

## **Impact of dysphagia assessment and management on risk of stroke-associated pneumonia: A systematic review**

ELTRINGHAM, Sabrina <<http://orcid.org/0000-0002-0453-2456>>, KILNER, Karen <<http://orcid.org/0000-0003-0196-8518>>, GEE, Melanie <<http://orcid.org/0000-0001-9149-4314>>, SAGE, Karen <<http://orcid.org/0000-0002-7365-5177>>, BRAY, Benjamin, POWNALL, Sue and SMITH, Craig

Available from Sheffield Hallam University Research Archive (SHURA) at:

<https://shura.shu.ac.uk/22229/>

---

This document is the Accepted Version [AM]

### **Citation:**

ELTRINGHAM, Sabrina, KILNER, Karen, GEE, Melanie, SAGE, Karen, BRAY, Benjamin, POWNALL, Sue and SMITH, Craig (2018). Impact of dysphagia assessment and management on risk of stroke-associated pneumonia: A systematic review. *Cerebrovascular Diseases*, 46 (3-4), 97-105. [Article]

---

### **Copyright and re-use policy**

See <http://shura.shu.ac.uk/information.html>

# **Impact of dysphagia assessment and management on risk of stroke-associated pneumonia: A systematic review**

Sabrina A. Eltringham, MSc;<sup>1,2</sup> Karen Kilner, Dr.;<sup>2</sup> Melanie Gee, MSc;<sup>2</sup> Karen Sage, Prof.;<sup>2</sup>  
Ben. D. Bray, Dr.;<sup>3</sup> Sue Pownall, Prof.;<sup>1,2</sup> Craig.J.Smith, Prof;<sup>4,5</sup>

<sup>1</sup>Speech and Language Therapy Department, Sheffield Teaching Hospitals NHS Foundation Trust, UK

<sup>2</sup>Faculty of Health and Wellbeing, Sheffield Hallam University, UK

<sup>3</sup>Sentinel Stroke National Audit Programme, Royal College of Physicians, London, UK

<sup>4</sup>Greater Manchester Comprehensive Stroke Centre, Manchester Academic Health Science Centre, Salford Royal Foundation Trust, UK

<sup>5</sup>Division of Cardiovascular Sciences, University of Manchester, UK

**Corresponding author** – Sabrina A. Eltringham, Speech and Language Therapy Department, Sheffield Teaching Hospitals NHS Foundation Trust, Glossop Road, Sheffield, UK

Tel: +44 114 271 2676

Fax: +44 114 271 3189

Email: [Sabrina.Eltringham@sth.nhs.uk](mailto:Sabrina.Eltringham@sth.nhs.uk)

**Key words:** Acute stroke, dysphagia, stroke-associated pneumonia

## **Abstract**

### **Background**

Patients with dysphagia are at increased risk of stroke-associated pneumonia. There is wide variation in the way patients are screened and assessed during the acute phase. The aim of this review was to identify which methods of assessment and management in acute stroke influence the risk of stroke-associated pneumonia. Studies of stroke patients that reported dysphagia screening, assessment or management and occurrence of pneumonia during acute phase stroke were screened for inclusion after electronic searches of multiple databases from inception to November 2016. The primary outcome was association with stroke-associated pneumonia.

### **Summary**

Twelve studies of 87824 patients were included. The type of dysphagia screening protocol varied widely across and within studies. There was limited information on what comprised a specialist swallow assessment and alternative feeding was the only management strategy, which was reported for association with stroke-associated pneumonia. Use of a formal screening protocol, early dysphagia screening and assessment by a speech and language pathologist (SLP) was associated with a reduced risk of stroke-associated pneumonia. There was marked heterogeneity between the included studies, which precluded meta-analysis.

### **Key Messages**

There is variation in assessment and management of dysphagia in acute stroke.

There is increasing evidence that early dysphagia screening and specialist swallow assessment by a SLP may reduce the odds of stroke-associated pneumonia.

There is the potential for other factors to influence incidence of stroke-associated pneumonia during the acute phase.

## Introduction

Stroke-Associated Pneumonia (SAP) incorporates the spectrum of lower respiratory tract infections within the first 7 days after stroke onset.<sup>[1]</sup> It is one of the most common post stroke infections, affecting 14% of patients,<sup>[2]</sup> and is associated with an increased risk of hospital mortality,<sup>[3]</sup> prolonged hospital stay,<sup>[4]</sup> and associated healthcare costs.<sup>[5]</sup> The timing of SAP reflects the complex relationship between infection and inflammatory responses which may precede and develop post stroke. Respiratory infections frequently trigger ischemic stroke and worsen in the days following.<sup>[6]</sup> Brain-induced immunodepression and aspiration related to impaired consciousness and dysphagia<sup>[7]</sup> increases vulnerability to SAP in the acute phase after stroke.

