**SUPPLEMENTARY MATERIAL**

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

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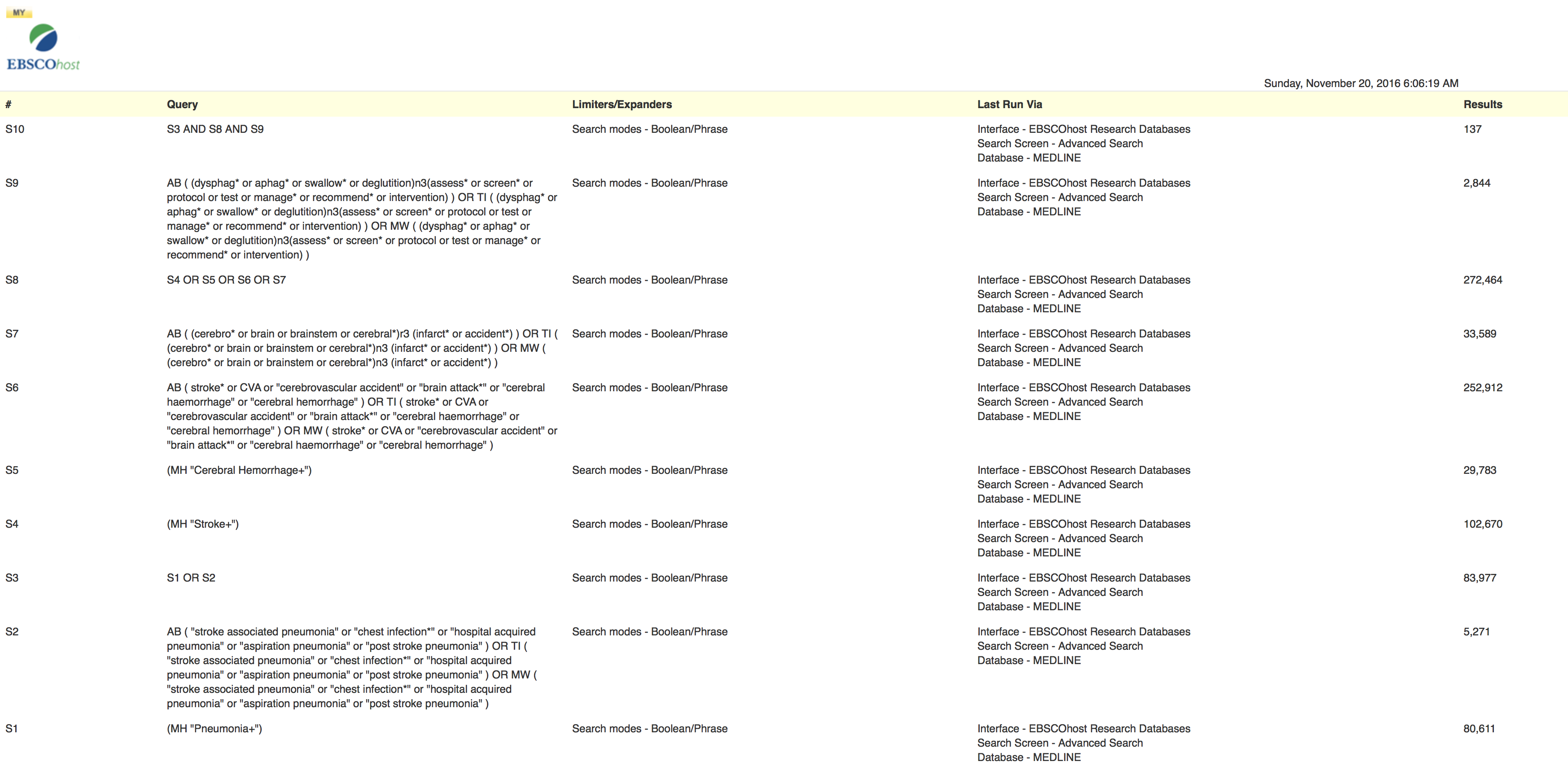
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**Online Table I - Medline (via EBSCOhost) Search Strategy**



**Online Table II – Inclusion and Exclusion Criteria**

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| **Inclusion Criteria** | **Exclusion Criteria** |
| Stroke homogenous population | Mixed population studies, non-stroke population. Intubated or ventilated CVA patients. |
| Dysphagia screening, assessment and management | Dysphagia therapy, rehabilitation |
| Treated ≤ 72 hours of admission – acknowledgement that ≤ 72 hours of admission may not be explicit in abstract therefore should be included to screening full text if abstract refers to dysphagia screening, assessment or management in acute stroke. | > 72 hours of admission |
| Stroke associated pneumonia or documentation of pneumonia after stroke onset. | Studies not documenting SAP or pneumonia post stroke. Pre existing pneumonia. |
| Peer reviewed, quantitative, qualitative and mixed method studies.  Studies in Systematic reviews which meet inclusion criteria | Non-peer reviewed studies, grey literature, editorial letters, book reviews. |

