of the non-aspirators desaturated by $\geq 2\%$. When the results of oximetry at swallow/aspiration and at 2min after swallowing were combined, 16 (73%) of the aspirators could be identified by this method, and four (13%) of the non-aspirators also had a significant oxygen desaturation. In total, 44 patients (81.5%) were accurately predicted as aspirators or non-aspirators ($\kappa=0.61$, $P<.001$). Prediction was better for males compared to females. The sensitivity and specificity of pulse oximetry were 73% and 87%, respectively.
<p>Sellars et al. (1998) UK No Score TPS=NA N=6</p>	<p>Intervention: Six patients (four with stroke) with established dysphagia underwent both videofluoroscopic modified barium swallow (VMBS) study evaluation with simultaneous oxygen saturation monitoring. Decline in O_2 saturation of $\geq 4\%$ from baseline was considered clinically significant.</p> <p>Outcomes: Incidence of aspiration; O_2 desaturation.</p>	<ol style="list-style-type: none"> Four patients demonstrated aspiration on VMBS. Of these, two exhibited significant O_2 desaturation.
<p>Sherman et al. (1999) USA No Score TPS=NA N=46</p>	<p>Intervention: 46 (16 with stroke) patients with swallowing difficulties underwent videofluoroscopic modified barium swallow (VMBS) study evaluation with simultaneous oxygen saturation monitoring (with a 5-6s sampling interval).</p>	<ol style="list-style-type: none"> 12/46 patients (six with stroke) aspirated on VMBS. Patients who aspirated had a significantly greater decline in oxygen saturation compared to those who did not aspirate.

	Outcomes: Incidence of aspiration; Oxygen desaturation.	3. The lowest O ₂ saturation value among patients who aspirated was 81% compared with 92% among patients who did not aspirate/penetrate.
Smith et al. (2000) UK No Score TPS=NA N=53	Intervention: 53 consecutive patients with acute stroke received a bedside evaluation, pulse oximetry and a videofluoroscopic modified barium swallow (VMBS) study. Outcomes: Incidence of aspiration; Pulse oximetry.	1. 15/53 patients aspirated on VMBS examination. 2. The SN, SP, PPV and NPV for pulse oximetry to identify aspiration were 87%, 39%, 36% and 88%, respectively.
Wang et al. (2005) Taiwan No Score TPS=NA N=60	Intervention: 60 patients (27 with stroke) received both oxygen saturation and videofluoroscopic modified barium swallow (VMBS) study evaluation. Oxygen saturation was monitored for 5min before and for 5min after the VMBS evaluation. Outcomes: Incidence of aspiration; Oxygen desaturation.	1. 23/60 patients demonstrated aspiration on VMBS examination. 2. Of these patients, nine displayed significant oxygen desaturation (a drop of >3% was considered significant). 3. Of the 37 patients who did not demonstrate aspiration on VMBS, 15 had an episode of oxygen desaturation. 4. The sensitivity and specificity were 39.1% and 59.4%, respectively. The positive and negative predictive values were 37.5% and 61.1%, respectively. The positive likelihood ratio was 0.96.
Ramsey et al. (2006) UK No Score TPS=NA N=189	Intervention: 189 stroke patients received a bedside swallowing assessment (BSA), pulse oximetry and videofluoroscopic modified barium swallow (VMBS) (n=54) studies. Two cut-points were selected to determine the presence/absence of oxygen desaturation (>2% and >5%). Outcomes: Incidence of aspiration; Oxygen desaturation.	1. 15 (28%) patients demonstrated aspiration on VMBS. Of these, 2% desaturation was seen in five (33.3%) of these patients and in two (13.3%) when >5% threshold was used. 2. 7/15 patients (47%) with demonstrated aspiration, failed the BSA. 3. The sensitivity and specificity associated with >2% desaturation were 33% and 62%, respectively and 13% and 95%, respectively for an oxygen desaturation threshold of >5%.

15.7.4 Ultrasonography

Table 15.7.4 Ultrasonography

Author, Year Country PEDro Score TPS	Methods	Outcomes
Hsiao et al. (2012) Taiwan PCT No Score TPS _{Exp1} = 69±46d TPS _{Exp2} =45±24d TPS _{Con} =NA N _{Start} =90 N _{End} =90	Population: Experimental group 1 (EG1; N=30): Mean age=67±12yr; Gender: Males=21, Females=9. Experimental group 2 (EG2; N=30): Mean age=64±10yr; Gender: Males=21, Females=9. Control group (CG; N=30): Mean age=63±9yr; Gender: Males=9, Females=21. Intervention: All participants received a submental ultrasonographic (SUS) examination whilst swallowing 5ml of water. An additional	1. A significant difference in mean change of TH was found between EG1 and EG2 (p=0.002) and EG1 and CG (p<0.001) but no significant difference was found between EG2 and CG (p=0.061). 2. A significant difference in HBD during swallowing was found between EG1 and EG2 (p=0.001) and EG1 and CG (p<0.001) but no significant difference was found

	<p>videofluoroscopic swallowing study (VFSS) examination was performed on 12 stroke patients to observe hyoid bone displacement in comparison with the SUS. Patients completed three examinations each. Assessments were conducted at post-treatment.</p> <p>Outcomes: Hyoid bone displacement (HBD); Tongue thickness (TH) during swallow.</p>	<p>between EG2 and CG ($p=0.22$).</p> <ol style="list-style-type: none"> 3. Using a cut-off point for tongue thickness of 1.0cm, the sensitivity and specificity of detecting patients in need of tube feeding using ultrasonography was 70.0% and 66.7%, respectively. 4. Using a cut-off point for hyoid bone displacement of 1.5cm, the sensitivity and specificity of detecting patients in need of tube feeding using ultrasonography was 73.3% and 66.7%, respectively. 5. No significant differences were found between the results of the SUS and VFSS ($p=0.266$).
<p>Park et al. (2015) Korea PCT No Score $TPS_{Mean \geq 1d}$ $TPS_{GroupA}=34.5 \pm 36.9d$ $TPS_{GroupB}=38.9 \pm 53.3d$ $N_{Start}=74$ $N_{End}=74$</p>	<p>Population: Acute stroke patients with dysphagia (Group A; $N=23$): Mean age= 61.3\pm11.0yr; Gender: Males=16, Females=7. Acute stroke patients without dysphagia (Group B; $N=24$): Mean age=59.3\pm5.4yr; Gender: Males=10, Females=14. Healthy Controls (Group C; $N=23$): Mean age=54.4\pm11.2yr; Gender: Males=10, Females=27.</p> <p>Intervention: Diaphragm excursion was assessed using ultrasonographic measurements obtained during quiet breathing, deep breathing and voluntary cough. On the same day, spirometric and respiratory pressures (using a spirometer and respiratory pressure meter, respectively) were recorded. The peak flow meter was used during a quick, explosive cough to measure peak cough flow (PCF).</p> <p>Outcomes: PCF; Static maximum inspiratory pressure; Maximum expiratory pressure (MEP); Forced vital capacity (FVC); Forced expiratory volume in 1s (FEV_1); FEV_1/FVC ratio.</p>	<ol style="list-style-type: none"> 1. Group A showed a statistically significantly lower movement of the hemiplegic diaphragm than the other two groups ($p<0.0001$). 2. Group A showed a statistically significant reduction in diaphragm excursion on the non-affected side during deep breathing. 3. Both groups A and B demonstrated a reduced diaphragm excursion during voluntary cough (VC) on the non-affected side, which was statistically significant ($p<0.0001$). 4. The ratio of the non-affected diaphragm to the hemiplegic side in group A was significantly increased compared to the other two groups during VC ($p<0.0001$). 5. There were statistically significant differences in the FVC among the three groups ($p=0.0005$); group A demonstrated a statistically significant drop in FVC (percentage predicted) and FEV_1 (percentage predicted) relative to the other two groups ($p=0.002$). 6. There were no significant differences between groups A and B with respect to MEP values ($p>0.05$). 7. In Model 1 of the multiple regression analysis for Groups A and B, National Institutes of Health Stroke Scale scores on admission were significantly associated with diaphragm excursion of the hemiplegic side during VC and explained up to 25% of the variance ($p<0.001$). 8. In Model 2, when adjusting for dysphagia with aspiration, the results showed that dysphagia was significantly associated with diaphragm excursion and explained up to 60% of the variance ($p<0.001$).

15.8 Interventions for Managing Dysphagia

15.8.1 Dietary Modifications

Table 15.8.1 Dietary Modifications

Author, Year Country PEDro Score TPS	Methods	Outcomes
Groher (1987) USA RCT PEDro=3 TPS=NA N=56	Intervention 56 stroke patients with chronic dysphagia, on a pureed diet prior to study and at least 1mo post-resolution of aspiration pneumonia were randomized to receive: 1) a soft mechanical diet and thickened liquids or 2) pureed foods and thin liquids. The recurrence of aspiration pneumonia over a 6-month period was assessed. Outcomes: Incidence of aspiration pneumonia.	<ol style="list-style-type: none"> Group 1 had fewer occurrences of aspiration pneumonia (5 vs. 28, $p<0.05$). If persons who developed pneumonia on more than one occasion are ignored the incidence of pneumonia was still lower in the group 1: 4 vs. 18.
Garon et al. (1997) USA RCT PEDro=5 TPS=NA N=20	Intervention: 20 dysphagic stroke patients were randomized to receive either a regular dysphagia diet including thickened fluids (control group) or to a dysphagia diet which allowed the inclusion of unlimited amounts of water (study group) between meals. Outcomes: Incidence of dehydration; Incidence of pneumonia; Requirement of intravenous fluids; Total fluid intake.	<ol style="list-style-type: none"> No patient in either group developed dehydration or pneumonia within the 30d trial period, or required intravenous fluids. There were no significant differences in total fluid intake between the groups. However, patients in the study group drank significantly less thickened fluid compared to patients in the control group.
Goulding & Bakheit (2000) UK RCT PEDro=6 TPS=NA N=46	Intervention: 46 dysphagic inpatients were randomized to receive thickened fluids prepared using conventional subjective assessment of viscosity or fluids thickened with the aid of a viscometer for 7d. Outcomes: Viscosity; Incidence of aspiration; Fluid consumed.	<ol style="list-style-type: none"> Higher viscosity of fluid prepared using subjective assessment. There were no significant differences in the incidence of aspiration between the groups. Strong correlation between increased viscosity and portion of thickened fluid that was not consumed.
Perلمان et al. (2004) USA No Score TPS=NA N=204	Intervention: 204 dysphagic patients underwent assessment of swallowing function and sensory evaluation with flexible endoscope. Patients were then divided into three groups with normal, moderate and severe sensory deficits. Each group was divided into those with impaired or normal pharyngeal squeeze. Patients were then tested for aspiration following a pureed food bolus. Outcomes: Incidence of aspiration.	<ol style="list-style-type: none"> 0% aspiration in the normal sensation, normal motor function group. 14% aspiration in the normal sensation, absent motor function group. 0% aspiration in the moderate decrease sensation, normal motor function group. 67% aspiration in the moderate decrease sensation, absent motor function group. 6% aspiration in the severe/absent sensation, normal motor function group. 40% aspiration in the severe/absent sensation, absent motor function group.
Diniz et al. (2009) Brazil	Intervention: 61 patients, 19 with acute stroke received a trial of either liquid or spoon-thick liquids	<ol style="list-style-type: none"> Aspiration occurred in 24 patients. A higher proportion of patients aspirated

<p>RCT PEDro=6 TPS=NA N=61</p>	<p>in random order and were assessed for evidence of dysphagia (penetration, aspiration or residue) using nasoendoscopy. Patients also underwent a clinical examination and bedside clinical assessment. Outcomes: Incidence of aspiration; Incidence of penetration.</p>	<p>with liquid samples (3 vs. 21, $p<0.001$). 3. There was no evidence of penetration among patients given spoon-thick liquids compared with eight instances following liquid challenges ($p<0.006$).</p>
<p>Alves et al. (2013) Brazil PCT No Score TPS_{Median}=5.5mo N_{Start}=66 N_{End}=66</p>	<p>Population: Patients with Stroke (PWS; N=36, with dysphagia; N=8): Mean age=63yr; Gender: Males=21, Females=15. Healthy Control Group (N=30): Mean age=59yr; Gender: Males=13, Females=17. Intervention: Each subject swallowed in random order and in the sitting position 5ml of liquid boluses with bitter (pH 6.0), sour (pH 3.0), sweet (pH 6.9) and neutral (pH 6.8) taste. Outcomes: Transit: clearance, duration, and amount of residue of bolus in the proximal, middle, and distal esophageal body.</p>	<p>1. There was no difference between PWS and controls in esophageal transit duration ($p>0.15$), or esophageal clearance duration ($p>0.16$). 2. In the distal esophagus, the transit and the clearance durations were longer with the sour bolus than with the other boluses in both groups ($p<0.01$). 3. The amount of residues in the proximal, middle and distal esophagus after swallows of a neutral bolus was higher in PWS than in controls ($p=0.02$). 4. With sweet bolus, the residues in the distal esophagus were higher in PWS than in controls ($p=0.01$). 5. In the PWS, residues in the distal esophagus were higher with the sour bolus, but the difference from other boluses was not significant.</p>
<p>Gatto et al. (2013) Brazil Prospective No Score TPS_{Median}=6d N_{Start}=52 N_{End}=52</p>	<p>Population: Experimental Group 1 (EG1; N=24): Mean age=Unspecified; Gender: Males=12, Females=12. Experimental Group 2 (EG2; N=28): Mean age=Unspecified; Gender: Males=16, Females=12. Intervention: All patients were observed during swallowing of a 5mL spoonful of paste comprising a total of four stimuli. EG1 received the stimuli in random order and EG2 received the stimuli in a set order (natural, cold, sour and sour-cold). Swallowing was observed using Videofluoroscopy. Assessment was conducted at post-treatment. Outcomes: Oral Transit Time (OTT); Total OTT (TOTT).</p>	<p>1. The sour-cold stimulus caused significant reduction in OTT and TOTT (both $p<0.05$) compared to the natural (room temperature) stimulus. 2. Cold and sour stimuli alone had no effect on swallowing behaviour when compared with the natural stimulus. 3. No significant differences were found between EG1 and EG2.</p>
<p>McGrail et al. (2013) USA PCT No Score TPS=NA N=20</p>	<p>Intervention: 20 patients and 10 healthy community controls (CG) were included in the study. The patient sample was comprised of individuals diagnosed with ischemic stroke and receiving either a thin liquid diet (TL) (n=10) or thick liquid diet (TH) (n=10). Fluid intake for all three groups was evaluated over a period of 72h and included only consumption of liquids typically considered beverages. 1500mL of fluids was considered a minimum standard daily intake. Outcomes: Fluid intake.</p>	<p>1. The community group was found to have significantly greater fluid intake than the hospital groups [$1961 \pm 529\text{mL/day}$ (CG) vs. $1237 \pm 442\text{mL/day}$ (TL, $p=0.004$) or $947 \pm 144\text{mL/day}$ (TH, $p=0.001$)]. 2. The thin liquid group also had significantly greater fluid intake than the thick liquid group ($p=0.04$). 3. Only one patient in the thin liquid group exceeded the minimum fluid intake standard, while no patients in the thick liquid group achieved the minimum standard.</p>