Incidence of dysphagia in stroke patients varies widely depending on patient characteristics, variations in study design, type and severity of stroke, time of assessment and diagnostic techniques.<sup>[8]</sup> In acute stroke, the incidence ranged between 37-78% depending on assessment method; lower incidence was detected using an initial screening test (37-43%) compared to clinical assessments (30-55%) and videofluoroscopy (VFS) (64-78%).<sup>[8]</sup>

Early identification of dysphagia post stroke informs decisions regarding nutritional management and may reduce pulmonary complications. Multiple national and international guidelines<sup>[9-13]</sup> recommend that people with acute stroke have their swallow screened by an appropriately trained healthcare professional, using a validated screening tool and remain nil by mouth (NBM) until a swallow screen is completed. Recommended time from admission to screen ranges from within 4<sup>[9,12]</sup> to 24 hours.<sup>[11]</sup> If dysphagia is suspected, the person should be referred to a healthcare professional with expertise in swallowing to have a specialist

assessment. This usually comprises of a cranial nerve examination, trials of different diet and fluid textures and compensatory strategies. Those with suspected aspiration should be reassessed for instrumental examination using techniques such as VFS or Flexible Endoscopic Evaluation of Swallowing (FEES).<sup>[9,10]</sup> Results from these assessments inform management which may include: NBM with alternative nutrition if swallowing is unsafe, diet or fluid modification, compensatory strategies or muscle strengthening exercises.

There is a wide variation in dysphagia screening protocols (DSP) and no consensus exists on the optimal DSP.<sup>[14]</sup> Most speech and language pathologists (SLPs) apply their clinical reasoning to tailor their bedside assessment over using a standardised assessment<sup>[15]</sup> such as The Mann Assessment of swallowing ability.<sup>[16]</sup> To complicate matters further, the terminology describing DSPs and bedside clinical assessments is often used inconsistently and interchangeably.<sup>[12]</sup>

The aim of this systematic review was to answer the question “How do methods of dysphagia screening, assessment and management during the first 72 hours of admission affect the risk of SAP?” The objective was to identify which methods influence the risk of SAP. A search of the National Institute for Health Research Centre for Reviews and Dissemination (NIHR CRD) Database<sup>[17]</sup> was undertaken to check there were no existing or on-going reviews, which addressed this question.

## **Methods**

Search strategy and selection criteria

---

A systematic review was undertaken according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement and Centre for Reviews and Dissemination guidance.<sup>[18,19]</sup> A building block<sup>[20]</sup> approach identified search terms for each concept which were added together, using the Boolean AND operator. Two search strategies were used to develop the search terms; National Clinical Guideline for Stroke<sup>[9]</sup> and the PISCES (Pneumonia in Stroke Consensus) Group<sup>[1]</sup>. Co-authors (SP, KS, MG) reviewed the search strategy (Appendices). Electronic databases were searched from inception for relevant studies: CINAHL (via EBSCOhost to 19/11/16), COCHRANE (via Wiley Online to 23/11/16), EMBASE (via NICE Healthcare Databases to 23/11/16), MEDLINE (via EBSCOhost to 19/11/16) and SCOPUS to 23/11/16. In addition, references and citations of included studies were screened.

The review was restricted to peer-reviewed English language stroke research, which evaluated dysphagia screening, assessment or management within the first 72 hours of admission to hospital, and recorded frequency of SAP. The time restriction of  $\leq 72$  hours might not be explicit in the title/abstract; therefore, if the abstract met all the other inclusion criteria, it was included in the next stage of the screening process. Non-stroke or mixed population, studies of exclusively intubated and mechanically ventilated patients or where dysphagia assessment or management was beyond 72 hours were excluded and studies not documenting SAP or pneumonia post stroke or pre-existing pneumonia.

Two authors independently applied the inclusion/exclusion criteria to titles and abstracts for eligibility (Appendices). Differences were forwarded to a third author for consensus.

Abstracts that met the inclusion criteria were recommended for full text reading. SAE, SP

and KS screened 10% of articles recommended and any differences were agreed by consensus. SAE assessed remaining articles.

#### Data Abstraction and Analysis

SAE piloted and designed a data extraction form base on Royal College of Physicians National Clinical Guideline for Stroke<sup>[21]</sup> and independently extracted data for the titles. Data extraction included study design and baseline characteristics of the population, as well method of screening, assessment and management, rate and association with pneumonia (Appendices). Quality Assessment tools<sup>[22, 23]</sup> were used to appraise the studies for risk of bias (Appendices).