**Table III – Study characteristics**

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| **Study** | **Design, Setting, Country** | **Aim** | | **Participants** | |
| Al-Khaled et al. (2016) | Prospective observational, 15 hospitals, regional registry, Germany | Association of EDS within 24hrs with occurrence of SAP, mortality, and disability | | 12276 Ischemic stroke patients; Mean age 73 ± 13, Median NIHSS 4 (IQR 2-9), 25.1% Dysphagic patients, AF 33% and HT 85% in patients who underwent dysphagia screen | |
| Arnold et al. (2016) | Prospective observational, tertiary stroke centre, regional hospital registry, Switzerland | Association of dysphagia with pneumonia, LOS, discharge destination. Dysphagic vs. Non Dysphagic favourable clinical outcome and mortality | | 570 Ischemic stroke patients; Mean age 65.1 (range, 19.6-94.7), Mean NIHSS for dysphagia patients 9.8 ± 7.0 vs. 4.5 ±5.1 non dysphagia patients, 20.7% Dysphagic patients, AF (not reported) and HT 36.2% for dysphagic patients vs. 63.7% for non dysphagic patients | |
| Bray et al. (2017) | Prospective observational, hospitals in England and Wales registered on national registry, United Kingdom | Association between delays in bedside dysphagia screening and comprehensive dysphagia assessments by a SLP with risk of SAP | | 63650 Ischemic and haemorrhagic stroke patients; Median age 77 (67-85), Median NIHSS 4 (IQR 2-9), Dysphagic patients 38.6%, AF 20.7%, HT 53.9% | |
| Hinchley et al. (2005) | Prospective observational, 15 healthcare institutions, national registry, USA | Adherence to dysphagia screening, type of screen, and development of pneumonia | | 2532 Ischemic stroke patients. Ave. age (SD) 70.5 (14), Mean NIHSS 7.2 (CI 6.8-7.5), % Dysphagic patients, % AF and % HT not reported | |
| Hoffmeister et al. (2013) | Retrospective observational, case note review, 7 public hospitals, Chile | Adherence to clinical evaluation at admission, use of intravenous thrombolysis, dysphagia screening and prescription of antithrombotic therapy at discharge and rates of pneumonia and mortality | | 677 Ischemic stroke patients. Mean age 69.8 (95% CI 68-71.6) in women and 66.3 years (95% CI 68.0-71.6) in men. NIHSS not recorded. % Dysphagic patients (not reported), AF (not reported), HT 77% | |
| Joundi et al. (2017) | Prospective observational, 11 regional stroke centres, regional hospital registry, Canada | Evaluate predictors of receiving dysphagia screening and outcomes: pneumonia, disability, and death | | 6677 Ischemic stroke patients. Age 80+ y 34.0% No documented screening vs. 41% documented screening. Mean NIHSS 4.29 no documented screening vs. 7.9 documented screening. 47.8% Dysphagic patients. AF 23.5%, HT 72.7%. | |
| Maeshima et al. (2014) | Prospective observational, rehabilitation unit, Japan | Factors determining pneumonia in acute stroke, and discharge destination | | 292 Ischemic stroke patients. Mean age (SD) 69.9 ± 12.2. 71.6% Dysphagic patients. NIHSS not recorded. AF 18%, HT 62%. | |
| Odderson et al. (1995) | Prospective observational, urban community hospital, USA | To assess the effects of swallowing management and to whether swallow function can be used to predict LOS and outcome disposition. | | 124 Ischemic stroke patients. Age of dysphagic patients 75.2 ±1.5 vs 75.3 ± 1.4 non dysphagic patients. NIHSS not recorded. 38.7% Dysphagic patients. AF and HT not recorded | |
| Odderson and McKenna (1993) | Prospective observational, community hospital, USA | To develop a clinical pathway to reduce length of stay to 7 days, minimise complications, coordinate resources, and to reduce costs. | | 121 Ischemic stroke patient. Average age 73.9. NIHSS, % Dysphagic patients, % AF, % HT not recorded | |
| Palli et al. (2017) | Quasi experimental, primary and tertiary stroke centre, Austria | To test the effectiveness of a 24/7 DSP vs. SLP dysphagia assessment on rate of pneumonia, time to dysphagia screening and LOS | | 384 Ischemic stroke patients. Mean Age 72.3±13.7. Mean NIHSS 3. 37.5% Dysphagic patients. AF and HT not recorded | |
| Perry and McLaren (2000) | Quasi experimental design, acute hospital, UK | Evaluate the impact of implementing evidenced based guidelines on dysphagia screening, assessment and patient outcomes | | 400 Acute stroke patients. Mean age (SD) Pre test group 73.4 (12.6)/71.6 (13.3) Post test group. Median NIHSS Pre test group 7 (IQR 5-12)/Post test group 8 (IQR 4-13). % Dysphagia 43.1% post-test vs. 41.6% pre test. AF and HT not recorded | |
| Smithard et al. (1996) | Prospective observational, hospital based, UK | Relationship between dysphagia and mortality, functional outcome, LOS, place of discharge, occurrence of chest infection, nutritional status, and hydration. | | 121 Acute stroke patients. Median age 79 (range, 40-93). NIHSS not reported. 50% Dysphagic patients. % AF and % HT not recorded. | |
| EDS - Early Dysphagia Screening, LOS - Length of stay, SAP - Stroke Associated Pneumonia, NIHSS - National Institutes of Health Stroke Scale, AF - Atrial Fibrillation, HT - Hypertension, IQR - Inter Quartile Range, CI - Confidence Intervals | | | | | |
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**Online Table IV – Type, time of dysphagia screen protocol (DSP), assessment and management, and association with SAP**