<p>Momosaki et al. (2013b) Japan Pre-post No Score TPS_{Mean}= 52.6±32.8d N_{Start}=52 N_{End}=52</p>	<p>Population: Mean age=72.3±8.3yr; Gender: Males=38, Females=14. Intervention: Patients were administered semisolid foods rated as 3 on the functional oral intake scale (FOIS). They were required to swallow 4g of randomly chosen semisolid food without chewing and were directly observed by flexible endoscopic evaluation of swallowing using a laryngeal flexible fiberscope. Outcomes: Semisolid food textures: hardness; adhesiveness; cohesiveness; gumminess.</p>	<ol style="list-style-type: none"> 1. When textures were compared between the food groups with and without residue, the results showed that there were no significant differences in terms of hardness (p=0.39), adhesiveness (p=0.86) or gumminess (p=0.42). However, there was a statistically significant difference for cohesiveness (p=0.005). 2. When comparing textures with and without penetration, there were no significant differences noted in hardness (p=0.97), adhesiveness (p=0.06), cohesiveness (p=0.12) or gumminess (p=0.12). 3. When comparing aspiration, results showed there were no significant differences in hardness (p=0.06), adhesiveness (p=0.08), or cohesiveness (p=0.76) however, there were statistically significant differences noted according to aspiration (p=0.03).
<p>Park et al. (2013) USA Pre-post No Score TPS_{Overall}=NA N_{Start}=30 N_{End}=30</p>	<p>Population: Mean age=70.5±6.9yr; Gender: Males=16, Females=14. Intervention: Patients (15 who aspirate and 15 non-aspirators) underwent a procedure that required swallowing two 5ml boluses for each of the three consistencies: thin liquid, nectar thick liquid and puree. Six swallows were analyzed from each subject to obtain oropharyngeal transit times. A total of 180 swallows were submitted for analyses. Videofluoroscopic swallowing examination (VFSE) on 30 patients from a previous study were collected. Outcomes: Oral transit time (OTT); Pharyngeal transit time (PTT).</p>	<ol style="list-style-type: none"> 1. Aspirators were observed to have longer OTTs than non-aspirators across the consistencies and these were statistically significant differences (F[2,22]=22.68, p<0.01) however, there was no significant difference between the two groups. 2. Use of thin liquid was associated with a significantly shorter OTT than both nectar thick liquids and puree in both groups (p<0.01 and p<0.01). There was no significant difference between nectar thick liquid and puree (p=0.35). 3. There was no interaction effect of bolus consistency x group. 4. Aspirators were observed to have longer PTTs than non-aspirators in all three consistencies, and these were statistically significant differences (F[1,36]=5.90, p=0.019). 5. For PTT, there were statistically significant between-group differences for nectar thick liquid (p=0.02) and puree (p=0.01) but not for thin liquid (p=0.41). 6. Use of the puree was associated with statistically significantly longer PTTs than did the thin liquid and the nectar thick liquids regardless of the groups (p=0.02 and p=0.01). There was no significant difference between the thin and nectar thick liquids (p=0.70). 7. There was no interaction effect of bolus consistency x group.

<p>Murray et al. (2014) Australia Case Control No Score TPS_{Mean}=NA N_{Start}=69 N_{End}=69</p>	<p>Population: Experimental Group 1 (EG1; N=45): Mean age=Unspecified; Gender: Males=23, Females=22. Experimental Group 2 (EG2; N=24): Mean age=Unspecified; Gender: Males=15, Females=9. Intervention: Medical records of patients from either an acute hospital (EG1) or a rehabilitation facility (EG2) were reviewed retrospectively to measure the intake of a thickened liquid diet and to assess the clinical and demographic factors that may be associated or predictive of intake. Assessments were conducted on liquid intake from 2d prior to cessation of thickened liquids. Outcomes: Thickened liquid intake.</p>	<ol style="list-style-type: none"> 1. The mean thickened liquid consumption for EG1 was 519±305ml, significantly lower than the intake of the patients in EG2 with a mean of 1274±442ml (p<0.001). 2. Within EG1, patients aged 41-64yr consumed significantly more thickened liquid than patients aged 65-75yr and >75yr (p=0.014) but there were no significant differences between genders (p=0.629) or stroke severity (p=0.845). 3. A two-way ANOVA revealed the significant variable in the interaction between age and gender on thickened liquid intake was younger age (p=0.009). 4. Patients within EG2 did not demonstrate any significant differences concerning thickened liquid intake with age or gender.
<p>Rofes et al. (2014) Spain Prospective No Score TPS_{Overall}=NA N_{Start}=120 N_{End}=120</p>	<p>Population: Mean age=74.4±12.4yr; Gender: Males=65, Females=55. Note: 55% of the population are stroke patients. A separate population of 14 healthy controls also underwent the same assessments for a total N=134. Intervention: A xanthan gum-base thickener (Resource ThickenUp Clear (RTUC)). The effect of different levels of viscosity (thin liquid, nectar-like, spoon-thick) on the clinical signs and symptoms of oropharyngeal dysphagia (OD) was assessed by the Volume-Viscosity Swallow Test (V-VST). The effect of different levels of viscosity on videofluoroscopic signs and symptoms was assessed by videofluoroscopy (VFS). Outcomes: V-VST; Penetration-Aspiration Scale (PAS).</p>	<p>Effect of RTUC on clinical signs and symptoms of OD:</p> <ol style="list-style-type: none"> 1. The prevalence of clinical signs of impaired efficacy and safety of swallow in patients with OD at each viscosity series was very high. 2. Up to 60.8% of patients completed the nectar series without presenting any sign of impaired safety of swallow (p<0.001 vs. thin liquid) and up to 95.8% safely completed the spoon-thick series (p<0.001 vs. nectar-like). 3. Increasing thin-liquid viscosity to spoon thick improved the labial seal efficacy of dysphagic patients (p<0.05), did not change the prevalence of oral residue or piecemeal deglutition and increased the prevalence of pharyngeal residue symptoms by 18.9% (p<0.05). <p>Effect of RTUC on videofluoroscopic signs of OD:</p> <ol style="list-style-type: none"> 1. Increasing bolus viscosity with xanthan gum thickener was significantly associated with an increase in the percentage of patients able to swallow safely from 23.72% to 55.08% at nectar viscosity (p<0.001) and to 84.74% at spoon-thick viscosity series (p<0.001). 2. The proportion of patients with clinically significant penetrations (scores 3-5) was reduced from 35.3% during thin-liquid series to 13.7% at nectar-like viscosity (p<0.01) and to 9.3% at spoon-thick (p<0.01). 3. The proportion of patients with aspiration

		<p>(scores 6-8) was reduced from 12.7% during thin-liquid series to 7.7% at nectar ($p<0.01$) and to 3.4% at spoon thick ($p<0.01$). The mean score of the PAS was reduced from 3.24 ± 0.18 at thin liquid to 2.20 ± 0.18 at nectar ($p<0.001$) and to 1.53 ± 0.13 at spoon thick ($p<0.001$).</p> <p>4. At thin-liquid viscosity, increasing bolus viscosity with the xanthum gum thickener did not significantly modify the prevalence of oral, vallecular nor pyriform sinus residue ($p>0.05$).</p> <p>Timing of swallow response (all patients):</p> <ol style="list-style-type: none"> 1. Increasing bolus viscosity to nectar and spoon-thick viscosities for all patients with OD did not significantly affect laryngeal vestibule (LV) closure time (363.1 ± 11.2ms at nectar viscosity and 434.8 ± 22.9ms at spoon thick, $p>0.05$ vs. thin liquid) or total duration of swallow response (959.3 ± 17.2ms at nectar viscosity and 1027.1 ± 26.03ms at spoon thick, $p>0.05$ vs. thin liquid). However, time to upper esophageal sphincter (UES) opening was increased at spoon-thick viscosity to 427.5 ± 24.3ms ($p=0.009$ vs. thin liquid). 2. Patients with impaired safety presented a delayed LV closure compared to patients with safe swallow in all three viscosities ($p<0.05$). 3. Patients with safe swallow at thin liquid and nectar-like viscosities had similar timing to airway closure (386.4 ± 26.8ms at thin liquid and 350.8 ± 11.8ms at nectar viscosity, $p>0.05$), but at spoon-thick viscosity, presented a later time to LV closure (427.8 ± 24.5ms, $p<0.01$) and UES opening.
<p>McGrail et al. (2015) USA Prospective No Score TPS_{Mean}=NA N_{Start}=39 N_{End}=39</p>	<p>Population: Thin fluids Group (N=21): Mean age=66.6 ± 21.4yr; Gender: Males=10, Females=11. Thick fluid Group (N=18): Mean age=73.2 ± 12.2yr; Gender: Males=12, Females=6.</p> <p>Intervention: Participants were allocated to one of two groups based on the consistency of liquids they were receiving at the time of enrollment. The groups consisted of different liquid viscosities: thin and thick. Participants were offered oral fluids (1500ml), and oral intake was monitored for 72 consecutive hours.</p> <p>Outcomes: Dysphagia Severity Scale; Functional Independence Measure (FIM).</p>	<ol style="list-style-type: none"> 1. Dysphagia and level of dependence for expression did not significantly predict oral fluid intake in either group. 2. On average, an approximate 255ml increase in oral fluid intake would be seen for each 1-point increase in FIM score for eating. 3. Cognition significantly predicted oral fluid intake in the thickened-liquid group ($p=0.0037$). 4. A parameter estimate of 4.5 was calculated for cognition, suggesting that on average, for each 1-point increase in FIM score, fluid intake would increase by approximately

15.8.2 Swallowing Treatment Programs

Table 15.8.2 Swallowing Treatment Programs

Author, Year Country PEDro Score TPS	Methods	Outcomes
<p>DePippo et al. (1994b) USA RCT Pedro=5 TPS_{Median}=4.57wk N_{Start}=115 N_{End}=114</p>	<p>Population: Group A (N=38): Mean age=76 (66-80)yr; Gender: Males=22, Females=16. Group B (N=38): Mean age=74.5 (64-80)yr; Gender: Males=19, Females=19. Group C (N=39): Mean age=73 (66-80)yr; Gender: Males=27, Females=12.</p> <p>Intervention: Group A was managed by diet and compensatory swallowing technique recommendations alone. Group B was managed by a therapist-prescribed diet and compensatory swallowing technique recommendations. Group C was managed by a dysphagia therapist prescribed and controlled diet and daily reinforcement of compensatory swallowing techniques. Patients were followed for the duration of their inpatient stay and 1yr post-stroke.</p> <p>Outcomes: Adherence to rehabilitative techniques; Medical complications; Incidence of pneumonia; Dehydration; Death.</p>	<ol style="list-style-type: none"> 1. There were no significant differences between groups for occurrence of medical complications when analyzed collectively, dehydration or death. No deaths occurred during the study period. 2. Group B patients developed pneumonia significantly sooner than patients in Group A (p=0.03). 3. 37% of patients in Group C used the techniques independently vs. 19% of patients in Groups A and B (p=0.08). 4. Patients who aspirated developed pneumonia significantly sooner than those who did not (p=0.02). 5. Patients who aspirated thick liquids or more solid test material developed pneumonia significantly sooner than patients who aspirated thin liquids or who did not aspirate (p=0.05). 6. Patients who aspirated after swallowing developed pneumonia earlier than those who aspirated before or during the swallow, or who did not aspirate (p=0.03).
<p>Odderson et al. (1995) USA No Score TPS=NA N=124</p>	<p>Intervention: 124 patients with non-hemorrhagic stroke admitted to an urban community hospital. Within 24h of admission, patients received a clinical swallowing evaluation and received appropriate dysphagia interventions if required, as per the protocol of a recently implemented clinical pathway.</p> <p>Outcomes: Incidence of aspiration pneumonia; Length of stay; Functional Independence Measure.</p>	<ol style="list-style-type: none"> 1. 48 (39%) patients were diagnosed with dysphagia on admission. 2. No incidences of aspiration pneumonia were reported. 3. In the year prior to the introduction of the pathway, 6.7% of patients developed aspiration pneumonia. In the first year the pathway was introduced, 4.1% of patients developed aspiration pneumonia. 4. Patients without dysphagia had a shorter LOS and were more likely to be discharged to the community. 5. Patients who passed the initial swallowing screen had higher FIM scores compared to those who failed.
<p>Lin et al. (2003) Taiwan No Score</p>	<p>Intervention: A quasi-experimental parallel, cluster design study that recruited 61 patients (2:1) from seven long-term care facilities to receive either</p>	<ol style="list-style-type: none"> 1. The results of between group comparisons on change scores (pre-test, post-test) showed statistically significant