#### Statistical Analysis

Inter rater reliability was analysed using the Kappa statistic. Heterogeneity was evaluated using random effects models.<sup>[24]</sup> Given that substantial heterogeneity was expected, further meta-analysis was not anticipated. Microsoft Excel produced forest plots for illustration only.  
[25]

#### **Declaration of Sources of Funding**

This work was supported by The Stroke Association [SE -TSA PGF 2017/03].

#### **Results**

Database searching found 518 references and 13 arose through other sources (Figure 1).

Inter-rater reliability for the inclusion/exclusion criteria was 0.71. Forty-one full text articles were assessed for eligibility. Twelve studies with a total of 87,824 ischemic and haemorrhagic stroke were included (Table 1). The majority were prospective observational

studies, of which 5 were registry based <sup>[26-30]</sup>. Two used a quasi-experimental design; <sup>[31,32]</sup> and post intervention data are reported (Figure 2). There was one retrospective review. <sup>[33]</sup> Europe, <sup>[26-28, 31, 32, 34]</sup> hosted 50% of studies, United States 25% <sup>[29, 35, 36]</sup>; the remainder were in Chile, <sup>[33]</sup> Japan <sup>[37]</sup> and Canada. <sup>[30]</sup> Stroke severity was reported in seven studies using the National Institutes of Health Stroke Scale (NIHSS). There was variation in the way participant characteristics such as age and NIHSS were reported and missing information, which precluded doing any summary statistics. One study <sup>[28]</sup> accounted for 72% of the combined population of studies, making measurement of mean statistically inappropriate. Marked variation in study design, reporting of participant characteristics and the dominance of one study prohibited meta-analysis.

Most studies controlled selection bias by consecutive recruitment of patients that met eligibility criteria and screening of all patients on admission. <sup>[26-32,35,36]</sup> There was still potential for bias dependent on the actual rate of screening. One study screened only patients considered at risk of dysphagia <sup>[33]</sup> while in another, it was unclear how the cohort was recruited. <sup>[37]</sup> Performance bias is also likely to have influenced reported findings. Potential risk for measurement bias exists because of heterogeneity in methods of dysphagia intervention and variation in the way SAP was diagnosed. The criterion for determining the reliability of results ranged from levels of significance only ( $p \leq 0.05$ ) <sup>[31]</sup>, to odds ratios (OR), <sup>[26,29,37]</sup> and adjusted odds ratio (aOR). <sup>[28,30,33]</sup> The confidence intervals for the association between dysphagia screening and SAP in the Chilean <sup>[33]</sup> and Japanese <sup>[37]</sup> study (Appendices), suggested uncertainty about the precision of the results.



## **Type and Methods of Dysphagia Screening**

Three studies reported more than one type of screening method involving a combination of informal, formal and standardised assessments.<sup>[29, 30,32]</sup> The Toronto Bedside Swallowing Screening Test (TOR-BSST) was most frequently used in the Canadian registry-based study.<sup>[30]</sup> Perry and McLaren found the Standardised Swallow Assessment (SSA) the most common method in their post-test group.<sup>[32]</sup> Two studies used The Gugging Swallow Screen (GUSS).<sup>[27,31]</sup> Smithard et al. used their own validated Bedside Swallow Assessment.<sup>[34]</sup> Maeshima et al. used a repetitive saliva swallow test and modified water test.<sup>[37]</sup> Two studies used locally developed screens,<sup>[26,35]</sup> and two did not describe the screening process or specify the DSP.<sup>[33,36]</sup> In the largest study the dataset lacked information on the nature of the DSP used.<sup>[28]</sup>

Screening was undertaken by nurses, physicians, physiotherapists with special training in dysphagia and SLPs. Methods of screening followed a stepwise procedure, which began with an indirect swallowing test or risk assessment followed by a direct swallow assessment with water and, in some studies, diet consistencies. Four studies involved an indirect and a direct swallow test with water only;<sup>[29,32,34,37]</sup> which is consistent with the TOR-BSST.<sup>[30]</sup> One study involved only direct assessment with water and/or thickened apple juice and an additional swallowing and cough provocation test to detect for silent aspiration.<sup>[26]</sup> The GUSS involves an indirect and direct swallow assessment with water, semi solid and solid diet consistencies.<sup>[27,30]</sup> Odderson et al. described a similar approach.<sup>[35]</sup>

### **Frequency and time of screening**

The percentage patients who were screened ranged from 12.1% to 100%. Differences were due to screening only participants perceived to be at risk, adherence to local protocols and

study design. In 4<sup>[26, 28-30]</sup> out of the 5 stroke registries, incidence of screening ranged from 61% to 87.7%. All patients underwent a screen in the Bernese Stroke Registry study.<sup>[27]</sup> Hinchey et al.<sup>[29]</sup> found adherence to dysphagia screening was higher in hospitals with a formal DSP compared to those without (78% vs. 56%), and formal dysphagia screening was associated with increased adherence to completing the screen before oral intake. Time of screen is shown in Table 1.