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| **Study** | **DSP Protocol** | **Time of screen** | **Specialist Swallowing assessment and management** | **Time of specialist assessment** | **Association between SAP** |
| Al-Khaled et al. (2016) | Water and/or thickened apple juice, swallowing and cough provocation test on admission before feeding or administration or oral drugs, by nurses or treating physician. | 55, 39, 4.7 and 1.5% of patients screened within 3, 3 to <24, 24 to ≤ 72, and >72h following admission. | If dysphagia suspected swallow therapists repeated screen and possibly performed further dysphagia tests (not specified). Types of management: initial feeding and administration of drugs via peripheral or/central venous catheter or NGT. | Not reported | EDS ≤ 24h of admission was associated with decreased risk of SAP during hospitalisation (OR 0.68; 95% CI 0.52-0.89;p=0.006) |
| Arnold et al. (2016) | GUSS by physiotherapists. Oral feeding withheld until intact swallow was demonstrated. | Within 24h after admission | VFS or FEES performed if patients had a GUSS score of <5 points in part 1 on the judgement of treating therapist and physician. < 10 points patients had a NGT. | Not reported | Not reported |
| Bray et al. (2017) | Bedside swallowing screen test by a trained clinician. No information on DSP used. | Median time 2.9h from admission (IQR 1.3-5.7 h). | Comprehensive assessment by SLP. | Median time 22.9 h from admission (IQR 6.2-49.4 h) | Patients with the longest delays in screening (4th quartile) aOR 1.14 (95% CI 1.03 to 1.24, p=0.008) and SLP assessment (4th quartile) aOR 2.01 (95% CI 1.76 to 2.30, p=<0.0001) had a higher risk of SAP |
| Hinchley et al. (2005) | Formal DSP defined as a checklist of previous and current risk factors of aspiration followed by a water challenge such as Burke water swallow test or a variant developed de novo by site. | DSPs performed before oral intake in 61% (95% CI, 50-72) and the range at individual sites was 22 to 100%. Unable to abstract at what point screen was performed. | Further evaluation by SLP (or similarly trained professional) if abnormalities observed. 22% had a SLP perform either a bedside or formal examination. Types of management: modified diet, NBM. | Not reported | Formal dysphagia screen decreased the odds of SAP 3-fold with unadjusted OR 0.11 (0.03 to 0.48) |
| Hoffmeister et al. (2013) | Simple valid bedside test before receiving any food, fluids or medication. Name of DSP and who administered it not specified. | Within 48h of admission. | Not reported | Not reported | No association between dysphagia screening and SAP aOR 1.58 (95% CI 0.60-4.15), p=0.36) |
| Joundi et al. (2017) | Screening could include informal bedside testing by healthcare providers or formal/standardised dysphagia screening tests (e.g., TOR-BSST) | 80.8% received documented screening ≤ 72h from admission. | SLP consultation. Management included: NBM, tube placement. | Not reported | Patients who failed dysphagia screening were more likely to develop pneumonia vs. those that passed aOR 4.71 (95% CI 3.43-6.47). Patient who failed were also more likely to develop aspiration pneumonia aOR 6.5 (95% CI 4.2-9.9) |
| Maeshima et al. (2014) | Repetitive saliva swallow test (RSST) and modified water swallow test described as Bedside Swallowing Assessment. | 1.7 ± 1.7 days from stroke onset. | In cases of abnormal BSA contrast radiography was performed. SLPs and clinical nurses undertook direct and indirect strategies and compensatory swallowing methods. | Not reported | Patients with an abnormal BSA was associated with SAP but not significantly OR 2.65 (95% CI .90-9.72; p=.0774) |
| Odderson et al. (1995) | Formal DSP before oral intake comprising of check list of risk factors, observation of swallow with ice chips and sips of water, followed by puree diet with thin or thick liquids. Diet advanced as appropriate. Undertaken by a SLP or a certified nurse. | Within 24h of admission. | Swallow evaluation completed by a SLP if the patient did not meet safe criteria for swallowing. Management included: swallowing precautions established and food texture defined. | Day 1 for initial screen and followed daily. | Not reported |
| Odderson and McKenna (1993) | NBM until SLP or certified nurse screens for swallowing dysfunction on Day 1. Name of screen not specified. | Within 24h of admission | Management included alternative nutritional support. | SLP swallow assessment on Day 2. Day 5 decision made regarding the need for alternative nutritional support such as percutaneous gastronomy tube (PEG). | Not reported. |
| Palli et al. (2017) | GUSS by nurses | Median 7h (range, 1-69) (intervention group) | SLP dysphagia assessment | Median 20 (range, 1–183) hours (Control group) | Lower rate of pneumonia 3.8% (intervention) vs. 11.6% (control group); p=0.004 |
| Perry and McLaren (2000) | Range of screening methods: gag, gag + drink water, drink water, standardised swallow assessment, criteria unknown. In post test group SSA most commonest method but SSA not specified. Baseline screening was exclusively a medical responsibility; after implementation of the guideline this was shared with ward-based nurses. | Within 24h after admission. 74.5% screened ≤ 24h in post test group vs. 57.3% pre test, p<0.001. | Full clinical assessment.  Management included: NBM, nutritional support, modified diets. | 39% Pre test group ≤ 72 h of admission vs. 56% post test group, p< 0.058. | Not reported |
| Smithard et al. (1996) | Author's own validated standardised bedside assessment of swallowing undertaken by a physician. Multi item tool with water swallow test. | Days 0 to 3 and on day 7. | VFS. Management included parenteral fluids. | When possible the physician performed the bedside assessment within 24h of VFS. | Aspiration as demonstrated on VF was not associated with an increased incidence of chest infection. |
| NGT (Nasogastric Tube), GUSS (Gugging Swallow Screen), DSP (Dysphagia Screening Protocol), NBM (Nil by Mouth), SLP (Speech and Language Pathologist), SSA (Standardised Swallow Assessment), TOR-BSST (Toronto Bedside Swallowing Screening Test), IQR (Inter quartile range), VFS (Videofluroscopy), FEES (FibreOptic Evaluation of Swallowing) | | | | | |