<p>TPS=NA N=61</p>	<p>swallowing training or no therapy (Patients received therapy following data collection). Swallowing training consisted of direct therapies (compensatory strategies, diet modification, environmental arrangement, the Mendelsohn manoeuvre, supraglottic swallowing and effortful swallowing) and indirect therapies (thermal stimulation, oral motor and lingual exercises and were provided 30min/d, 6d/wk for 8wk. Outcomes: Swallowing function; Nutritional status; Neurological examination.</p>	<p>improvements favouring the treatment group for: swallowing function [incidence of coughing/choking at meals ($p=0.000$), volume/s swallowed ($p=0.009$), volume per swallow ($p=0.008$)], neurological examination ($p=0.032$) and nutrition parameters [mid-arm circumference ($p=0.030$) and weight ($p=0.045$)].</p>
<p>Carnaby et al. (2006) USA RCT PEDro=8 TPS=NA N=306</p>	<p>Intervention: 306 patients with clinical dysphagia admitted to hospital with acute stroke were randomly assigned to receive usual care ($n=102$), standard low-intensity intervention ($n=102$), or standard high-intensity intervention and dietary prescription ($n=102$). Treatment continued for ≤ 1mo. Outcomes: Survival free of abnormal diet at 6mo.</p>	<ol style="list-style-type: none"> 1. Of patients randomly allocated usual care, 56% (57/102) survived at 6mo free of a modified diet compared with 64% (65/102) allocated to standard (low-intensity) swallowing therapy and 70% (71/102) of patients who received high-intensity swallowing therapy. 2. Compared with usual care and low-intensity therapy, high-intensity therapy was associated with a significantly increased proportion of patients who returned to a normal diet ($p=0.04$) and recovered swallowing ($p=0.02$) by 6mo.
<p>Takahata et al. (2011) Japan Case control No Score TPS=NA N=219</p>	<p>Intervention: The outcomes of two groups of patients admitted with intracerebral hemorrhage were compared. The first group ($n=90$) was admitted before the implementation of an early intervention program delivered mainly by nurses. The second group ($n=129$), after its implementation. The intervention program included screening prior to the initiation of oral intake using pudding or jelly (not water), intensive oral care, postural adjustment during feeding with chin tuck and advancement of the diet as appropriate. Outcomes: 7-item Functional Oral intake Scale: proportion of patients able to tolerate early feedings at discharge (score of 4-7); Incidence of chest infection.</p>	<ol style="list-style-type: none"> 1. The proportion of patients who could tolerate oral feeding was significantly higher in the early intervention group compared with the control group: 112 (86.8%) vs. 61 (67.8%), $p<0.001$. 2. After adjusting for baseline imbalances, early intervention was still associated with oral feeding tolerance (OR: 4.42; 95% CI, 1.81-10.8; $P = 0.001$). 3. The incidence of chest infection was lower in the early intervention group compared with the control group 27/129 (20.9%) vs. 32/90 (35.6%) (OR 0.48, 95% CI, 0.26-0.88; $P = 0.016$).
<p>McCullough et al. (2012) USA Prospective No Score TPS_{Mean}=9.5mo N=18</p>	<p>Intervention: 18 patients with dysphagia after first stroke were randomly assigned to one of two treatment groups in a two week crossover design (AB or BA). The 2wk treatment regime involved 2/d, 45min session, and required patients to perform a series of 30-40 swallows using the Mendelsohn maneuver per session. Before each swallow, a small amount of water was placed in the mouth using a dental swab (for the purposes of facilitating swallowing). Outcomes: Duration of Hyoid maximum anterior excursion (HMAE); Hyoid maximum elevation (HME) ; Mean width of the upper esophageal sphincter</p>	<ol style="list-style-type: none"> 1. 17 patients had follow up data available. There were significant improvements in duration of HME ($P=0.011$) and duration of HMAE ($P=0.009$) at 2wk post-treatment compared to baseline values. 2. No other statistically significant results were found.

	opening; Penetration-Aspiration scale; Oropharyngeal residue; Dysphagia outcome severity scale.	
<p>McCullough et al. (2013) USA Prospective No Score TPS_{Mean}=9.5mo TPS_{Range}=6wk-22mo N_{Start}=18 N_{End}=18</p>	<p>Population: Age≥21yr; Gender: unspecified. Intervention: Mendelsohn manoeuvre. Group A received 2wk of treatment followed by 2wk of no treatment (BBAA) and Group B received 2wk of no treatment followed by 2wk of treatment (AABB). Outcomes: Hyoid Maximum Anterior Excursion (HMAE); Hyoid Maximum Elevation (HME); Mean width upper esophageal sphincter opening (MWUESO); Videofluoroscopic swallowing study.</p>	<ol style="list-style-type: none"> 1. Reliability assessments for the three measures showed that there was statistically significant correlation for the three measures (interjudge: $r=0.85$, $p<0.01$) and intrajudge ($r=0.90$, $p<0.01$). 2. There were no significant improvements for all three measures after the 2wk treatment period. 3. Consistency (liquid vs puree) was significantly associated with an increase in MWUESO ($p=0.03$) (i.e., increasing consistency translated into increased width of UESO). 4. With respect to dose-response, there were no significant differences in the HMAE, HME and MWUESO between treatment weeks and no-treatment weeks. However, there were statistically significant differences between the first and second weeks of treatment (HMAE, $p=0.05$; HME, $p=0.01$; MWUESO, $p=0.016$).
<p>Nakamura & Fujishima (2013) Japan Pre-Post No Score TPS_{Mean}=NA N_{Start}=24 N_{End}=24</p>	<p>Population: Intervention Group (N=24): Mean age=71.5±10.3yr; Gender: Males=19, Females=5. Intervention: Patients received ice massages with a cotton-tipped stick on the posterior tongue, tongue base, velum, and posterior pharyngeal wall for 10s. Patients were asked to perform a dry swallow within 10s of receiving the ice massage or without receiving the ice massage twice each in an alternating design with a 10s interval between each trial. Assessments were conducted during each trial through the use of a videofluoroscopy examination. Outcomes: Swallow latency.</p>	<ol style="list-style-type: none"> 1. Mean swallow latency after ice massage was significantly shorter than the latency without ice massage ($1.55±0.420s$ vs $2.17±1.53s$, $p=0.00366$) amongst patients who were able to initiate swallowing in all four trials. 2. Among patients who could not initiate swallowing in all four trials, a significantly higher average number of swallow responses were triggered after ice massage than without ice massage ($1.30±0.70s$ vs $0.5±0.50s$, $p=0.0267$).
<p>Bakhtiyari et al. (2015) Iran RCT PEDro=5 TPS_{E1}=3d TPS_{E2}=2wk TPS_{E3}=1mo N_{Start}=84 N_{End}=60</p>	<p>Population: Early group (E1; N=20): Mean age=66.4±4.09yr; Gender: Males=13, Females=7. Medium group (E2; N=20): Mean age=67.15±3.67yr; Gender: Males=14, Females=6. Late group (E3; N=20): Mean age=67.85±3.97yr; Gender: Males=16, Females=4. Intervention: All participants received traditional swallowing therapy 3x/wk for 3mo. Participants were randomized to receive the treatment at 3d (E1), 2wk (E2), or 1mo (E3) post-stroke. Assessments were conducted at pre and post treatment. Outcomes: Swallowing Recovery; Pneumonia Frequency.</p>	<ol style="list-style-type: none"> 1. Swallowing recovery was significantly greater in E1 compared to E2 ($p=0.002$) and E3 ($p=0.003$). There was no significant difference in swallowing recovery between groups E2 and E3. 2. Pneumonia frequency was significantly lower in E1 compared to E2 and E3 ($p=.002$).
<p>El-Tamawy et al. (2015)</p>	<p>Population: Experimental group (EG; N=15): Mean age=61.53±7.259yr; Gender: Unspecified. Control</p>	<ol style="list-style-type: none"> 1. After 6wk EG group showed a significantly greater improvement in Oral Transit Time

<p>Egypt RCT PEDro=5 TPS=n/a N_{Start}=30 N_{End}=30</p>	<p>group (CG; N=15): Mean age=61.33±6.565yr; Gender: Unspecified. Intervention: All participants received traditional medical treatment for 6wk. Participants were randomized to receive additional physical therapy and neuromuscular electrical stimulation treatment (EG) or no additional treatment (CG) for 6wk. Assessments were conducted at pre and post treatment. Outcomes: Oral Transit Time; Aspiration Rate; Penetration Rate; Hyoid Elevation; Laryngeal Elevation; Esophageal Sphincter Function.</p>	<p>(p<0.01), Aspiration and Penetration Rate (p=0.008), Hyoid Elevation (p=0.002), and Laryngeal Elevation (p=0.001) compared to the CG group. 2. There was no significant difference in Esophageal Sphincter Function between groups.</p>
<p>Hagg & Tibbling (2015) Sweden Cohort No Score TPS_{PP}=59wk TPS_{IQ}=5wk N_{Start}=31 N_{End}=31</p>	<p>Population: Palatal Plate training group (PP; N=13): Mean age=68yr (46-82); Gender: Male=11, Female=2. IQoro^R training group (IQ; N=18): Mean age=66yr (53-81); Gender: Male=9, Female=9. Intervention: All participants received either Palatal Plate training (PP) or IQoro^R training (IQ) for 3mo. Assessments were conducted at baseline, 3mo, and follow-up. Outcomes: Swallowing Capacity (SC).</p>	<p>1. There was a significant improvement in SC at 3mo in both IQ (p<0.001) and PP (p<0.001); however, only the IQ improved at follow-up (p=0.015). 2. There was no significant difference between groups at 3mo (p=0.132) or follow-up (p=0.325).</p>
<p>Hagg & Tibbling (2015) Sweden PCT No Score TPS_{AC}=5wk TPS_{CH}=57wk N_{Start}=31 N_{End}=31</p>	<p>Population: Acute group (AC; N=11): Mean age=71yr (59-81). Chronic group (CH; N=20): Mean age=61yr (46-82). Gender: Male=20, Female=11. Intervention: All participants received intraoral stimulation for 3mo. Participants were analyzed in 2 groups 1) Acute (AC; n=11), and 2) Chronic (CH; n=15). Assessments were conducted at baseline, 3mo, and follow-up. Outcomes: Swallowing Capacity (SC).</p>	<p>1. Both CH and AC groups showed improvement in SC at 3mo and follow-up (all p<0.001).</p>
<p>Li et al. (2016) China PCT No Score TPS_{EG}=17.8±24.61mo TPS_{CG}=13.3±15.87mo N_{Start}=20 N_{End}=20</p>	<p>Population: Game-Based Biofeedback Training group (EG; n=10): Mean age=65.1±19.44yr; Gender: Male=5, Female=5. Traditional Swallowing Training group (CG; n=10): Mean age=69.7±9.35yr; Gender: Male=6, Female=4. Intervention: Participants were allocated to receive additional game-based biofeedback training (EG) or traditional swallowing treatment (CG). 16 1hr sessions took place over 3wk. Assessments were conducted at baseline and 3wk. Outcomes: Hyoid Bone Displacement; Functional Oral Intake Scale (FOIS).</p>	<p>1. EG group showed a significantly greater improvement in FOIS (p=0.007) and hyoid bone displacement (p=0.014) after 3wk compared to the CG group.</p>
<p>Hagg & Tibbling (2016) Sweden PCT No Score TPS_{CH}>6mo TPS_{AC}<1mo N_{Start}=26 N_{End}=26</p>	<p>Population: Mean age=68yr (49-82); Gender: Male=15, Female=11. Intervention: All participants received IQoro^R training (IQ) for 3mo. Participants were analyzed in 2 groups 1) Chronic (CH; n=15), and 2) Acute (AC; n=11). Assessments were conducted at baseline, 3mo, and 59wk follow-up. Outcomes: Oropharyngeal Motor Dysfunction (OPMD).</p>	<p>1. Both CH and AC groups showed improvement in OPMD at 3mo and follow-up (all p<0.05).</p>
<p>Mao et al. (2016)</p>	<p>Population: Acupuncture group (EG; n=45): Mean</p>	<p>1. The EG groups showed a significantly</p>

<p>China PCT No Score TPS_{EG}=38±20d TPS_{CG}=37.34±12.08d N_{Start}=105 N_{End}=98</p>	<p>age=65.84±10.06yr; Gender: Male=27, Female=18. Control group (CG: n=53): Mean age=64.09±9.44yr; Gender: Male=32, Female=21. Intervention: Participants were allocated to receive additional acupuncture therapy in combination with traditional swallowing treatment (EG) or traditional swallowing treatment (CG). All participants received treatment 5d/wk over 4wk. Assessments were conducted at baseline and 4wk. Outcomes: Royal Brisbane Hospital Outcome Measure for Swallowing (RBHOMS); Standardized Swallowing Assessment (SSA); Video Fluoroscopic Swallowing Study (FVSS).</p>	<p>greater improvement in VFSS (p=0.007) and SSA (p<0.001) at 4wk compared to the CG group. 2. There was no significant difference between groups at 4wk in RBHOMS (p=0.71).</p>
<p>Steele et al. (2016) Canada RCT PEDro=6 TPS_{E1}=76.86±44.4d TPS_{E2}=63.71±45.6d N_{Start}=14 N_{End}=11</p>	<p>Population: Tongue-Pressure Profile Training group (E1: n=7): Mean age=74.86±11.05yr; Gender: Male=4, Female=3. Tongue-Pressure Strength and Accuracy Training group (E2: n=7): Mean age=67.14±16.24yr; Gender: Male=5, Female=2. Intervention: Participants were randomly allocated to receive either Tongue-Pressure Profile Training (E1) or Tongue-Pressure Strength and Accuracy Training (E2) for 24 total sessions. Assessments were conducted at baseline and post training. Outcomes: Tongue Strength; Penetration-Aspiration Scale (PAS).</p>	<p>1. There was no significant difference between groups in tongue strength (p>0.05); however, tongue strength did improve overall (p<0.001). 2. There was no significant difference between groups in PAS (p>0.05).</p>
<p>Park et al. (2016) China RCT PEDro=6 TPS_{EG}=27.4±6.3wk TPS_{CG}=26.6±6.8wk N_{Start}=33 N_{End}=27</p>	<p>Population: Expiratory Muscle Strengthening group (EG: n=14): Mean age=64.3±10.7yr; Gender: Male=6, Female=8. Placebo group (CG: n=13): Mean age=65.8±11.3yr; Gender: Male=6, Female=7. Intervention: Participants were randomly allocated to receive expiratory muscle strength training using a device (EG) or placebo training using a sham device (CG). All participants received treatment 5d/wk over 4wk. Assessments were conducted at baseline and 4wk. Outcomes: Functional Oral Intake Scale (FOIS); Penetration-Aspiration Scale (PAS).</p>	<p>1. EG group showed a significantly greater improvement in Liquid PAS (p=0.03) and FOIS (p=0.04) after treatment compared to the CG group. 2. There was no significant difference between groups in Semisolid PAS (p=0.38) after treatment.</p>
<p>Xia et al. (2016) China RCT PEDro=6 TPS_{EG}=9.3±2.3d TPS_{CG}=8.7±2.5d N_{Start}=124 N_{End}=120</p>	<p>Population: Acupuncture group (EG: n=62): Mean age=65.3±14.2yr; Gender: Male=35, Female=27. Control group (CG: n=62): Mean age=66.1±14.3yr; Gender: Male=36, Female=26. Intervention: Participants were randomly allocated to receive acupuncture in combination with standard swallowing therapy (EG) or standard swallowing therapy alone (CG). All participants received treatment 6d/wk over 4wk. Assessments were conducted at baseline and 4wk. Outcomes: Swallowing-Related Quality of Life (SWAL-QOL); Dysphagia Outcome Severity Scale (DOSS).</p>	<p>1. The EG group showed significantly greater improvements in SWAL-QOL (p<0.01) and DOSS (p<0.01) scores at 4wk compared to the CG group.</p>
<p>Zhang et al. (2016) China</p>	<p>Population: Medulla Oblongata group (MO: n=22): Mean age=63.3±8.5yr; Gender: Male=19, Female=3.</p>	<p>1. There were significant improvements in all groups after treatment in KWT, FIRS, and</p>