### **Type and Methods of Specialist Swallow Assessment**

Six studies reported patients seen for a clinical swallow assessment or consultation by a SLP<sup>[28-30,32,35]</sup> or equivalent trained professional.<sup>[26]</sup> No studies reported use of a validated assessment. There was limited information on what comprised a specialist swallow assessment (Appendices). Two studies<sup>[31,36]</sup> used the terms SLP screening and assessment interchangeably but did not provide information on what each involved. Odderson et al.<sup>[35]</sup> reported that where a patient did not meet the criteria for safe swallowing, swallowing evaluation was completed by a SLP and reviewed daily. Al-Khaled et al.<sup>[26]</sup> reported that, if swallowing difficulties were suspected following the screen, further dysphagia tests were performed.

### **Frequency and time of assessment**

The proportion of patients who had a SLP assessment varied by study. Bray et al.<sup>[28]</sup> found 39% of all patients had a SLP assessment contrasting with Odderson and McKenna's<sup>[36]</sup> 87% assessed and subsequently treated (61%). Hinchey et al.<sup>[29]</sup> stated 22% received a SLP bedside or formal examination. Joundi<sup>[30]</sup> reported 77% of patients who had a documented screen were assessed by SLP.

Four studies provided information on when patients were seen by a SLP. [28, 31, 32,36] Bray et al. [28] reported 39% had a SLP assessment 22.9 hours post admission (median; IQR 6.2-49.4 hours). Perry and McLaren [32] reported that, in the post-test study group, 56% were assessed within 72 hours compared to 39% in the pre-test group ( $p < 0.058$ ). Odderson and McKenna [36] reported a SLP assessment on Day 2. On Day 5, a decision was made about the need for alternative nutritional support e.g. percutaneous gastronomy tube (PEG). Palli [31] reported prior to the implementation of 24/7 Nurse screening, patients had a swallow assessment 20 hours from admission (range, 1-183 hours).

Three studies referred to instrumental investigations or contrast radiography; [27, 34,37] Smithard et al. [34] performed VFS when possible within 24 hours of the bedside assessment, and further dysphagia evaluation was performed by VFS or FEES as part of the GUSS if a patient scored  $< 5$  points. No information was provided on number of patients for these investigations. Maeshima et al. [37] reported contrast radiography was performed if any abnormality in bedside swallow assessment or pulmonary aspiration with oral intake was suspected but no information on how often this occurred.

### **Type and Methods of Dysphagia Management**

Nine studies [26, 27, 29, 30, 32, 34-37] referred to types and methods of dysphagia management during the acute stroke phase. The level of detail was limited. Types of management included direct, indirect and compensatory strategies. Examples of direct strategies were: nil by mouth with enteral or parenteral feeding/fluids, [26,27, 29, 30,32, 34-37] if the swallow was unsafe, or supplementary nutrition/hydration if oral intake was insufficient, therapeutic eating of small amounts, diet modification, and adjusted posture. [29, 32,35,37] Indirect strategies included: oral care, oral articulation exercises and pharynx cooling stimulation. [37] Compensatory strategies

included: chin tuck, head rotation and multiple swallowing.<sup>[37]</sup> Al-Khaled<sup>[26]</sup> referred to SLP initiating measures of therapy but did not describe what this involved.

### **Definition and Diagnosis of Pneumonia**

The Centers for Disease Control and Prevention (CDC) criteria<sup>[38]</sup> were used to define pneumonia in 3 out of 12 studies (Appendices).<sup>[27, 29, 37]</sup> One study<sup>[31]</sup> used the PISCES SAP diagnostic criteria<sup>[1]</sup>. Four used a combination of clinical symptoms, signs, and radiologic findings on X Ray and laboratory results.<sup>[27, 30, 32, 34]</sup> The definition for 4 studies was based on clinician initiation of antibiotics.<sup>[28, 32-34]</sup> Odderson et al.<sup>[35]</sup> referred to criteria for aspiration pneumonia but did not define the criteria. Odderson and McKenna<sup>[36]</sup> provided no definition.