**Online Table V – Diagnosis, reporting and incidence of SAP**

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| **Study** | **Diagnosis and reporting of SAP** | **Incidence of SAP** |
| Al-Khaled et al. (2016) | Combination of clinical presentations, radiologic signs detected on CXR, and blood test result. Pneumonia reported during hospitalisation (mean 9 days) | 10.2% (N=1271); 95% CI 9.7-10.8 overall. 29.7% (N=917) dysphagia patients vs. 3.7%(337) non dysphagia patients (p<0.001). |
| Arnold et al. (2016) | CDC criteria. During hospitalisation. Total LOS for dysphagia patients 7.9 ±4.8 days vs. 7.2 ±4.4 days for non dysphagic patients | 6% overall.  22.9% (N=27) dysphagia patients vs. 1.1% (N=5) non dysphagia patients (p<0.001).  35.1% dysphagia tube fed patients vs. 17.3% dysphagia non tube fed (p=0.035). |
| Bray et al. (2017) | Antibiotics for a new clinical diagnosis of SAP 7 days from admission | 8.7% (N=5533) overall.  14.6% (N=3592) dysphagia patients referred for comprehensive assessment. |
| Hinchley et al. (2005) | CDC Criteria. During hospitalisation. Median LOS in patients who developed pneumonia was 14 days vs. 5 days in those without pneumonia (p<0.0001) | 4.7% overall. 5.7% in patients screened for dysphagia vs. 2.3% in patients who were not (p<0.0001). 5.4% in sites with a formal dysphagia screening protocol vs 2.4% in sites with no formal written protocol (p=0.0016). |
| Hoffmeister et al. (2013) | Documented by a physician, and requiring abx. During hospitalisation. No data provided on LOS. | 23.6% overall (95% CI 20.4-27.2) |
| Joundi et al. (2017) | Pneumonia confirmed radiologically with 30 days of hospitalisation. | 13.1% (N=322) in patients who failed a dysphagia screen vs. 1.9% (N=52) in patients who passed. |
| Maeshima et al. (2014) | CDC criteria. ≤ 72 hours admission and ≥ 72 hours admission | 17.8% overall (N=52/292).  17.8% in patients with an abnormal initial BSA vs. 4.8% in patients with normal BSA.  26.9% (N=14) developed SAP ≤ 72 h of admission, 53.8% (N=28) developed SAP > 72 h of admission with no oral intake capacity, and 19.2% (N=10) developed SAP >72 h with oral intake capacity. |
| Odderson et al. (1995) | No information on diagnosis of (aspiration) pneumonia. During hospitalisation. | No patients developed aspiration pneumonia. |
| Odderson and McKenna (1993) | No information on diagnosis of (aspiration) pneumonia. During hospitalisation. | 4.1% overall vs. 6.7% in previous yr (pre pathway). |
| Palli et al. (2017) | PIECES SAP diagnostic criteria. During hospitalisation. Intervention group 8 days, range, 2–40 versus Control group 9, range, 1–61 days. | 3.8% (N=7) Intervention Group vs. 11.6% (N=23) Control Group (p=0.004). |
| Perry and McLaren (2000) | Clinically identified and accompanied by > 2 clinical signs, abnormal chest, productive cough with prescription of Abx. During hospitalisation. 29.5 (30.3) days post vs. 29.9 (30.2) pre test. | 35% (N=27) Pre test dysphagia patients vs. 15% (N=11) Post test dysphagia patients, P<0.005.  4% (N=4) Pre test non dysphagia vs. 2% (N=2) Post test non dysphagia. |
| Smithard et al. (1996) | 2>: tachycardia, inspiratory crackles, bronchial breathing, and use of Abx from days 0 to 7. CXR performed on day of admission and at day 7. 7 days post admission | BSA 33% (N=20) in dysphagia patients using vs. 16% (N=9) non dysphagic patients, p<.05 |