<p>Cohort No Score TPS_{MO}=20.31d TPS_{MP}=20.38d TPS_{MC}=23.71d N_{Start}=64 N_{End}=64</p>	<p>Midbrain/Pons group (MP: n=16): Mean age=63.5±8.6yr; Gender: Male=10, Female=6. Multiple Cerebral group (MC: n=26): Mean age=62.9±11.8yr; Gender: Male=18, Female=8. Intervention: All participants received “Tongguan Liqiao” acupuncture for 28d and were analyzed by infarction site: medulla oblongata (MO), Midbrain/Pons (MP), and multiple cerebral infarction (MC). Assessments were conducted at baseline and post treatment. Outcomes: Kubota Water Test (KWT); Fujishima Ichiro Rating Scale (FIRS); Standard Swallowing Assessment (SSA).</p>	<p>SSA (all p<0.01).</p>
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15.8.3 Non-Oral Feedings

Table 15.8.3 Non-Oral Feedings

<p>Author, Year Country PEDro Score TPS</p>	<p>Methods</p>	<p>Outcomes</p>
<p>Nakajoh et al. (2000) Japan No Score TPS=NA N=143</p>	<p>Intervention: The incidence of pneumonia was prospectively analyzed for 1yr in three groups of post-stroke patients on the basis of the following clinical conditions: oral feeding without dysphagia (n = 43); oral feeding with dysphagia (n = 48); and nasogastric tube feeding with dysphagia (n = 52). The incidence of pneumonia in bedridden patients with nasogastric tube feeding (n = 14) was also studied. Pre-study, the swallowing and cough reflexes of each patient were measured. The swallowing reflex was evaluated according to latency of response, which was timed from the injection of 1mL of distilled water into the pharynx through a nasal catheter to the onset of swallowing. Outcomes: Incidence of pneumonia; Latency of swallowing response.</p>	<ol style="list-style-type: none"> 1. The incidence of pneumonia was significantly higher in patients with oral feeding than in those with tube feeding (54.3% vs. 13.2%, P < 0.001). 2. In bedridden patients with tube feeding, the latency of response was longer than 20s and no patient coughed at the highest concentration of citric acid. The incidence of pneumonia was 64.3% in such patients. 3. The state of protective reflexes had a significant relation to the incidence of pneumonia. 4. Feeding tube placement may have a beneficial role in preventing aspiration-pneumonia in mildly or moderately disabled post-stroke patients with attenuated protective reflexes.
<p>Dziewas et al. (2004) Germany No Score TPS=NA N=100</p>	<p>Intervention: Over an 18mo period, 100 consecutive acute stroke patients who were fed by a naso-gastric feeding tube because of dysphagia were prospectively evaluated. Outcomes: Incidence of pneumonia; Predictors of pneumonia.</p>	<ol style="list-style-type: none"> 1. Pneumonia was diagnosed in 44% of the tube fed patients. All pneumonias occurred while the tube was in situ. Most patients acquired pneumonia on the second or third day after stroke onset. 2. Patients with pneumonia more often required endotracheal intubation and mechanical ventilation than those without pneumonia. 3. Independent predictors for the occurrence of pneumonia were a decreased level of consciousness and severe facial palsy.

<p>Mamun & Lim (2005) Singapore TPS=NA N=122</p>	<p>Intervention: 122 patients admitted to a geriatric ward (75% with stroke) were assessed by a speech language pathologist. Following assessment patients were recommended to have either oral feeding with modified diet or nasogastric (NG) tube feeding. The incidence of aspiration-pneumonia among patients on oral feeding, NG tube feeding and patients who refused nasogastric tube feeding were compared.</p> <p>Outcomes: Incidence of pneumonia; Mortality.</p>	<ol style="list-style-type: none"> 90 patients were recommended for non-oral feeding. Of these, 64 agreed and 26 refused and were fed orally. 32 patients were deemed safe with an oral, modified diet. There were 14 cases of aspiration-pneumonia confirmed using pre-defined criteria during the 2mo follow-up, resulting in death in five cases. 12 of these pneumonia cases were reported among patients fed by an NG tube, and two in patients who refused NG tubes and were fed orally, and no cases were reported among patients deemed safe on an oral diet (p=0.04, between NG fed and orally fed patients). Four of the five deaths occurred in the NG group.
<p>Leder et al. (2008) USA No Score TPS=NA N=1260</p>	<p>Intervention: 1260 consecutively enrolled inpatients, 630 with a nasogastric (NG) tube in place and 630 without an NG tube at the time of assessment for dysphagia. The aspiration status of all subjects was established using flexible endoscopic evaluation of swallowing. Three trials each of both pudding and thin fluid consistencies were trialed.</p> <p>Outcomes: Incidence of aspiration.</p>	<ol style="list-style-type: none"> There were no significant differences in aspiration of either liquid or puree food consistencies dependent on presence of an NG tube. The analysis was adjusted for sex, age, or diagnostic category.
<p>Dubin et al. (2013) USA Retrospective study No Score TPS_{Mean}=NA N_{Start}=407 N_{End}=407</p>	<p>Population: Percutaneous endoscopic gastrostomy (PEG) group (N=51): Age range=42-95yr; Gender: Males=26, Females=25. No PEG group (N=356): Age range=19-97yr; Gender: Males=205, Females=151.</p> <p>Intervention: Retrospective data was recorded and compared across patients with acute ischemic stroke (AIS) and intracerebral hemorrhage (ICH) to determine the odds of PEG placement in patients with acute stroke.</p> <p>Outcomes: Odds ratio of PEG tube placement.</p>	<ol style="list-style-type: none"> The odds of patients with PEG score ≥ 3 getting a PEG as an inpatient were 15 times higher than those with PEG score < 3 (OR 15.68, 95% CI 4.55,54.01). A score of ≥ 3 points is 91.7% sensitive and 62.8% specific for undergoing PEG placement during hospitalization for AIS patients. The odds of ICH patients with PEG score of ≥ 3 undergoing PEG placement as an inpatient were nearly 12 times higher than those with PEG score < 3 (OR 12.49, 95% CI 1.54,101.29). A score of ≥ 3 points is 96.2% sensitive and 33.3% specific for having a PEG tube placed. Severity of dysphagia was not predictive of PEG placement for either AIS patients (p=0.252) or ICH patients (p=0.523).
<p>Lee et al. (2014) South Korea Retrospective No Score TPS_{Mean}<5d N_{Start}=138 N_{End}=138</p>	<p>Population: Non-Brain Stem Group (NBS; n=99): Mean age=69.3yr; Gender: Males=72, Females=27. Brain Stem Group (BS; n=39): Mean age=62.8yr; Gender: Males=34 Females=5.</p> <p>Intervention: Retrospective review of stroke patients with dysphagia admitted to a hospital between March 2009 and February 2012. Patients had previously received physical and occupational</p>	<ol style="list-style-type: none"> Mean NGT removal was 16.4\pm14.2d in the BS and 25.2\pm19.3d in the NBS. 58% of patients in the NBS had their NGT removed while only 44% in the BS did. NBS significant differences between removal and non-removal (p<0.05): <ul style="list-style-type: none"> Mean PAS was 7.8\pm0.5 in patients who could not have their NGT removed and

	<p>therapy for 1hr/d, 5d/wk in addition to swallowing therapy 20min/d, 2d/wk. Patients were divided according to their lesion location.</p> <p>Outcomes: National Institutes of Health Stroke Scale (NIHSS); Modified Rankin Scale (mRS); Risk factors related to stroke: hypertension, diabetes mellitus, alcohol, smoking and atrial fibrillation; Penetration Aspiration Scale (PAS); Mini-Mental Status Examination (MMSE); Modified Barthel Index (MBI); Nasogastric tube (NGT) removal status.</p>	<p>7.0±0.8 in patients who could have it removed.</p> <ul style="list-style-type: none"> • Mean MMSE was 6.6±7.5 NGT not removed, 11.8±8.1 NGT removed. • Mean MBI 25.0±17.9 NGT not removed, 35.4±24.1 NGT removed. • NIHSS, mRS, hypertension, diabetes mellitus, alcohol, smoking and atrial fibrillation were not significantly different between patients who could remove their NGT and those who could not. <p>4. BS significant differences between removal and non-removal (p<0.05):</p> <ul style="list-style-type: none"> • 50% of patients who could not remove NGT were smokers, 17.6% NGT removed were smokers. • Mean PAS 7.9±0.3 NGT not removed, 6.2±0.4 NGT removed. • NIHSS, mRS, hypertension, diabetes mellitus, alcohol, atrial fibrillation, MMSE, MBI were not significantly different between patients who could remove their NGT and those who could not.
<p>Chen et al. (2015) China PCT No Score TPS_{Mean}=NA N_{Start}=210 N_{End}=206</p>	<p>Population: Experimental Group (EG; N=126): Mean age=68.1±17.5yr; Gender: Males=71, Females=55. Control Group (CG; N=80): Mean age=61.3±14.3yr; Gender: Males=44, Females=36.</p> <p>Intervention: The experimental group received enteral nutrition (EN) with an initial rate defined according to the total volume and the infusion rate was adjusted based on gastric residual volume (GRV) assessed every hour. The control group received EN without monitoring the GRV and reached the target infusion volume within 72hr. EN was provided at 500ml, 1000ml, and at 1500ml.</p> <p>Outcomes: Regurgitation; Aspiration.</p>	<ol style="list-style-type: none"> 1. During EN therapy, regurgitation and aspiration occurred in eight (6.3%) and 10 (7.9%) cases respectively, in the EG. 2. There was no significant difference in incidence of reflux (p=0.194), aspiration (p=0.212) and suspension of EN (p=0.113) when EN volume varied between 500ml and 1500ml in the EG. 3. Regurgitation and aspiration occurred in 15 (18.8%) and 14 (17.5%) cases, respectively in the CG. 4. There was a significantly higher incidence of regurgitation and aspiration in the CG than in the EG (p=0.006; p=0.037).

15.8.4 Selection of Feeding Tubes

Table 15.8.4 Selection of Feeding Tubes

Author, Year Country PEDro Score	Methods	Outcomes
<p>Park et al. (1992) Scotland RCT Pedro=6</p>	<p>Intervention: 28d of enteral feeding using either a percutaneous endoscopic gastrostomy (PEG) tube or naso-gastric (NG) tube was evaluated in 40 patients (18 with stroke) with long-standing (>4wk)</p>	<ol style="list-style-type: none"> 1. Treatment failure occurred in 18/19 patients in the NG group compared to 0/19 in PEG group. 2. Patients in the NG group received less