Measurement of when pneumonia was reported varied. Most studies reported pneumonia during hospitalisation.<sup>[26,27,29,31-33,35,36]</sup> Two studies reported within 7 days of admission.<sup>[28,34]</sup> Maeshima et al.<sup>[37]</sup> reported pneumonia pre/post 72 hours of admission and one study reported within 30 days of hospitalisation.<sup>[30]</sup>

### **Incidence of SAP**

Overall incidence was reported in 8 studies<sup>[26-29,33,35-37]</sup> (Appendices) and ranged from 0% to 23.6%,<sup>[35, 33]</sup> with the largest population at 8.7%.<sup>[28]</sup> Maeshima et al.<sup>[37]</sup> found 26.9% developed SAP had early onset pneumonia with development of pneumonia within 72 hours of admission. Six studies compared rates of pneumonia between dysphagia and non-dysphagia patients<sup>[26,27,30,32,34,37]</sup> Patients with dysphagia were at increased risk of SAP compared to patients without dysphagia (OR 8.57; 95% CI 5.65-13) (Figure 2). Five studies found implementing a formal dysphagia screening protocol or clinical pathway significantly reduced pneumonia rates.<sup>[29,31,32, 35,36]</sup> Odderson and McKenna found implementing a clinical

pathway which involved an integrated team with immediate rehabilitation improved rates of pneumonia.<sup>[36]</sup>

### **Associations between SAP and dysphagia screening**

Six studies analysed associations between dysphagia screening and SAP.<sup>[26,28-30,33,37]</sup> Hinchey et al. found pneumonia rate was significantly higher in those who had any screen versus those who did not ( $p < 0.0001$ ).<sup>[29]</sup> Joundi et al. found patients who failed dysphagia screening were more likely to develop pneumonia (aOR, 4.71; 95% CI, 3.43-6.47) and aspiration pneumonia (aOR, 6.5; 95% CI, 4.2-9.9) compared to those that passed.<sup>[30]</sup> Maeshima found an abnormal screen was associated with SAP (OR 2.65; 95% CI .90-9.72;  $p = 0.774$ ).<sup>[37]</sup> Hoffmeister et al. found no association between dysphagia screening and pneumonia (aOR 1.58 (0.60;4.15)  $p$ -value 0.36).<sup>[33]</sup> However, neither of these results were statistically significant.<sup>[33,37]</sup>

Three studies analysed the effect of early dysphagia screening and patients developing pneumonia. Palli et al.<sup>[31]</sup> found that 24/7 dysphagia screening outside the working hours of SLP significantly reduced time to dysphagia screening from median 20 to 7 hours ( $P = 0.001$ ). Two studies found risk of developing SAP was increased with late dysphagia screening.<sup>[26,28]</sup> Early Dysphagia Screening (EDS <24 hours of admission) was independently associated with decreased risk of SAP (OR 0.68; 95% CI 0.52-0.89).<sup>[26]</sup> Bray et al. found a modest association between time from admission to dysphagia screen with the longest delays in screening having 36% higher odds of SAP compared to those in the first quartile.<sup>[28]</sup>

### **Associations between SAP and Specialist Swallow Assessment**

Bray et al.<sup>[28]</sup> found a strong independent relationship between delay in SLP assessment and incidence of SAP. Delays in SLP assessment were associated with an absolute increase in the

risk of SAP of 3% over the first 24 hours. Delays in SLP assessment > 24 hours were associated with an additional 4% absolute increase in SAP. Patients in the slowest quartile had 1.98 (1.67-2.35) odds of SAP compared with patients receiving the quickest SLP assessment. Smithard et al. found no evidence to justify the routine use of VFS in screening for aspiration in acute stroke.<sup>[34]</sup>

### **Associations between SAP and Dysphagia Management**

Alternative feeding was the only management strategy where data were analysed in relation to SAP. Arnold et al. found dysphagia tube-fed compared to dysphagia non-tube patients had higher risk for in-hospital pneumonia and need of antibiotic treatment. After adjusting for confounding variables, the association between tube placement and pneumonia was not statistically significant (OR, 2.2; 95% CI, 0.89-5.5; p=0.087).<sup>[27]</sup> Maeshima et al. found 53.8% of patients who developed SAP were NBM with nasogastric and enteral feeding and developed SAP after 72h. These patients and those that developed early onset pneumonia had the most severe neurological syndromes and cognitive dysfunctions.<sup>[37]</sup>

### **Discussion**

A recent published review found insufficient evidence to determine the effect of dysphagia screening protocols.<sup>[39]</sup> However Smith et al. included only randomized controlled trials (RCTs) and did not focus specifically on pneumonia as an outcome. Our review found emerging evidence that EDS is associated with lower incidence of SAP and supports current guidelines that all patients should be screened for dysphagia on admission before oral intake. There may be reason for performing later screening in patients with altered consciousness.<sup>[26]</sup> In studies that examined association between dysphagia screening and development of SAP, a range of screening practices were used thereby precluding recommendation of a particular

protocol. A formal written protocol improved adherence and demonstrated higher numbers of patients being screened. An integrated team approach and clinical pathway also improved rates of pneumonia.