Online Figure I - Percentage of patients diagnosed with SAP

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| **Study** | **Sample Size** | **% diagnosed with SAP (95% CI)** | | **Random effects weights** | **% diagnosed with SAP, random effects, 95% CI** |
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| Al-Khaled et al. 2016 | 12276 | 10.35 | (9.81, 10.89) | 14.3% |
| Arnold et al. 2016 | 570 | 5.61 | (3.72, 7.5) | 13.0% |
| Bray et al. 2017 | 63650 | 8.69 | (8.47, 8.91) | 14.4% |
| Hinchley et al. 2005 | 2532 | 4.70 | (3.88, 5.52) | 14.1% |
| Hoffmeister et al. 2013 | 677 | 24.67 | (21.42, 27.91) | 11.0% |
| Maeshima et al. 2014 | 292 | 17.81 | (13.42, 22.2) | 9.2% |
| Odderson and McKenna 1993 | 121 | 4.13 | (0.59, 7.68) | 10.6% |
| Odderson et al. 1995 | 124 | 0.00 | (0, 2.42) | 13.4% |
| **Total** | **80242** | **9.03** | **(6.8, 11.26)** | **100.0%** |
| Random effects model: I2 = 81.9% ; Q = 38.63 df = 7 (P > 0.001) | | | | |

**Online Table VI – Quality Appraisal**

**Al-Khaled et al. (2016)**

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| CASP Cohort Checklist - Section (A) Are the results of the study valid? | (1) Did the study address a clearly focused issue?  (2) Was the cohort recruited in an acceptable way? (Risk of selection bias)  (3) Was the exposure accurately measured to minimise bias? (risk of measurement or classification bias)  (4) Was the outcome accurately measured to minimise bias?  (5a.) Have the authors identified all important confounding factors?  (5b.) Have they taken account of the confounding factors in the design and/or analysis?  (6a.) Was the follow up of subjects complete enough?  (6b.) Was the follow up of subjects long enough? | Yes - To investigate Early Dysphagia Screening (EDS) within <24h admission with incidence of SAP, mortality and disability in acute ischemic stroke patients  Yes - Cohort of patients were representative of a defined population. Baseline characteristics clearly defined. Data was collective prospectively as part of a registry based study.  Partially - Not all patients underwent a dysphagia screen. Groups were people who were screened and those who were not. Can't tell if the dysphagia screen was validated.  Yes - SAP was measured using combination of subjective/objective measurements: clinical presentation, radiologic signs/CXR and blood test results. The measurement was the same in patients with dysphagia and without dysphagia  Yes - The authors attempted to control documentation and data collection procedures. Baseline characteristics were comprehensively reported for the different groups analysed.  Partial - Study design excluded patients with haemorrhagic stroke, which has potential to exclude patients with more severe neurological deficits/severe dysphagia. Logistic regression was carried out to estimate ORs. Adjusted ORs were not performed.  Yes.  Yes for the purposes of SAP. |
| Section (B) What are the results? | (7) What are the results of the study?  (8) How precise are the results?  (9) Do you believe the results? | See Table IV, V  Results appear precise and are statistically significant.  Yes with acknowledgement of potential for confounding factors listed and additionally potential for impact of other confounding factors e.g. nil by mouth status, alternative feeding, mouth care. |
| Section C - Will the results help locally? | (10) Can the results be applied to the local population?  (11) Do the results of this study fit with other available evidence?  (12) What are the implications of this study for practice? | Yes - the subjects studied and standardised stroke care is not sufficiently different form the local population. The study design was appropriate to answer the question.  Yes – Supports recent findings by Bray et al. [28].  Supports EDS of acute stroke patients. Potential for later screening dependent on conscious status. |

**Arnold et al. (2016)**

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| CASP Cohort Checklist - Section (A) Are the results of the study valid? | (1) Did the study address a clearly focused issue?  (2) Was the cohort recruited in an acceptable way? (Risk of selection bias)  (3) Was the exposure accurately measured to minimise bias? (risk of measurement or classification bias)  (4) Was the outcome accurately measured to minimise bias?  (5a.) Have the authors identified all important confounding factors?  (5b.) Have they taken account of the confounding factors in the design and/or analysis?  (6a.) Was the follow up of subjects complete enough?  (6b.) Was the follow up of subjects long enough? | Yes – Incidence of dysphagia in stroke patients and to compare clinical outcomes including occurrence of pneumonia.  Yes - Cohort of patients were representative of a defined population. Baseline characteristics clearly defined. Data was prospectively collected from consecutive patients admitted as part of a registry based study.  Yes – All patients were assessed with a validated screen. Further objective assessment performed dependent on outcome of screen.  Yes – SAP diagnosed according to CDC criteria.  Yes – Stratified for age, baseline NIHSS score, sex, infarct location, diabetes and smoking.  Yes – Influence of potential predictors on outcomes evaluated using univariate logistic regression analysis. Multivariate logistic regression analysis.  Yes  Yes – for the purpose of in-hospital pneumonia. |
| Section (B) What are the results? | (7) What are the results of the study?  (8) How precise are the results?    (9) Do you believe the results? | See Table IV, V  Comparison of incidence of pneumonia between groups is statistically significant. Confidence intervals not given.  Yes. |
| Section C - Will the results help locally? | (10) Can the results be applied to the local population?  (11) Do the results of this study fit with other available evidence?  (12) What are the implications of this study for practice? | Yes - the subjects studied and standardised stroke care is not sufficiently different form the local population. The study design was appropriate to answer the question.  Yes – Consistent with other studies that have found increased risk of SAP in patients with dysphagia. Low incidence of dysphagia reported compared to other studies.  Support further research into dysphagia management in acute stroke and other factors, which may potentially impact on SAP. Authors found weak association with incidence of pneumonia and tube insertion. |