TPS=NA N=40	dysphagia. Outcomes: Failure of treatment; Volume of feed received; Weight gained.	volume of feed compared to PEG group (55% vs. 93%, $p<0.001$). 3. PEG group patients gained significantly more weight after 7d of feeding than NG patients ($p<0.05$).
Norton et al. (1996) UK RCT PEDro=6 TPS _{Mean} =14d N=30	Intervention: 30 dysphagic stroke patients were randomized to receive either a gastrostomy feeding tube (GT) or a nasogastric tube (NG). Outcomes: Mortality; Nutritional indices: weight, serum albumin, mid-arm circumference; Received feed: proportion, omitted; Discharge from hospital.	1. At 6wk post-stroke, a significantly greater proportion of patients died in the NG group compared to the GT group (8 vs. 2, $p<0.05$). 2. Patients in the GT group had improved nutritional indices including weight, serum albumin (27.1g/l to 30.1g/l vs. 31.4g/l to 22.3g/l in the NT group, $p<0.003$), and mid-arm circumference. 3. NT patients received significantly smaller proportion of their prescribed feed compared with the GT group (78% vs. 100%, $p<0.001$). 4. There were no omitted feeds among patients in the GT group compared to 10/14 (71%) NT patients who lost at least 1d feed. 5. Six GT patients were discharged from hospital <6wk of the procedure compared with none from the NT group ($p<0.05$).
Lien et al. (2000) Taiwan No Score TPS=NA N=8	Intervention: Eight stroke patients with a modified feeding tube in place allowing for both percutaneous endoscopic gastrostomy (PEG) and jejunal (PEJ) feeding were tested for gastroesophageal reflux using 24hr esophageal pH monitoring. Outcomes:	1. 24hr esophageal acid exposure (% of time that pH readings were <4) were significantly lower on PEJ feeding days compared to PEG feeding days (10.1% vs. 20.6%). 2. During meal infusion, 7/8 patients had less esophageal acid exposure during PEJ feeding compared to PEG feeding.
Dennis et al. (2005) UK 7 (RCT)	321 acute stroke patients, from 47 hospitals in 11 countries, were randomized to receive either a PEG (n=162) or NG feeding tube (n=159) within 3 days of enrolment into the study. Death and poor outcome (defined as a Modified Rankin Score of 4-5) was assessed at 6 months.	Feeding with a PEG tube was associated with an increase in the absolute risk of death or poor outcome of 7.8% ($p=0.05$). There was no difference in the incidence of pneumonia between the groups. There were more gastrointestinal bleeds among patients in the NG group (18 vs. 5, $p=0.005$), but more pressure sores among patients in the PEG group (12 vs. 4, $p=0.04$). Only 48% of patients allocated to treatment in the PEG group actually received the treatment within 3 days.
Kostadima et al. (2005) Greece 6 (RCT)	41 acutely ill, ventilator dependent patients with a diagnosis of either stroke (n=25) or head injury (n=16) were randomized to receive a gastrostomy or to NG tube for enteral feeding. Tubes were inserted within 24 hours of intubation. Patients were followed for 3 weeks and the incidence of pneumonia was noted and compared between groups. A diagnosis of pneumonia was established using previously validated criteria.	At the end of weeks 2 and 3 the cumulative incidence of pneumonia was significantly higher in the NG compared to the gastrostomy group ($p<0.05$). At the end of the first week the incidence of pneumonia was higher in the gastrostomy group although the result was not statistically significant. Gastrostomy NG

		Week 1 2/20 1/20 Week 2 2/18 8/19 Week 3 2/16 8/18
Beavan et al. (2010) UK 7 (RCT)	104 patients requiring non-oral feeding following acute stroke received an NG tube which was secured using either conventional means (adhesive tape) (n=53) or a nasal loop (n = 51). The main outcome measure was the proportion of prescribed feed and fluids delivered via NGT in 2 weeks. Secondary outcomes were frequency of NGT insertions, treatment failure, tolerability, mortality; length of hospital stay; residential status; and Barthel Index at 3 months.	Subjects in the nasal loop group received a significantly greater volume of prescribed feeds and fluids over 2 weeks (75% vs. 57%, p=0.02) and required fewer NG tubes (median 1 vs.4). There were no differences in outcomes at 3 months (death, BI scores. Death or dependency, length of hospital stay.

15.8.5 Mode of Nutritional Intake

Table 15.8.5 Mode of Nutritional Intake

Author, Year Country PEDro Score TPS	Methods	Outcomes
Nakajima et al. (2014) Japan Case Control No Score TPS _{Range} >3mo N _{Start} =2913 N _{End} =2913	Population: Experimental Group 1 (EG1; N=2677): Median age=72yr; Gender: Males=1709, Females=968. Experimental Group 2 (EG2; N=236): Median age=81; Gender: Males=124, Females=112. Intervention: Data from a stroke centre database on patients admitted between April 2003 and March 2012 who had completed a questionnaire regarding nutritional intake was reviewed. EG1 consisted of patients who utilised an oral mode of intake and EG2 consisted of patients who utilised a non-oral mode of intake. Assessments were completed 3mo post-onset of stroke. Outcomes: Questionnaire on mode of nutritional intake; Trial of Org Acute Stroke Treatment (TOAST); National Institutes of Health Stroke Scale (NIHSS).	<ol style="list-style-type: none"> 1. The proportion of patients with an oral mode of intake increased significantly after each year (p=0.034). 2. Median NIHSS score on admission and on day 10 post-stroke were both significantly lower in EG1 compared to EG2 (p<0.001). 3. Significant differences between groups were reported with EG1 experiencing a greater frequency of small vessel occlusion (31.5% vs 4.2%), other determined aetiology (4% vs 0.4%) and undetermined aetiology (19.1% vs 16.1%) and EG2 experiencing a greater frequency of cardioembolism (61.4% vs 27.5%) according to TOAST classifications (p<0.001).
Maeshima et al. (2013) Japan Case Series No Score TPS _{Mean} =2.3d N _{Start} =334 N _{End} =334	Population: Mean age=70.1yr; Gender: Male=236, Female=98. Intervention: Retrospective review of stroke patients with dysphagia admitted to a hospital between August 2008 and July 2011. Patients were divided between oral intake (n=291) and tube feeding (n=43). Patients initially stayed in an acute care hospital (mean stay duration=29.2±12.2d) before being discharged to a rehabilitation hospital (mean stay duration=1002±59.4d). Outcomes: Repetitive saliva swallowing test (RSST); Modified water swallowing test (MWST); Nutritional intake: dysphagia diet, regular diet or enteral	<ol style="list-style-type: none"> 1. RSST was abnormal in 227/325 patients. 2. MWST results were abnormal in 185/290 patients. 3. VFSS was conducted in 146/334 patients and showed the presence of aspiration in 111/146 patients. 4. At the point of discharge from a rehabilitation hospital, 262 patients were on a regular diet, 29 were on a dysphagia diet and 43 were on enteral feeding (32 nasogastric tube, six intermittent oroesophageal tube and five gastrostomy tube).

	feeding; Functional Independence Measure (FIM); Videofluoroscopic swallowing study (VFSS).	<ol style="list-style-type: none"> 5. The enteral feeding group was older than the oral intake group. 6. Lower FIM gain and FIM efficiency were observed for the enteral feeding group at the acute care hospital. 7. Lower FIM scores on discharge from the rehabilitation hospital were observed for the enteral feeding group. 8. Lower FIM gain and FIM efficiency were observed for the enteral feeding group at the rehabilitation hospital. 9. Significant correlations were observed between mode of nutritional intake at discharge from the acute care hospital and age ($p=0.003$) and FIM gain ($p=0.040$).
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15.8.6 Electrical Stimulation

Table 15.8.6 Electrical Stimulation

Author, Year Country PEDro Score TPS	Methods	Outcomes
Park et al. (1997) UK No Score	Case reports of 4 dysphagic stroke patients receiving electrical stimulation of the palatal area to improve swallowing function.	Improvement in swallowing function in 2/4 patients including a reduction in transit time and absence of pooling/penetration/aspiration.
Freed et al. (2001) USA No score	Controlled trial whereby 99 dysphagic stroke patients were assigned to receive either thermal-tactile stimulation (TS) or electrical stimulation (ES). TS was given in 3-20 minutes daily sessions. A small mirror was chilled in ice and then applied to the anterior faucial arch. In ES treatment, the electrodes of a hand-held stimulator were placed on the neck in one of two positions until muscle fasciculations occurred. Frequency and pulse width were fixed at 80Hz and 300 ms. Swallowing function was assessed before and after treatment using a 0 (worst) to 6 (best) aspiration scale. Treatment continued until patient achieved a score of 5 or was discharged from hospital.	Mean swallowing scores between the groups were similar at baseline. At the time of final assessment the mean swallowing scores were significantly higher among patients in the ES groups compared to the TS group (4.52 vs. 1.13). 98% of ES patients showed some improvement, whereas 27% of TS patients remained at initial swallow score and 11% got worse. These results are based on similar numbers of treatments (average of 5.5 for ES and 6.0 for TS).
Power et al. (2006) UK 4 (RCT)	16 dysphagic stroke subjects were randomized to receive treatment consisting of stimulation of the anterior faucial pillar with either no (sham) stimulation or stimulation at a frequency of 0.2 Hz for 10 minutes (5 on each side). Swallowing was assessed before and 60 min after electrical or sham stimulation. Swallowing measures included laryngeal closure (initiation and duration) and pharyngeal transit time, taken from VMBS study. Aspiration severity was assessed using an 8-point	Compared with baseline, no change was observed in the speed of laryngeal elevation, pharyngeal transit time, or aspiration severity within subjects or between groups for either active or sham stimulation.

	scale.	
Bülow et al. (2008) Sweden 3 (RCT)	25 stroke patients from 3 European swallowing centers were randomized to receive a 3-week trial (15 sessions) of either neuromuscular electrical stimulation (NMES) or traditional swallowing therapy (TT). Measurements including videoradiographic swallowing evaluation, nutritional status, oral motor function test, and a visual analog scale (VAS) for self-evaluation of complaints, were assessed before and after treatment.	While subjects in both groups improved over the treatment period there were no statistically significant differences on any of the outcomes.
Permsirivanich et al. (2009) Thailand 6 (RCT)	23 stroke patients with dysphagia persisting for > 2 weeks were randomized to receive either rehabilitation swallowing therapy (RST) or neuromuscular electrical stimulation therapy (NMES). The subjects received 60 minutes of either RST or NMES treatment for five consecutive days, had two days off and then five more consecutive days of treatment for a four-week period or until they reached functional oral intake scale (FOIS) level 7. FOIS, the primary outcome measure, was assessed before /after treatment. FOIS score 1=NPO, FOIS score 7= oral diet, no restrictions	Before therapy, 73% of the RST group and 83% of the NMES group required non-oral feeding (FOIS levels 1-3). At the end of the study period, 75% of the RST group and 90% of the NMES group could manage oral intake (FOIS groups 4-7). The differences in proportions were not statistically significant. 18% of RST and 17% of the NMES subjects had attained a FOIS score of 7. There was a significant difference in the change scores, favouring the NMES group (+3.17 vs. 2.46, p<0.001)
Lim et al. (2009) Korea No Score	36 received thermal-tactile stimulation (TTS) treatment only (control group) or TTS + neuromuscular electrical stimulation, applied simultaneously. Swallowing function was assessed before and 4 weeks after treatment using the swallow function scoring system (scoring: 0-6 with lower scores indicating greater severity), the penetration-aspiration scale (PAS) (scoring: 1-8 with higher scores indicating increasing aspiration/penetration) and pharyngeal transit time. Semi-solid and liquid consistencies were evaluated.	28 persons completed the study. Median swallowing scores for the control group, on semi-solids consistency, before and after treatment were 3 and 4, and 2 and 4 for the experimental group. Median PAS scores for the control group before and after treatment were 3.5 and 4 (indicating a worsening) and 5.5 and 2.5 for the experimental group. The differences in both scores between the two groups were significant. There was significantly greater improvement in pharyngeal transit time in the experimental group.
Jayasekeran et al. (2010) UK 8 (RCT)	50 acute dysphagic stroke patients were assigned randomly to receive either active or sham pharyngeal electrical stimulation (PES) once daily for 3 days. (n = 28). The primary end point was the reduction of airway aspiration at 2 weeks post intervention assessed using VFS. Additional outcomes included scores on a Dysphagia Severity Rating (DSR) rating scale	Patients who received the active form of PES experienced significantly fewer episodes of aspiration, greater improvement in DSR and remained in hospital for a shorter period of time compared with patients who received sham treatment.
Gallas et al. (2010) France No Score	11 stroke patients with dysphagia lasting greater than 8 weeks received sub mental electrical stimulations for 1 h every day for 5 days (electrical trains: 5 s every minute, 80 Hz). During stimulations patients were asked to swallow one teaspoon of paste or liquid. Swallowing was evaluated before and after treatment using a dysphagia handicap index questionnaire (max score of 120 and VMBS.	The mean score on the dysphagia questionnaire improved over the treatment period (31 vs. 23, p<0.05). On VMBS examination, laryngeal aspiration and pharyngeal residue had decreased significantly and swallowing reaction time increased.

<p>Xia et al. (2011) China 4 (RCT)</p>	<p>120 patients with post-stroke dysphagia were randomly assigned to one of 3 groups: 1) conventional swallowing therapy group, 2) electrical stimulation (ES) with the VitalStim therapy group, and 3) VitalStim therapy plus conventional swallowing therapy group. Treatments with ES were given twice a day for 230 min each, 5 days a week for 4 weeks. Swallowing function was evaluated by using the Standardized Swallowing Assessment (SSA).</p>	<p>SSA scores before and after treatment were: Conventional-40.9 to 30.1, ES-38.7 to 29.6, ES + Conventional-39.5 to 21.4. The scores were significantly greater in the VitalStim therapy plus conventional swallowing training group than in the conventional swallowing training group and VitalStim therapy group, but no significant difference existed between conventional swallowing therapy group and VitalStim therapy group.</p>
<p>Park et al. (2012) Korea 7(RCT)</p>	<p>20 patients with dysphagia that persisted >1 month stroke onset were randomly divided into two groups: those who underwent effortful swallow with infrahyoid motor electrical stimulation (experimental group, n = 10) and effortful swallow with infrahyoid sensory electrical stimulation (control group, n = 10). In the experimental group, electrical stimulation was applied to the skin above the infrahyoid muscle with the current was adjusted until muscle contraction occurred and the hyoid bone was depressed. In the control group, the stimulation intensity was applied just above the sensory threshold. The patients in both groups were then asked to swallow effortfully in order to elevate their hyolaryngeal complex when the stimulation began. A total of 12 sessions of 20 min of training for 4 weeks were performed. Measurements of the extent of hyolaryngeal excursion, the maximal width of the upper esophageal sphincter (UES) opening, and the penetration-aspiration scale before and after training were performed.</p>	<p>In the experimental group, the maximal vertical displacement of the larynx was increased significantly after the intervention. The maximal vertical displacement of the hyoid bone and the maximal width of the UES opening increased but was not statistically significant. There was no increase in the control group. The results of between group differences were not reported.</p>
<p>Rofes et al. (2013) Spain RCT PEDro=6 TPS_{Overall}≥1mo TPS_{Exp1}=228.3±48.3d TPS_{Exp2}=433.4±162.6d N_{Start}=20 N_{End}=20</p>	<p>Population: Experimental Group 1 (EG1; N=10): Mean age=72.2±3.6yr; Gender: Males=7, Females=3. Experimental Group 2 (EG2; N=10): Mean age=77.7±2.3yr; Gender: Males=8, Females=2. Intervention: EG1 received surface e-stim treatment (sensory stimulus) for 10d while EG2 received the motor stimulus. Outcomes: Eating Assessment Tool (EAT-10); Sydney Swallowing Questionnaire (SSQ); Penetration-aspiration scale (PAS); Oropharyngeal swallow response.</p>	<ol style="list-style-type: none"> 1. Patients in the EG2 demonstrated a statistically significant improvement in the SSQ (-31.4%, p=0.028) but not in the EAT-10 (-26.5%, p>0.05). Patients in the EG1 did not demonstrate significant improvements in the questionnaire scores (-26.5% in the EAT-10 and -20.1% in the SSQ, p>0.05). 2. Both treatment intensities were significantly associated with an improvement in the safety of swallow; the sensory and motor stimuli were significantly associated with a reduction in the number of unsafe swallows by 66.7% (p<0.001), and by 62.5% (p=0.002), respectively. 3. A statistically significant reduction in the mean PAS score was observed in patients who received the sensory stimulus (from 5.0 to 2.7, p=0.009), but not the motor stimulus (from 3.6 to 3.3, p=0.521). 4. Regarding efficacy of swallow, oral residue