Delays in SLP assessment were associated with SAP with an absolute risk of pneumonia incidence of 1% per day of delay. There was limited information about the assessment components. One study evaluated the role of VFS to screen for aspiration, one of the main risk factors for SAP. There was no evidence to support its routine use during the first 72 hours of admission. Limited use of VFS in the acute phase post stroke is expected, given patients may be too acutely unwell to leave the ward. No study reported use of FEES, which has the advantage of administration at the bedside, is cost effective and with no radiation exposure can be repeated if clinically indicated. When used selectively FEES has been shown to reduce pneumonia rates, improve functional outcomes and is receiving increasing support in acute stroke dysphagia assessment.<sup>[40, 41]</sup> Stroke-related dysphagia may be graded using Endoscopic scales such as the Fibre Optic Endoscopic Dysphagia Severity Scale (FEDSS)<sup>[42,43]</sup> or Penetration-Aspiration Scale (PAS).<sup>[44]</sup>

The potential for tube feeding to contribute to infection by promoting oral-pharyngeal colonisation or aspiration, and other factors such as poor oral and dental hygiene, requiring assistance with mobility, positioning, and concurrent chest and cardiac disease, have been identified as potential risk factors for SAP.<sup>[45,46]</sup> Further research about the association between these factors and dysphagia patients developing SAP would improve our understanding of their impact during the first 72 hours of admission and potentially improve patient outcomes.

No RCTs examining a specific DSP or specialist swallow assessments and the impact on SAP was found. The heterogeneity of study designs, reporting and the size of the largest study<sup>[28]</sup> precluded meta-analysis. Caution is recommended in drawing overall conclusions and generalising. Future reporting would benefit from a more standardised approach to allow meta-analyses.

## **Conclusion**

This review found increasing evidence that early dysphagia screening and specialist swallow assessment helps to reduce the odds of SAP. Variation in assessment methods and management factors (e.g. tube feeding) may be associated with SAP. Further understanding is needed on the effect of these variations and other confounding factors, which may contribute to the development of SAP during this acute phase.

## **Disclosures**

None

## **References**

1. Smith, JC, Kishore, KA, Vail, A, Chamorro, A, Garau, J, Hopkins, JS, et al. Diagnosis of stroke-associated pneumonia: Recommendations from the pneumonia in stroke consensus group. *Stroke*. 2015;46:8:2335-2340. doi:10.1161/STROKEAHA.115.009617.
2. Kishore, KA, Vail, A, Chamorro, A, Garau, J, Hopkins, JS, Di Napoli, M, et al. How is pneumonia diagnosed in clinical stroke research?: A systematic review and meta-analysis. *Stroke*. 2015;46:5:1202-1209. doi:10.1161/STROKEAHA.114.007843.



3. Westendorp, WF, Nederkoorn, PJ, Vermeij, J, Dijkgraaf, MG, & van de Beek, D. Post-stroke infection: A systematic review and meta-analysis. *BMC Neurology*. 2011;11:1:110. doi: 10.1186/1471-2377-11-110.
4. Finlayson O, Kapral M, Selchen D, Saposnik G, Hall R, & Asllani E. Risk factors, inpatient care, and outcomes of pneumonia after ischemic stroke. *Neurology*. 2011;77:14:1338-1345.
5. Katzan, IL, Dawson, NV, Thomas, CL, Votruba, ME. & Cebul, RD..The cost of pneumonia after acute stroke. *Neurology*. 2007;68:22:1938-1943. doi:10.1212/01.wnl.0000263187.08969.45.
6. Emsley HC, & Hopkins SJ. Acute ischaemic stroke and infection: Recent and emerging concepts. *The Lancet Neurology*. 2008;7:4:341-353.
7. Hannawi, Y, Hannawi, B, Rao, CPV, Suarez, JL, and Bershad, EM, Stroke-Associated Pneumonia: Major Advances and Obstacles. *Cerebrovascular Diseases*. 2013;35:5:430-43. doi: 10.1159/000350199.
8. Martino, R, Foley, N, Bhogal, S, Diamant, N, Speechley, M, & Teasell, R. Dysphagia after stroke: Incidence, diagnosis, and pulmonary complications. *Stroke*. 2005;36:12:2756. doi:10.1161/01.STR.0000190056.76543.eb.
9. Intercollegiate Stroke Working Party. National Clinical Guideline for Stroke. Fifth Edition. 2016. London: Royal College of Physicians. Accessed via <https://www.strokeaudit.org/Guideline/Full-Guideline.aspx> on 27 June 2017.
10. Jauch EC, Saver JL, Adams HP Jr, Bruno A, Connors JJ, Demaerschalk BM, et al. American Heart Association Stroke Council; Council on Cardiovascular Nursing; Council on Peripheral Vascular Disease; Council on Clinical Cardiology. Guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare

- professionals from the American Heart Association/American Stroke Association. *Stroke*. 2013;44:870–947. doi: 10.1161/STR.0b013e318284056a.
11. Casaubon LK, Boulanger JM, Blacquiere D, Boucher S, Brown K, Goddard T, et al. Heart and Stroke Foundation of Canada Canadian Stroke Best Practices Advisory Committee. Canadian Stroke Best Practice Recommendations: Hyperacute Stroke Care Guidelines, Update 2015. *Int J Stroke*. 2015;10:924–940. doi: 10.1111/ijss.12551.
  12. Clinical Guidelines for Stroke Management (2017). Accessed via <https://informme.org.au/Guidelines/Clinical%20Guidelines%20for%20Stroke%20Management%202017> on 25 September 2017.
  13. European Stroke Organisation (ESO) Executive Committee; ESO Writing Committee. Guidelines for management of ischaemic stroke and transient ischaemic attack. *Cerebrovasc Dis*. 2008;25:457–507.
  14. Daniels SK, Valid items for screening dysphagia risk patients with stroke: a systematic review. *Stroke*. 2012; 43; 892-897. doi:10.1161/STROKEAHA.111.640946.
  15. McAllister S, Kruger S, Doeltgen S, Tyler-Boltrek E. Implications of variability in clinical bedside swallowing assessment practices by speech language pathologists. *Dysphagia*. 2016;31;650-662. doi:10.1007/s00455-016-9724-8.
  16. Mann G, MASA: The Mann assessment of swallowing ability. Thomson Learning Inc, Clifton (NY) (2002).
  17. NIHR Centre for Reviews and Dissemination – CRD Database. Accessed via <https://www.crd.york.ac.uk/CRDWeb/> on 14 October 2017
  18. Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009) Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med*6(7): e1000097. <https://doi.org/10.1371/journal.pmed.1000097>

19. Centre for Reviews and Dissemination. Systematic Reviews: Guidance for undertaking reviews in healthcare. Accessed via [https://www.york.ac.uk/media/crd/Systematic\\_Reviews.pdf](https://www.york.ac.uk/media/crd/Systematic_Reviews.pdf) on 14 October 2017
20. Booth, A. Unpacking your literature search toolbox: on search styles and tactics. *Health Information & Libraries Journal*. 2008;25:4:313-317. doi: 10.1111/j.1471-1842.2008.00825.x
21. Intercollegiate Stroke Working Party. National Clinical Guideline for Stroke. Evidence Tables. London: Royal College of Physicians  
<https://www.strokeaudit.org/Guideline/Appendices.aspx>. Accessed 18 October 2017.
22. Critical Appraisal Skills Programme (CASP) CASP checklists. <http://www.casp-uk.net/checklists>. Accessed 18 October 2017.
23. National Heart, Lung and Blood Institute. Quality Assessment Tool for Before and After (Pre-Post) Studies with No Control Group. <https://www.nhlbi.nih.gov/health-pro/guidelines/in-develop/cardiovascular-risk-reduction/tools/before-after>. Accessed 18 October 2017.
24. DerSimonian R & Laird N. Meta-analysis in clinical trials. *Controlled Clinical Trials*. 1986;7:177-188.
25. Neyeloff JL, Fuchs SC & Moreira LB. Meta-analyses and Forest plots using a microsoft excel spreadsheet: step-by-step guide focusing on descriptive data analysis. *BMC Research Notes*. 2012;5:52.
26. Al-Khaled, M, Matthis, C, Binder, A, Mudter, J, Schattschneider, J, Pulkowski, U, et al. Dysphagia in patients with acute ischemic stroke: Early dysphagia screening may reduce stroke-related pneumonia and improve stroke outcomes. *Cerebrovascular Diseases* (Basel, Switzerland). 2016; 42:1-2:,81-89.