**Bray et al. (2017)**

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| CASP Cohort Checklist - Section (A) Are the results of the study valid? | (1) Did the study address a clearly focused issue?  (2) Was the cohort recruited in an acceptable way? (Risk of selection bias)  (3) Was the exposure accurately measured to minimise bias? (risk of measurement or classification bias)  (4) Was the outcome accurately measured to minimise bias?  (5a.) Have the authors identified all important confounding factors?  (5b.) Have they taken account of the confounding factors in the design and/or analysis?  (6a.) Was the follow up of subjects complete enough?  (6b.) Was the follow up of subjects long enough? | Yes – Association between delays in dysphagia screening and SLP ax and incidence of SAP < 7 days after admission.  Yes - Cohort of patients were representative of a defined population. Baseline characteristics clearly defined. Data was prospectively collected from consecutive patients admitted as part of a registry based study.  Partial – DSP was not specified but unsurprising given registry based study. Screen/comprehensive SLP ax subjective and likely variation, acknowledged by author and requiring further research.  Yes – SAP based on judgment of clinician and administration of Abx in 7 days.  Yes  Yes – Multilevel multivariable logistic regression models to account for age, sex. stroke sub type, pre stroke functional level, place of stroke, vascular morbidity, and either NIHSS or level of consciousness. Sensitivity analysis to explore confounding effect of level of consciousness.  Yes  Yes – for the purpose of SAP. |
| Section (B) What are the results? | (7) What are the results of the study?  (8) How precise are the results?    (9) Do you believe the results? | See Table IV, V  Results are precise and statistically significant.  Yes. |
| Section C - Will the results help locally? | (10) Can the results be applied to the local population?  (11) Do the results of this study fit with other available evidence?  (12) What are the implications of this study for practice? | Yes - the subjects studied are part of national England/Wales registry and are representative. The study design was appropriate to answer the question.  Yes –Results provide direct evidence for dysphagia screening and assessment after stroke to support guidelines.  Results imply dysphagia screening and SLP assessment is effective in reducing risk of SAP and a dose relationship between delays in SLP ax and risk of SAP. |

**Hinchey at al. (2005)**

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| CASP Cohort Checklist - Section (A) Are the results of the study valid? | (1) Did the study address a clearly focused issue?  (2) Was the cohort recruited in an acceptable way? (Risk of selection bias)  (3) Was the exposure accurately measured to minimise bias? (risk of measurement or classification bias)  (4) Was the outcome accurately measured to minimise bias?  (5a.) Have the authors identified all important confounding factors?  (5b.) Have they taken account of the confounding factors in the design and/or analysis?  (6a.) Was the follow up of subjects complete enough?  (6b.) Was the follow up of subjects long enough? | Yes – Adherence rates to dysphagia screening before oral intake and prevalence of pneumonia.  Yes - Data was prospectively collected from consecutive patients admitted as part of a registry based study. Cohort of patients were part of a group randomised, controlled, multicentre trial. Discrepancies in age and race between two groups but could not be proved that this impacted on pneumonia rates.  Can’t tell – Type of dysphagia screen listed but risk of measurement bias due to study sites modifying protocols invalidating any testing for validity or reliability.  Yes – SAP diagnosed according to CDC criteria.  Yes – Reliability of reporting, sampling bias, and capture rates. Dysphagia screen and type of dysphagia screen was documented in 96% of cases.  Yes – Logistic regression models used to assess degree of association between type of dysphagia screen and NIHSS score on adherence and pneumonia rates. ORs used to describe magnitude or a unit increase in an independent variable and the odds of pneumonia.  Yes  Yes – for the purpose of in hospital pneumonia. |
| Section (B) What are the results? | (7) What are the results of the study?  (8) How precise are the results?    (9) Do you believe the results? | See Table IV, V  Odds ratios are unadjusted. Confidence intervals appear precise. Difference in pneumonia rates at sites with a DSP vs. no DSP was statistically significant.  Yes. |
| Section C - Will the results help locally? | (10) Can the results be applied to the local population?  (11) Do the results of this study fit with other available evidence?  (12) What are the implications of this study for practice? | Yes - the results indicate increased adherence rates of dysphagia screening and decreased pneumonia rates where a formal DSP is in place.  Yes – Support existing guidance that patients should be screened for dysphagia with a validated screen.  Formal DSP should be in place and all patients should be screened not just those identified “at risk”. |