		<p>was significantly reduced by both treatment intensities; the sensory stimulus was significantly associated with a decreased prevalence of oral residue by 66.2% (p=0.011) and by 70.7% (p=0.002) for the motor stimulus.</p> <ol style="list-style-type: none"> 5. The motor treatment was significantly associated with a reduction in pharyngeal residue by 66.7% (p=0.002), but not the sensory stimulus, 20.7% (p=0.211). 6. Findings related to the oropharyngeal swallow response showed that both treatments were associated with a statistically significant reduction in laryngeal vestibule (LV) closure and opening times; the sensory stimulus was significantly associated with a reduction in the LV closure time by 22.94% (p=0.027) and the LV opening time by 14.89% (p=0.009); the motor treatment reduced the LV closure time by 38.26% (p=0.009) and the LV opening time by 10.85% (p=0.029). 7. For the upper esophageal sphincter (UES), there was no significant association with a reduction in UES opening times with the sensory stimulus (26.26%, p = 0.108) but there was a statistically significant reduction after the motor treatment (39.39%, p = 0.009). 8. For Hyoid motion: both treatment groups were significantly associated with a reduction in the time for hyoid to reach the maximal vertical extension (18.6% in the sensory group, p = 0.036 and 24.8% in the motor group, p = 0.008) and to reach the maximal anterior extension for the motor treatment group only (33.8%, p=0.041).
<p>Kushner et al. (2013) USA PCT No Score TPS_{Exp}=15.7d TPS_{Con}=15.4d N_{Start}=92 N_{End}=92</p>	<p>Population: Experimental Group (EG; n=65): Age range=19-89yr; Gender: Male=38, Female=27. Control Group (CG; n=27): Age range=49-91yr; Gender: Male=16, Female=11. All patients had feeding tube dependent dysphagia.</p> <p>Intervention: All patients received traditional dysphagia therapy with progressive resistance training for 1hr/d, >5d/wk for a mean of 18±3d. Traditional dysphagia training was directed at improving the strength, endurance, range of motion and mobility of the oral and laryngeal musculature. Progressive resistance training consisted of performing exercises for lingual strengthening,</p>	<ol style="list-style-type: none"> 1. FOIS improved significantly more in the EG compared to the CG (mean change: EG=4.4, CG=2.4, p<0.001). 2. Significantly more patients in the EG had minimal or no swallowing restrictions post-intervention (FOIS 5-7) compared to the CG (EG=46%, CG=26%, p=0.01).

	<p>exercises for laryngeal adduction and elevation, the effort swallow maneuver, the Masako maneuver and Shaker exercises. EG also received neuromuscular electrical stimulation (NMES) for hourly sessions at 5-120Hz directed to points on the face and neck. NMES was provided in conjunction with progressive resistance training.</p> <p>Outcomes: Functional Oral Intake Scale (FOIS).</p>	
<p>Sun et al. (2013) Canada Pre-Post No Score TPS=NA N_{Start}=29 N_{End}=29</p>	<p>Population: Mean age=70.1±8.9yr; Gender: Males=24, Females=5.</p> <p>Intervention: Combined Fiberoptic Endoscopic Evaluation of Swallowing (FEES), Neuromuscular electrical stimulation (NMES), and traditional swallowing rehabilitation. All patients received 12 treatment sessions of NMES, 1hr/d for 5 consecutive days/wk within a period of 2-3wk; Baseline FEES was done within 1wk after recruitment, 1d before the start of NMES while follow-up FEES was done within 2d after completion of NMES. The traditional swallowing rehabilitation was done 1d after the completion of follow-up FEES. Each session lasted about 50min/d, 3/wk for a total of 12 sessions.</p> <p>Outcomes: Functional Oral Intake Scale (FOIS); Clinical evaluation of the degree of dysphagia; Patient's self-perception: swallowing ability, global satisfaction with combination therapy; Pharyngeal secretion; Pharyngeal stasis; Penetration-Aspiration Scale (PAS); Cough score.</p>	<ol style="list-style-type: none"> 1. Statistically significant improvements were demonstrated in FOIS, degree of dysphagia, and patient self-perception of swallowing ability after the combination therapy. 2. Median FOIS scores improved statistically significantly from 2 at baseline to 6 after NMES ($p<0.01$), and no patients decreased in functional oral intake. These improvements were maintained at the 6mo and 2yr follow-ups ($p<0.001$). 3. There was a statistically significant improvement in the median degree of dysphagia after NMES ($p<0.001$) relative to baseline. At 6mo follow-up, there was a statistically significant improvement ($p=0.014$) and this was maintained at the 2yr follow-up ($p<0.001$). 4. The median score for patients' self-perception of swallowing ability improved after NMES ($p<0.001$). There was an additional statistically significant improvement at 6mo follow-up ($p=0.009$), which was maintained at the 2yr follow-up ($p<0.001$). 5. Most patients (69%) made improvements on the FOIS after NMES. At 6mo and 12mo follow-ups, additional patients improved on FOIS levels. 6. Relative to baseline, there was a statistically significant improvement after NMES for pharyngeal secretion, pharyngeal stasis, and PAS ($p<0.001$). However, there was no significant difference in the cough score after NMES ($p=0.236$).
<p>Nam et al. (2013) South Korea RCT PEDro=7 TPS_{Exp1}=38.20±16.50d TPS_{Exp2}=37.32±20.68d N_{Start}=66</p>	<p>Population: Experimental Group 1 (EG1; N=25): Mean age=62.28±11.43yr; Gender: Males=13, Females=12. Experimental Group 2 (EG2; N=25): Mean age=60.88±12.27yr; Gender: Males=14, Females=11.</p> <p>Intervention: EG1 received hyolaryngeal electrical stimulation therapy (EST) on the suprahyoid muscle only and EG2 received EST on the suprahyoid and infrahyoid muscles. All patients attended 10-15</p>	<ol style="list-style-type: none"> 1. No significant differences between EG1 and EG2 were found in the increment of maximal anterior hyoid excursion distance ($p=0.130$), maximal anterior velocity of the hyoid excursion ($p=0.254$), and maximal superior laryngeal elevation distance ($p=0.525$). 2. Patients within EG1 demonstrated a significant mean increase in the anterior

<p>N_{End}=50</p>	<p>sessions over 2-3wks with each lasting 30min. Assessments were conducted at baseline and at post-treatment. Outcomes: Maximal velocity of hyoid excursion and laryngeal elevation.</p>	<p>excursion distance (mean change=1.56±0.52mm, p=0.008) and in anterior excursion velocity (mean change=8.76±3.42 mm/s, p = 0.017). 3. Patients within EG2 demonstrated a significant mean increase in the maximal superior excursion distance of laryngeal elevation (mean change=2.09±0.78mm, p=0.013), and in the maximal absolute excursion distance of laryngeal elevation (mean change=2.20±0.82mm, p=0.013).</p>
<p>Soon et al. (2013) Taiwan Pre-Post No Score TPS_{Mean}=NA N_{Start}=11 N_{End}=11</p>	<p>Population: Mean age=50±18yr; Gender: Male=9, Female=2. Intervention: Patients received electrotherapy as part of the swallowing electrical stimulation system (SESS). Electrical stimulation was directed to the masseter and digastric muscles at a frequency of 60Hz with an intensity ranging from 0-80mA. Outcomes: Swallowing duration: 2mL, 5mL, 10mL, 150mL; Swallowing time: 2mL, 5mL, 10mL, 150mL.</p>	<ol style="list-style-type: none"> 1. The swallowing duration (time from EMG offset to swallowing attempt) according to the digastric channel was significantly shorter post-intervention on the 2mL, 5mL, 10mL and 150mL swallowing tasks (p=0.01). 2. The swallowing time was reduced post-intervention on the 2mL (difference=2.55s), 5mL (difference=3.37s), 10mL (difference=4.4s) and 150mL (difference=28.44s) swallowing tasks. 3. The ratio of improvement of swallowing duration was significant for the 10mL swallowing task for the left and right digastric muscles (19.35% and 27.39%, respectively) (p<0.05). 4. No significant ratios of improvement on swallowing duration were observed for the 2mL, 5mL or 150mL swallowing tasks.
<p>Huang et al. (2014) Taiwan RCT PEDro=7 TPS_{Exp1}=25.2d TPS_{Exp2}=16.6d TPS_{Exp3}=23.5d N_{Start}=29 N_{End}=29</p>	<p>Population: Experimental Group 1 (EG1; N=11): Median age=67yr; Gender: Males=6, Females=5. Experimental Group 2 (EG2; N=8): Median age=64.5yr; Gender: Males=5, Females=3. Experimental Group 3 (EG3; N=10): Median age=68.9yr; Gender: Males=9, Females=1. Intervention: EG1 were provided with traditional swallowing therapy, EG2 received neuromuscular electrical stimulation (NMES), and EG3 completed a combination of both conditions. Sessions for all groups lasted 60min and were performed 3/wk for a total of 10 sessions. Assessments were conducted at baseline and post-treatment. Outcomes: Functional Dysphagia Scale (FDS); soft diet, cookie diet, thick liquid diet, thin liquid diet; 8-point Penetration-Aspiration Scale (PAS); Functional Oral Intake Scale (FOIS).</p>	<ol style="list-style-type: none"> 1. EG1 improved significantly on the PAS (p=0.04) and the FOIS (p=0.03) from baseline to post-treatment but not on any of the FDS measures. 2. EG2 improved significantly on the FOIS (p=0.01) only from baseline to post-treatment. 3. EG3 improved significantly on the PAS (p=0.04), FOIS (p=0.005) and on the FDS during a soft diet (p=0.03). <ol style="list-style-type: none"> 1. All three groups demonstrated significant change on the FDS while on a cookie diet (p=0.03) and on a thick liquid diet (p=0.04) at post-treatment but no significant change was found for PAS (p=0.87), FOIS (p=0.31), soft diet (p=0.43) or thin liquid diet (p=0.31).
<p>Lee et al. (2014) South Korea RCT PEDro=4 TPS_{Exp}=5.0d</p>	<p>Population: Experimental Group (EG; n=31): Mean age=63.4yr; Gender: Male=22, Female=9. Control Group (CG; n=26): Mean age=66.7yr; Gender: Male=20, Female=6. Intervention: All patients received traditional</p>	<ol style="list-style-type: none"> 2. 52/57 patients did not require tubal feeding post-intervention, two patients in EG and three in CG required tubal feeding for long-term nutrition. 3. 27/57 patients required a limited diet 9wk

<p>TPS_{Con}=5.5d N_{Start}=57 N_{End}=57</p>	<p>dysphagia therapy for 1hr/d for 15d. Traditional dysphagia training included thermal-tactile stimulation (rubbing anterior faucial pillars with cold probe then having the patient swallow) in combination with lingual strengthening, exercises for laryngeal adduction and elevation, the effort swallow maneuver, the Mendelsohn maneuver, the Masako maneuver and Shaker exercises. EG also received neuromuscular electrical stimulation (NMES) for 30min/d, 5d/wk for 3wk directed to the sternohyoid muscles. NMES was provided in conjunction with traditional dysphagia training. Outcomes: Functional Oral Intake Scale (FOIS); Videofluoroscopic swallowing study; Feeding status; Adverse events.</p>	<p>post intervention and 25/57 patients were able to receive a normal diet. 4. FOIS showed significantly greater improvement in the EG compared to the CG from baseline to post-intervention (mean change EG=1.4±1.0, CG=0.5±0.7, p=0.000), 3wk post intervention (mean change EG=2.4±1.3, CG=1.1±0.9, p=0.000) and 9wk post intervention (mean change EG=3.1±1.4, CG=1.7±0.9, p=0.000). 5. No patients showed aspiration pneumonia and no adverse events were reported after NMES 9wk post-intervention.</p>
<p>Terre et al. (2015) Spain RCT PEDro=8 TPS_{Mean}=3mo TPS_{Range}=1-5mo N_{Start}=20 N_{End}=20</p>	<p>Population: Experimental Group (EG; N=10); Mean age=48 (28-60)yr; Gender: Males=6, Females=4. Control Group (CG; N=10): Mean age=51 (22-69)yr; Gender: Males=6, Females=4. Intervention: EG received neuromuscular electrical stimulation (NMES) and CG received sham electrical stimulation (SES). Outcomes: Functional oral intake scale (FOIS).</p>	<p>1. After treatment, there was an improvement in feeding capacity in the EG compared to the CG (2.9 points vs 1 point increase, p=0.005). 2. At 3mo follow-up, the mean FOIS values improved in both groups. At that time, there were no statistically significant differences and tracheal aspiration persisted in six patients in each group. 3. There was a statistically significant improvement in relation to the bolus viscosity at which aspiration appeared in the EG vs. CG (p=0.015).</p>
<p>El-Tamawy et al. (2015) Egypt RCT PEDro=5 TPS=n/a N_{Start}=30 N_{End}=30</p>	<p>Population: Experimental group (EG; N=15): Mean age=61.53±7.259yr; Gender: Unspecified; Control group (CG; N=15): Mean age=61.33±6.565yr; Gender: Unspecified. Intervention: All participants received traditional medical treatment for 6wk. Participants were randomized to receive additional physical therapy and neuromuscular electrical stimulation treatment (EG) or no additional treatment (CG) for 6wk. Assessments were conducted at pre and post treatment. Outcomes: Oral Transit Time; Aspiration Rate; Penetration Rate; Hyoid Elevation; Laryngeal Elevation; Esophageal Sphincter Function.</p>	<p>1. After 6wk EG group showed a significantly greater improvement in Oral Transit Time (p<0.01), Aspiration and Penetration Rate (p=0.008), Hyoid Elevation (p=0.002), and Laryngeal Elevation (p=0.001) compared to the CG group. 2. There was no significant difference in Esophageal Sphincter Function between groups.</p>
<p>Momosaki et al. (2015) Japan Pre-Post No Score TPS=33.5±4.44mo N_{Start}=8 N_{End}=8</p>	<p>Population: Mean age=65.0±2.93yr; Gender: Males=6, Females=2. Intervention: All participants received repetitive peripheral magnetic stimulation (rPMS; 20 trains of stimuli over 10min), followed by 20min of swallowing rehabilitation. Each participant received this combination of treatment 2x/d for 6 consecutive days. Outcomes: Functional Oral Intake Scale (FOIS); Laryngeal Elevation Delay Time (LEDT); Mann</p>	<p>1. Following treatment there was a significant improvement in MASA (p=0.01), PAS (p=0.01), LEDT (p=0.02), and SWAL-QOL (p=0.01). 2. Following treatment there was no significant change in FOIS (p=0.08).</p>