27. Arnold M, Liesirova K, Broeg-Morvay A, Meisterernst J, Schlager M, Mono M.-L, et al. Dysphagia in acute stroke: Incidence, burden and impact on clinical outcome. *Plos One*. 2016;11:2
28. Bray, BD, Smith, CJ, Cloud, GC, Enderby, P, James, M, Paley, L, et al. The association between delays in screening for and assessing dysphagia after acute stroke, and the risk of stroke-associated pneumonia. *Journal of Neurology, Neurosurgery and Psychiatry*. 2016. doi:10.1136/jnnp-2016-313356.
29. Hinchey, JA, Shephard, T, Furie, K, Smith, D, Wang, D, & Tonn, S. Formal dysphagia screening protocols prevent pneumonia. *Stroke; a Journal of Cerebral Circulation*. 2105;36:9:1972-1976.
30. Joundi, RA., Martino, R, Saposnik, G, Giannakeas, V, Fang, J, & Kapral, M. K. Predictors and outcomes of dysphagia screening after acute ischemic stroke. *Stroke*, 2017;48:4:900-906. doi:10.1161/STROKEAHA.116.015332
31. Palli, C, Fandler, S, Doppelhofer, K, Niederkorn, K, Enzinger, C. Vetta, C, et al. Early dysphagia screening by trained nurses reduces pneumonia rate in stroke patients. *Stroke*. 2017;48(9), 2583-2585. doi:10.1161/STROKEAHA.117.018157
32. Perry L, & McLaren SM. An evaluation of implementation of evidence-based guidelines for dysphagia screening and assessment following acute stroke: Phase 2 of an evidence-based practice project. *Journal of Clinical Excellence*. 2000;2:3: 147-156
33. Hoffmeister, L, Lavados, PM, Comas, M, Vidal, C, Cabello, R, & Castells, X. Performance measures for in-hospital care of acute ischemic stroke in public hospitals in Chile. *BMC Neurology*. 2013;13. Doi:10.1186/1471-2377-13-23
34. Smithard, D.G, O'Neill, PA, Parks, C, & Morris, J. Complications and outcome after acute stroke. does dysphagia matter? *Stroke; a Journal of Cerebral Circulation*. 1996; 27:7:,1200-1204.

35. Odderson IR, Keaton JC, & McKenna BS. Swallow management in patients on an acute stroke pathway: Quality is cost effective. *Archives of Physical Medicine and Rehabilitation*. 1995;76:12:1130-1133.
36. Odderson IR, & McKenna BS. A model for management of patients with stroke during the acute phase: Outcome and economic implications. *Stroke*. 1993; 24:12: 1823-1827.
37. Maeshima, S, Osawa, A, Hayashi, T, & Tanahashi, N. Elderly age, bilateral lesions, and severe neurological deficit are correlated with stroke-associated pneumonia. *Journal of Stroke and Cerebrovascular Diseases*. 2014; 23:3:,484-489.
38. Horan, T. C, Andrus, M, & Dudeck, M. A. (2008). CDC/NHSN surveillance definition of health care–associated infection and criteria for specific types of infections in the acute care setting. *AJIC: American Journal of Infection Control*, 36(5), 309-332
39. Smith EE, Kent DM, Bulsara KR, Leung LY, Lichtman JH, Reeves MJ, Tow ghi A, Whiteley WN, Zahuranec DB; on behalf of the American Heart Association Stroke Council. Effect of dysphagia screening strategies on clinical outcomes after stroke: a systematic review for the 2018 guidelines for the early management of patients with acute ischemic stroke. *Stroke*. 2018;49:e123–e128. DOI: 10.1161/STR.0000000000000159
40. Bax, L., McFarlane, M., Green, E., & Miles, A. Speech-language pathologist-led fiberoptic endoscopic evaluation of swallowing: Functional outcomes for patients after stroke. *Journal of Stroke & Cerebrovascular Diseases*. 2014; 23(3), e195-200.  
doi:10.1016/j.jstrokecerebrovasdis.2013.09.031
41. Leder SB, & Espinosa JF. Aspiration risk after acute stroke: comparison of clinical examination and fiberoptic endoscopic evaluation of swallowing. *Dysphagia* 2002;17(3):214-218.
42. Warnecke T, et al. Fiberoptic Endoscopic Dysphagia Severity Scale predicts outcome after acute stroke. *Cerebrovascular Diseases*. 2009; 28: 283-289.

43. Warnecke T, et al. Aspiration and dysphagia screening in acute stroke – the Gugging Swallowing Screen revisited. *European Journal of Neurology*. 2017, 594-601
44. Colodny N. Interjudge and intrajudge reliabilities in fiberoptic endoscopic evaluation of swallowing (fees) using the penetration-aspiration scale: a replication study. *Dysphagia*. 2002; 17(4):308-15.
45. Beavan, J. Update on management options for dysphagia after acute stroke. *British Journal of Neuroscience Nursing*. 2015;11: 10-19.
46. Brogan E, Brookes K, Langdon C, Budgeon C, & Blacker D. Can't swallow, can't transfer, can't toilet: Factors predicting infections in the first week post stroke. *Journal of Clinical Neuroscience*. 2015;22:1:92-97.