**Hoffmeister et al. (2013)**

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| CASP Cohort Checklist - Section (A) Are the results of the study valid? | (1) Did the study address a clearly focused issue?  (2) Was the cohort recruited in an acceptable way? (Risk of selection bias)  (3) Was the exposure accurately measured to minimise bias? (risk of measurement or classification bias)  (4) Was the outcome accurately measured to minimise bias?  (5a.) Have the authors identified all important confounding factors?  (5b.) Have they taken account of the confounding factors in the design and/or analysis?  (6a.) Was the follow up of subjects complete enough?  (6b.) Was the follow up of subjects long enough? | Yes – Adherence rates to performance measures/indicators of pneumonia.  Can’t tell – Medical notes from selected hospitals were retrospectively reviewed. All patients with a diagnosis of ischemic stroke were included.  Can’t tell – Name of DSP not specified.  Yes – Documented by a physician, and requiring abx.  Yes – Reliability of reporting, selection bias.  Yes – Power analysis. Data extracted by independent and external researchers. Blind audit of 10% of data collection. Inter rata reliability was analysed using the Kappa statistic. Stratified random sampling.  No – dysphagia screening was only carried out in 12% of patients.  Yes – for the purpose of in hospital pneumonia. |
| Section (B) What are the results? | (7) What are the results of the study?  (8) How precise are the results?    (9) Do you believe the results? | See Table IV, V  Results of no association between dysphagia screening and pneumonia are not statistically significant confidence interval crosses line of no effect.  Dysphagia screening could not be evaluated in the multivariable model due to low numbers screened. |
| Section C - Will the results help locally? | (10) Can the results be applied to the local population?  (11) Do the results of this study fit with other available evidence?  (12) What are the implications of this study for practice? | Can’t tell  Pneumonia rate is very high and adherence to dysphagia screening is low.  Dysphagia screening influences the incidence of pneumonia. |

**Joundi et al. (2017)**

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| CASP Cohort Checklist - Section (A) Are the results of the study valid? | (1) Did the study address a clearly focused issue?  (2) Was the cohort recruited in an acceptable way? (Risk of selection bias)  (3) Was the exposure accurately measured to minimise bias? (risk of measurement or classification bias)  (4) Was the outcome accurately measured to minimise bias?  (5a.) Have the authors identified all important confounding factors?  (5b.) Have they taken account of the confounding factors in the design and/or analysis?  (6a.) Was the follow up of subjects complete enough?  (6b.) Was the follow up of subjects long enough? | Yes - Predictors of receiving documented dysphagia screen and pneumonia outcome after failing a screen  Yes – Consecutive patients from stroke registry  Yes – 80.8% of patients eligible patients underwent a dysphagia screen.  Yes - Pneumonia confirmed radiologically with 30 days of hospitalisation  Yes – baseline and confounding variable clearly identified.  Yes – Baseline characteristics in patients with and without screening were compared. Multiple logistic regression analysis. Stratified sampling.  Yes  Yes - Potentially too long re SAP definition. |
| Section (B) What are the results? | (7) What are the results of the study?  (8) How precise are the results?    (9) Do you believe the results? | See Table IV, V  Results are precise and statistically significant.  Yes |
| Section C - Will the results help locally? | (10) Can the results be applied to the local population?  (11) Do the results of this study fit with other available evidence?  (12) What are the implications of this study for practice? | Yes  Yes  Reinforces recommendations for universal screening. |

**Maeshima et al. (2014)**

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| CASP Cohort Checklist - Section (A) Are the results of the study valid? | (1) Did the study address a clearly focused issue?  (2) Was the cohort recruited in an acceptable way? (Risk of selection bias)  (3) Was the exposure accurately measured to minimise bias? (risk of measurement or classification bias)  (4) Was the outcome accurately measured to minimise bias?  (5a.) Have the authors identified all important confounding factors?  (5b.) Have they taken account of the confounding factors in the design and/or analysis?  (6a.) Was the follow up of subjects complete enough?  (6b.) Was the follow up of subjects long enough? | Yes – Factors determining onset and development of SAP in patients with acute stroke and which affect patient outcome.  Can't tell. Unclear if consecutive referrals. Does not give information over what period patients recruited.  Can't tell if BSA is validated. All patients were exposed to BSA.  Yes - SAP was diagnosed according to CDC criteria. Can't tell if study clinician team were blinded to outcome of bedside swallow ax.  Patient characteristics (NIHSS not recorded) described but not adjusted for baseline characteristics.  Multivariate analysis was used to examine associate between dysphagia and pneumonia. Significance set at <0.05.  Yes  Yes for Early-onset pneumonia. |
| Section (B) What are the results? | (7) What are the results of the study?  (8) How precise are the results?    (9) Do you believe the results? | See Table IV, V  Results are not significant for abnormal BSA and association with SAP. Confidence interval crosses line of no effect and is imprecise.  Can’t tell |
| Section C - Will the results help locally? | (10) Can the results be applied to the local population?  (11) Do the results of this study fit with other available evidence?  (12) What are the implications of this study for practice? | Yes  Yes – High proportion of patients experience SAP< 72 hrs of admission.  Indicate DSP useful tool for detecting potential onset of SAP. |