	Assessment of Swallowing Ability (MASA); Penetration-Aspiration Scale (PAS); Swallowing Quality of Life (SWAL-QOL).	
Bath et al. (2016) UK RCT PEDro=7 TPS=13.4±9.7d N _{Start} =162 N _{End} =121	Population: Pharyngeal Electrical Stimulation group (EG; N=87): Mean age=74.0±9.9yr; Gender: Males=48, Females=39. Control group (CG; N=75): Mean age=74.9±12.6yr; Gender: Males=46, Females=29. Intervention: Participants were randomized to receive Pharyngeal Electrical Stimulation (EG) or sham stimulation (CG) for 3 consecutive days. Outcomes were assessed at baseline and 2wk. Outcomes: Penetration Aspiration Score (PAS); Clinical Swallowing.	1. There was no significant difference between EG and CG groups at 2wk in PAS or clinical swallowing (all p>0.05).
Byeon & Koh (2016) Korea RCT PEDro=6 TPS _{E1} =4.5±1.1mo TPS _{E2} =4.8±1.2mo N _{Start} =45 N _{End} =45	Population: Neuromuscular Electrical Stimulation group (E1; N=27): Mean age=65.2±7.7yr; Gender: Males=17, Females=10. Thermal Tactile Oral Stimulation group (E2; N=18): Mean age=67.5±8.3yr; Gender: Males=16, Females=12. Intervention: Participants were randomized to receive Neuromuscular Electrical Stimulation (E1) or Thermal Tactile Oral Stimulation (E2) for 30min, 5d/wk over 3wk. Outcomes were assessed at baseline and 3wk. Outcomes: Videofluoroscopic Study (VFS).	1. There was no significant difference between E1 and E2 groups in VFS at 3wk (p>0.05).
Ko et al. (2016) Korea PCT No Score TPS _{EG} =28±8d TPS _{CG} =35±17d N _{Start} =18 N _{End} =18	Population: Neuromuscular Electrical Stimulation group (EG; N=12): Mean age=72±9yr; Gender: Males=9, Females=3. Conventional Swallowing Training group (CG; N=6): Mean age=60±16yr; Gender: Males=3, Females=3. Intervention: Participants were allocated to receive Neuromuscular Electrical Stimulation in combination with Conventional Swallowing Training (EG) or Conventional Swallowing Training (CG) alone for 2wk. Outcomes were assessed at baseline, 2wk, and 4wk. Outcomes: Grade Roughness Breathiness Asthenia and Strain Scale (GRBAS); Functional Dysphasia Scale (FDS).	1. EG showed a significantly greater improvement in GRBAS scores at 2wk (p<0.05), but no at 4wk compared to the CG group. 2. 2wk GRBAS scores correlated significantly with FDS scores.
Vasant et al. (2016) UK RCT PEDro=7 TPS _{EG} =16d (9-23) TPS _{CG} =11d (7-17) N _{Start} =36 N _{End} =33	Population: Pharyngeal Electrical Stimulation group (EG; N=18): Mean age=71yr (56-79); Gender: Males=9, Females=9. Placebo group (CG; N=18): Mean age=71yr (61-78); Gender: Males=13, Females=5. Intervention: Participants were randomly allocated to receive Pharyngeal Electrical Stimulation (EG) or Sham Stimulation (CG) for 10min/d over 3d. Outcomes were assessed at baseline and 2wk. Outcomes: Dysphagia Severity Rating (DSR); Penetration-Aspiration Scale (PAS).	1. There was no significant difference between groups in DSR at 2wk (p=0.26) or 3mo (p=0.97). 2. There was no significant difference between groups in PAS at 2wk (p=0.23) or 3mo (p=0.07).
Zhang et al. (2016) China	Population: Sensory group (E1; N=28): Mean age=61.3±7.1yr; Gender: Males=16, Females=12.	1. All groups improved significant improvements following treatment in SSA,

<p>RCT PEDro=5 TPS_{E1}=22.1±4.0d TPS_{E2}=20.6±4.3d TPS_{CG}=21.3±4.1d N_{Start}=90 N_{End}=82</p>	<p>Motor group (E2; N=27): Mean age=62.2±9.2yr; Gender: Males=19, Females=8. Conventional Traditional Swallowing Therapy group (CG; N=27): Mean age=62.6±8.7yr; Gender: Males=17, Females=10. Intervention: Participants were randomly allocated to receive Sensory (E1) or Motor (E2) Neuromuscular Electrical Stimulation in combination with Conventional Swallowing Training (EG) or Conventional Swallowing Training (CG) alone, 2x/d, 5d/wk, over 4wk. Outcomes were assessed at baseline and 4wk. Outcomes: Standardized Swallowing Assessment (SSA); Functional Oral Intake Scale (FOIS); Swallowing-Related Quality of Life (SWAL-QOL).</p>	<p>FOIS, and SWAL-QOL (all p≤0.01). 2. There was a significant group effect with the E1 performing better than E2, and E2 performing better than CG in SSA (p=0.01), FOIS (p=0.02), and SWAL-QOL (p=0.04).</p>
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15.8.7 Head Positioning

Table 15.8.7 Head Positioning

<p>Author, Year Country PEDro Score TPS</p>	<p>Methods</p>	<p>Outcomes</p>
<p>Terre & Mearin (2012) Spain No Score N=72</p>	<p>47 patients (31 stroke, 16 traumatic brain injury) with confirmed aspiration and 25 controls without aspiration (14 stroke, 11 TBI) swallowed thickened fluids of differing volumes in random order (either the normal anatomical or the chin down position) during VMBS examination. Various swallowing parameters were evaluated.</p>	<p>During the chin-down posture, 55% of patients avoided aspiration (40% pre-swallow aspiration and 60% aspiration during swallow). Fifty-one percent of patients had silent aspiration; of these, 48% persisted with aspiration while in the chin-down posture. A statistically significant relationship was found between the existence of pharyngeal residue, cricopharyngeal dysfunction, pharyngeal delay time and bolus volume with the persistence of aspiration. The chin-down posture did not change swallow biomechanics in patients without aspiration.</p>
<p>Logemann et al. (1989) USA No Score N=19</p>	<p>The effect of head rotation on swallowing function was evaluated on 5 lateral medullary stroke patients and 14 healthy adults.</p>	<p>Head rotation did not alter the swallowing efficiency of healthy subjects. In stroke patients head rotation improved swallowing “efficiency” from 21 to 50% and increased the diameter of the upper esophageal sphincter from 7.7 to 11.6 mm.</p>

15.8.8 Thermal Application

Table 15.8.8 Thermal Application

<p>Author, Year Country PEDro Score TPS</p>	<p>Methods</p>	<p>Outcomes</p>
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<p>Rosenbek et al. (1991) USA RCT Cross-over PEDro=6</p>	<p>In a crossover ABAB study, 7 patients received a week-long period of thermal application (chilled laryngeal mirror used to stroke the anterior faucial pillar on both sides), followed by 3 cc of water or ice chips, followed by no treatment for one week.</p>	<p>No evidence that treatment with thermal application improved incidence of aspiration, penetration or residue.</p>
<p>Rosenbek et al. (1998) USA 5 (RCT)</p>	<p>45 patients were randomized to receive treatment that included rubbing both anterior faucial pillars briskly, 3 or more times with an ice stick. Study Group A:150 trials of tactile-thermal stimulation per week; Study Group B:300 trials per week; Study Group C:450 trials per week; Study Group D:600 trials per week 2 outcomes were assessed at 1 and 2 weeks: Duration of Stage Transition-DST (sec) with intakes of 3 mL and 10 mL liquid; Penetration/Aspiration-P/A with intakes of 3 mL and 10 mL liquid.</p>	<p>Combining all levels of intensity, mean DST was reduced with 3 mL fluid intake at week 2 (1.17 sec, p=0.06). There were no significant improvements in DST using 10 mL fluid. With both 3 and 10 mL boluses, no intensity of treatment was associated with a clinically significant improvement in P/A. score. A statistically significant improvement in mean P/A scores was associated with 150 trials per week at weeks 1 and 2 (3 mL bolus only). Combining all levels of intensities, mean P/A scores were reduced with 3 mL fluid intake at weeks 1 (0.55, p=0.04 and 2 (0.59, p=0.03).</p>
<p>Nakamura & Fujishima (2013) Japan RCT PEDro=6 N=24</p>	<p>24 patients were included in a cross over trial consisting of 4 rounds of swallowing commands alternating between a swallow command after ice massage, and a swallow command after no ice massage. The starting condition (ice massage first or no ice massage first) for each patient was randomized. The ice massage consisted of 10 seconds of light application of an ice stick around key areas of the oral cavity (posterior tongue, tongue base, velum, posterior pharyngeal wall). For patients who were able to swallow after each of the 4 rounds, the time elapsed from the swallow command to when the larynx reached the highest position on the VFES was recorded. For those patients who were unable to swallow all 4 rounds, the number of times the patient successfully swallowed after each condition was enumerated.</p>	<p>10 patients were unable to swallow in all 4 rounds. For those patients, a greater number of swallows were completed after ice massage vs. after no ice massage (1.40±0.72 vs. 0.20±0.32; P=0.0413). For the 14 patients who swallowed in all 4 rounds, there was a statistically significant shorter time to swallow after receiving ice massage vs. after no ice massage (1.55±0.42 vs. 2.17±1.53; t=2.16; P=0.00366). The swallowing time, however, was dependent on lesion location. Those individuals with nuclear lesions did not experience statistically significant improvements in swallow time compared to those individuals with supranuclear lesions.</p>
<p>Byeon & Koh (2016) Korea RCT PEDro=6 TPS_{E1}=4.5±1.1mo TPS_{E2}=4.8±1.2mo N_{Start}=45 N_{End}=45</p>	<p>Population: Neuromuscular Electrical Stimulation group (E1; N=27): Mean age=65.2±7.7yr; Gender: Males=17, Females=10. Thermal Tactile Oral Stimulation group (E2; N=18): Mean age=67.5±8.3yr; Gender: Males=16, Females=12. Intervention: Participants were randomized to receive Neuromuscular Electrical Stimulation (E1) or Thermal Tactile Oral Stimulation (E2) for 30min, 5d/wk over 3wk. Outcomes were assessed at baseline and 3wk. Outcomes: Videofluoroscopic Study (VFS).</p>	<p>1. There was no significant difference between E1 and E2 groups in VFS at 3wk (p>0.05).</p>

15.8.9 Pharmacotherapy

Table 15.8.9 Pharmacotherapy

Author, Year Country PEDro Score TPS	Methods	Outcomes
Perez et al. (1998) UK 7 (RCT)	17 patients were randomized to receive 30 mg slow release nifedipine orally or placebo for 28 days. All patients also received treatment by a speech therapist.	Patients in the treatment group demonstrated significant improvement in mean pharyngeal transit time and swallowing delay compared to patients in the control group.
Arai et al. (2003) Japan RCT (insufficient data provided to score-letter to the editor)	51 stroke patients, all with proven silent aspiration (assessed by 1 mL of Technetium Tin Colloid was given during sleep by nasal catheter) were studied. 39 normotensive patients were randomized to receive cabergoline (0.25 mg/day) n=13, amantadine (50 mg/day) n=14, or no active treatment (n=12). The remaining 12 patients were hypertensive and received imidapril (5 mg/day). Treatment lasted for 12 weeks.	Silent aspiration disappeared in 10/13 patients given cabergoline, 10/14 patients given amantadine and 9/12 patients given imidapril and in 1/12 of the control patients. Significant differences were noted between the collective treatment group and no treatment group.
Shimizu et al. (2008) Japan No Score	The pharyngeal transit time (PTT) of 10 elderly subjects with stroke was assessed using VMBS before and after 6 weeks of therapy with 5 mg imidapril. The results were compared with 10 age-matched healthy subjects.	The PTT of control subjects was unchanged from first to second assessment. (2.4 vs. 2.6 sec). The PTT of subjects receiving the ACE inhibitor significantly decreased from baseline to 5 weeks (2.5 vs. 1.6 sec, p<0.01). Abnormalities in the oral and esophageal phases were not altered by treatment.
Kondo et al. (2014) Japan Pre-Post No Score TPS _{Mean} =13.4mo N _{Start} =10 N _{End} =10	Population: Mean age=79.3yr; Gender: Male=8, Female=2. Intervention: Patients were administered a single application of 0.025% capsaicin ointment to the right external auditory canal. Outcomes: Video-endoscopy (VE) swallowing score.	1. VE swallowing scores significantly decreased 5min post-application (pre=4.5±1.4, post=3.0±1.9, p=0.017). 2. No adverse effects were observed.
Osawa et al. (2013a) Japan No Score	189 patients admitted to a rehabilitation department and considered candidates for cilostazol were included for retrospective chart review. Data extracted from the charts included age, stroke type, CNS score, MMSE score, FIM score, discharge destination, oral intake at discharge, presence of aspiration pneumonia and the use of cilostazol.	Aspiration pneumonia was detected in 27 patients (14.3%). There was a statistically significantly lower incidence of aspiration pneumonia in patients who received cilostazol compared to patients who did not receive cilostazol (3/48 vs. 24/141; P=0.476). No other chart extracted factors were significantly associated with its use.
Abe et al. (2013) Japan RCT PEDro=4 TPS _{Mean} <72hr N _{Start} =21 N _{End} =20	Population: Experimental Group (EG; N=10): Mean age=65yr; Gender: Males=6, Females=4. Control Group (CG; N=10): Mean age=74yr; Gender: Males=4, Females=6. Intervention: The experimental group received aspirin (100mg/d) plus cilostazol (100mg/d), while the control group received aspirin (100mg/d) alone. Assessments were conducted at baseline, 28d and 180d post-treatment. Outcomes: Latent time of swallowing reflex (LTSR).	1. The EG demonstrated a significant decrease in LTSR from 28d to 180d after the treatment (p<0.05). 2. No significant change was observed in the CG from 28d to 180d after the treatment. 3. No significant between group difference was found with regards to the LTSR.

15.8.10 Transcranial Direct Current Stimulation (tDCS)

Table 15.8.10 Transcranial Direct Current Stimulation (tDCS)

Author, Year Country PEDro Score TPS	Methods	Outcomes
Kumar et al. (2011) USA 7 (RCT)	14 patients within 1-7 days of unilateral hemispheric infarction were randomized to receive anodal transcranial direct current stimulation (tDCS) versus sham stimulation to the unaffected hemisphere over 5 consecutive days with concurrent standardized swallowing maneuvers. The Dysphagia Outcome and Severity scale (scale range of 1-7) was assessed before and after treatment.	Patients who received anodal tDCS gained more points on the DOSS (2.60 vs. 1.25, $p=0.019$) after controlling for the effects of stroke and dysphagia severity, age and time from stroke onset. Six out of 7 (86%) patients in tDCS group gained at least 2 points of improvement compared with 3 out of 7 (43%) patients in the sham group ($P=0.107$).
Yang et al. (2012) South Korea 8 (RCT)	16 patients were randomized to either active anodal transcranial direct current stimulation (tDCS) ($n=9$) or sham treatment ($n=7$). Treatment lasted 30 min, 5x/week, for 2 weeks. The intervention group received anodal tDCS (increased gradually to 1 mA over several seconds) over the affected pharyngeal motor cortex and conventional swallowing training for the first 20 min of each session. The last 10 minutes of each session involved swallowing training alone. Treatment was comparable in the control group, but the tDCS lasted only 30 seconds. Functional dysphagia scale (FDS), oral transit time (OTT), pharyngeal transit time (PTT) and total transit time (TTT) were measured before, immediately after and at 3 months follow up.	Patients receiving anodal tDCS experienced statistically significant improvements in swallowing function based on the change in FDS score from pre intervention to 3 months post intervention when compared to controls (13.00 ± 12.18 , vs. 9.83 ± 7.06 ; $P=0.041$). There were no statistically significant changes in OTT, PTT or TTT between the tDCS group and control group.
Shigematsu et al. (2013) Japan RCT PEDro=7 TPS _{Overall} ≥4wk TPS _{Exp} =12.9±7.8wk TPS _{Con} =12.1±9.0wk N _{Start} =20 N _{End} =20	Population: Experimental Group (EG; $N=10$): Mean age= 66.9±6.3yr; Gender: Males=7, Females=3. Control Group (CG; $N=10$): Mean age=64.7±8.9yr; Gender: Males=7, Females=3. Intervention: The EG received 10 sessions of 1-mA anodal transcranial direct current stimulation (tDCS). The CG received sham stimulation to the ipsilesional pharyngeal motor cortex. Outcomes: Dysphagia Outcome and Severity Scale (DOSS).	<ol style="list-style-type: none"> The EG demonstrated an improvement of 1.4 points in DOSS ($p=0.006$) immediately after the last session and 2.8 points ($p=0.004$) 1mo after the last session. The CG did not demonstrate any significant improvement in DOSS scores after the last session however, they demonstrated an improvement of 1.2 points ($p=0.026$) 1mo after the final session. The improvements in the DOSS score for the EG were greater than those in the CG ($p=0.029$ after the last session; $p=0.007$ 1mo after the last session).

15.8.11 Repetitive Transcranial Magnetic Stimulation (rTMS)

Table 15.8.11 Repetitive Transcranial Magnetic Stimulation (rTMS)

Author, Year Country	Methods	Outcomes
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PEDro Score TPS		
<p>Khedr et al. (2009) Egypt 6 (RCT)</p>	<p>26 patients with post-stroke dysphagia due to single hemispheric stroke were randomly allocated to receive real (n = 14) or sham (n = 12) rTMS of the affected motor cortex. Each patient received a total of 300 rTMS pulses at an intensity of 120% hand motor threshold for five consecutive days. Clinical ratings of dysphagia were assessed using the Dysphagic Outcome and Severity Scale before and after the last session and then again after 1 and 2 months. Scores ranged from 1 (no dysphagia) to IV (obvious dysphagia precluding oral feeding). All subjects received standard medical and physical therapy.</p>	<p>At baseline the mean dysphagia score for the control group was 3.7 vs. 3.4 for the real rTMS group. By 2 months the real rTMS groups' mean score was approximately 1.0 vs. 3.0 for the control group. There was a significant time x group interaction.</p>
<p>Khedr & Abo-Elfetoh (2010) Egypt 6 (RCT)</p>	<p>22 patients with acute ischemic stroke with lateral medullary syndrome or brainstem infarction severe bulbar manifestation were randomly allocated to receive active (n=11) or sham (n=11) repetitive transcranial magnetic stimulation (rTMS) of the esophageal motor cortex. Each patient received 300 rTMS pulses at 3 Hz and an intensity of 130% resting motor threshold to each hemisphere for five consecutive days. Outcomes were assessed before and immediately after the last session, and then again after 1 and 2 months using a 4-point dysphagia grading scale, NIHSS, BI and the Hemiplegic Stroke Scale.</p>	<p>Among patients with lateral medullary there were significant improvements in dysphagia scores and BI scores in the active rTMS group compared with the sham group that were maintained over the study period. Among patients with other types of brainstem infarcts who received rTMS, there was significant improvement in dysphagia scale scores compared with sham treatment.</p>
<p>Park et al. (2013) USA RCT PEDro=8 TPS_{Overall}≥1mo TPS_{Exp}=59.9±16.3d TPS_{Con}=63.9±26.8d N_{Start}=18 N_{End}=18</p>	<p>Population: Experimental Group (EG; N=9): Mean age= 73.6±3.8yr; Gender: Males=5, Females=4. Control Group (CG; N=4): Mean age=68.8±9.3yr; Gender: Males=5, Females=4. Intervention: The EG received real, 5Hz rTMS over contra-lesional pharyngeal motor cortex 10min/d for 2wk, and the CG received sham rTMS under the same conditions. Videofluoroscopic swallowing study was performed after treatment cessation and 2wk after that. Patients in both groups performed the videofluoroscopic swallowing study before the rTMS intervention. Outcomes: Videofluoroscopic dysphagia scale (VDS); Penetration-Aspiration Scale (PAS).</p>	<ol style="list-style-type: none"> 1. There was a statistically significant difference for the EG in mean VDS as indicated between baseline (33.6±12.1) and 2wk (25.3±9.8) (p<0.05) and between baseline and 4wk (p<0.05). 2. There was a statistically significant improvement in the pharyngeal phase, but not the oral phase for mean VDS in the EG (p<0.05). There was no significant difference in mean VDS between the oral and pharyngeal phases for the CG. 3. For PAS, there was a statistically significant difference in the EG between baseline (3.41±2.32) and 2wk (1.93 ± 1.52) (p<0.05) and between baseline and 4wk (1.37±0.87) (p<0.05). However, there was no significant difference between the EG and CG (p>0.05). 4. In the EG, the prevalence of aspiration and penetration, vallecular and pyriform sinus residue, delayed triggering of pharyngeal swallowing and abnormal pharyngeal transit time (PTT) in EG was 66.7%, 66.7%, 33.3%, and 44.4%, respectively. After rTMS

		<p>the prevalence of aspiration decreased to 33.3% and 33.3%, respectively for aspiration and penetration, and vallecular and pyriform sinus residue.</p> <p>5. In the CG, the prevalence of aspiration and penetration, vallecular and pyriform sinus residue, delayed triggering of pharyngeal swallowing, and abnormal PTT in CG was 77.8%, 22.2%, 77.8% and 33.3%, respectively. After sham RTMS, the prevalence of each of these was 66.7%, 22.2%, 77.8% and 22.2%, respectively.</p>
<p>Michou et al. (2014) UK RCT PEDro=6 TPSPES=89±61.45mo TPSrTMS=30.33±23.48 mo TPSPAS=38±31.71mo NStart=18 NEnd=18</p>	<p>Population: PES Group (N=6): Mean age=60.33±16.83yr; Gender: Males=5, Females=1. rTMS Group (N=6): Mean age=67.33±7.66yr; Gender: Males=6, Females=0. PAS Group (N=6): Mean age=72.83±5.95yr; Gender: Males=4, Females=2.</p> <p>Intervention: Participants received one of three experimental protocols: 1) repetitive transcranial magnetic stimulation (rTMS); 2) paired associative stimulation (PAS); 3) pharyngeal electrical stimulation (PES). All participants received both real and sham applications of the allocated intervention treatment in random order on two different days. Videofluoroscopic assessments were conducted before and after the interventions.</p> <p>Outcomes: Safety of Swallows (cumulative Penetration-Aspiration (cPA) Scale); Pharyngeal Response Time (PRT).</p>	<p>1. The mean difference in the cPA from pre- to post-intervention were significantly different between sham and PES (p=0.033) and between sham and PAS (p=0.007), but not after rTMS.</p> <p>2. After combining the groups into real and sham conditions, a reduction in percentage change in cPA scores of -15.5±3.5% was observed, while there was an increase in cPA scores in sham arms by 10.6±6.8. This difference between the two groups was statistically significant (p=0.005).</p> <p>3. PRT showed a proportionally significant difference following real stimulation treatments compared to the sham arms (p=0.007).</p>
<p>Momosaki et al. (2014) Japan RCT PEDro=6 TPSExp=19±8mo TPSCon=21±8mo NStart=20 NEnd=20</p>	<p>Population: Experimental Group (EG; N=10): Mean age= 61±22yr; Gender: Males=8, Females=2. Control Group (CG; N=10): Mean age=66±9yr; Gender: Males=6, Females=4.</p> <p>Intervention: The EG received functional magnetic stimulation (FMS) of 30Hz, applied to the suprahyoid muscles in a 20s train using a parabolic coil for 10min (total 1200 pulses). The CG received sham stimulation applied for 10min at the same site.</p> <p>Outcomes: Timed Water Swallow Test; Interswallow interval (ISI); Swallowing Volume Velocity; Functional Oral Intake Scale.</p>	<p>1. All patients completed the stimulation and none showed any adverse reactions throughout the stimulation.</p> <p>2. There were no between-group differences observed in the ISI after FMS.</p> <p>3. There were statistically significant differences in terms of speed (p=0.008) and capacity (p=0.005) for the real group as compared to the sham group.</p>

<p>Cheng et al. (2015) China RCT PEDro=5 TPS_{Mean}=NA N_{Start}=4 N_{End}=4</p>	<p>Population: Experimental Group (EG; N=2). Control Group (CG; N=2). Mean age of study sample=71yr; Gender of sample study: Females=2, Males=2. Intervention: The EG received 10 sessions of active repetitive transcranial magnetic stimulation (rTMS) for 2wk applied on the tongue motor region of the cortex, while the CG received sham rTMS for 2wk. Each participant received a total of 3000 pulses of 5Hz active or sham stimulation per day for 10d. Assessments were conducted at baseline, 1wk, and 1mo post rTMS. Outcomes: Tongue Pressure Assessment using the Oral Performance Instrument; Swallowing-related Quality of Life Questionnaire (SAPP); Videofluoroscopic Swallowing Study using oropharyngeal swallow efficiency (OPSE).</p>	<ol style="list-style-type: none"> 1. An improvement in OPSE in participants who received active stimulation but not those who received sham stimulation was found. 2. An evident reduction in the SAPP total scores in the participants receiving real rTMS but not those receiving sham stimulation was found. 3. There was no observable difference in changes in maximum tongue strength between the participants receiving real rTMS compared to those receiving sham stimulation.
<p>Du et al. (2016) China RCT PEDro=9 TPS_{E1}=8d (4-15) TPS_{E2}=6d (5-28.5) TPS_{CG}=9d (7-26.25) N_{Start}=40 N_{End}=38</p>	<p>Population: Repetitive Transcranial Magnetic Stimulation 3Hz group (E1; N=15): Mean age=58.2±2.78yr; Gender: Males=13, Females=2. Repetitive Transcranial Magnetic Stimulation 1Hz group (E2; N=13): Mean age=57.92±2.47yr; Gender: Males=7, Females=6. Control group (CG; N=12): Mean age=58.83±3.35yr; Gender: Males=6, Females=6. Intervention: Participants were randomized to receive 5 daily sessions of 3Hz Repetitive Transcranial Magnetic Stimulation (E1), 1Hz Repetitive Transcranial Magnetic Stimulation (E2), or sham stimulation (CG). Outcomes were assessed at baseline, 5d, 1mo, 2mo, and 3mo. Outcomes: Standardized Swallowing Assessment (SSA).</p>	<ol style="list-style-type: none"> 1. E1 and E2 groups showed a significantly greater improvement in SSA compared to the CG group at all time points after treatment (all p<0.001)

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