**Odderson et al. (1993)**

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| CASP Cohort Checklist - Section (A) Are the results of the study valid? | (1) Did the study address a clearly focused issue?  (2) Was the cohort recruited in an acceptable way? (Risk of selection bias)  (3) Was the exposure accurately measured to minimise bias? (risk of measurement or classification bias)  (4) Was the outcome accurately measured to minimise bias?  (5a.) Have the authors identified all important confounding factors?  (5b.) Have they taken account of the confounding factors in the design and/or analysis?  (6a.) Was the follow up of subjects complete enough?  (6b.) Was the follow up of subjects long enough? | Yes – Effects of swallow management on a clinical pathway and to evaluate whether swallow function on admission can predict occurrence of aspiration pneumonia.  Yes – All patients over 12 month period.  Can't tell if DSP or swallow evaluation is validated. All patients had a screen.  Can’t tell - No information on diagnosis of (aspiration) pneumonia.  Can’t tell. Patient characteristics not described.  Partially – Chi-squared test to assess differences for patients with/without dysphagia. Significance set at <0.05.  Yes  Yes for in hospital pneumonia. |
| Section (B) What are the results? | (7) What are the results of the study?  (8) How precise are the results?    (9) Do you believe the results? | See Table IV, V  No patients developed aspiration pneumonia.  Yes. |
| Section C - Will the results help locally? | (10) Can the results be applied to the local population?  (11) Do the results of this study fit with other available evidence?  (12) What are the implications of this study for practice? | Yes  Yes  Demonstrate importance of an initial swallow screen and management. |

**Odderson et al. (1993)**

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| CASP Cohort Checklist - Section (A) Are the results of the study valid? | (1) Did the study address a clearly focused issue?  (2) Was the cohort recruited in an acceptable way? (Risk of selection bias)  (3) Was the exposure accurately measured to minimise bias? (risk of measurement or classification bias)  (4) Was the outcome accurately measured to minimise bias?  (5a.) Have the authors identified all important confounding factors?  (5b.) Have they taken account of the confounding factors in the design and/or analysis?  (6a.) Was the follow up of subjects complete enough?  (6b.) Was the follow up of subjects long enough? | Yes – To improve and standardise quality of care by developing a clinical pathway to prevent aspiration pneumonia.  Yes – All patients over 12 month period.  Can't tell if DSP is validated. All patients had a screen.  Can’t tell - No information on diagnosis of (aspiration) pneumonia.  Can’t tell. Patient characteristics not described.  Partially – Statistical analysis performed for differences between groups. Significance set at <0.05.  Yes  Yes for in hospital pneumonia. |
| Section (B) What are the results? | (7) What are the results of the study?  (8) How precise are the results?    (9) Do you believe the results? | See Table IV, V  Due to low numbers results are not statistically significant. numbers.  Yes. |
| Section C - Will the results help locally? | (10) Can the results be applied to the local population?  (11) Do the results of this study fit with other available evidence?  (12) What are the implications of this study for practice? | Yes  Yes – initial swallow assessment before oral intake may reduce rate of aspiration pneumonia.  Implementation of stroke pathway with immediate application of rehabilitation can positively affect incidence of pneumonia. |

**Smithard et al. (1999)**

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| CASP Cohort Checklist - Section (A) Are the results of the study valid? | (1) Did the study address a clearly focused issue?  (2) Was the cohort recruited in an acceptable way? (Risk of selection bias)  (3) Was the exposure accurately measured to minimise bias? (risk of measurement or classification bias)  (4) Was the outcome accurately measured to minimise bias?  (5a.) Have the authors identified all important confounding factors?  (5b.) Have they taken account of the confounding factors in the design and/or analysis?  (6a.) Was the follow up of subjects complete enough?  (6b.) Was the follow up of subjects long enough? | Yes – To determine whether dysphagia is related to development pneumonia after stroke using bedside and videofluroscopy.  Yes – All patients over 12 month period.  Yes – authors stated their BSA has been validated. Physicians performing BSA were blinded to results of VFS.  Yes - 2> clinical signs, use of Abx from days 0 to 7, and CXR day of admission and at day 7.  Can’t tell. Patient characteristics not described.  Multiple regression and multiple logistic regression analyses were performed after adjustment of other factors (not described). Significance set at <0.05.  Data regarding chest infection were incomplete in four subjects.  Yes for SAP. |
| Section (B) What are the results? | (7) What are the results of the study?  (8) How precise are the results?    (9) Do you believe the results? | See Table IV, V  Confidence Intervals not given. Results are statistically significant.  Yes. |
| Section C - Will the results help locally? | (10) Can the results be applied to the local population?  (11) Do the results of this study fit with other available evidence?  (12) What are the implications of this study for practice? | Yes  Yes – Period post stroke when patients are susceptible to chest infections.  Usefulness in identifying aspiration on VF during acute phase stroke may be limited. |

**Palli et al. (2017)**

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| NIH National Heart, Lung, and Blood Institute Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group – Quality Rating - Fair | (1) Was the study question or objective clearly stated? | Yes - Evaluation of effectiveness of a 24/7 screening intervention by nursing staff over SLP swallow ax |
|  | (2) Were the eligibility/selection for the study population pre specified and clearly defined? | Yes - Patients admitted with a diagnosis of ischemic stroke |
|  | (3) Were the participants in the study representative of those who would be eligible for the intervention in clinical population of interest | Yes – But only include patients with acute ischemic stroke. |
|  | (4) Were all eligible participants that met the pre specified entry criteria enrolled? | Yes - As far as I can tell. |
|  | (5) Was the sample provided sufficiently large to provide confidence in the findings? | Can’t determine - Power calculation not specified |
|  | (6) Was the intervention clearly described**?** | Yes - GUSS |
|  | (7) Were the outcome measures pre specified? | Yes - Time to dysphagia screen and pneumonia rate. |
|  | (8) Were the people assessing the outcomes blinded to the participant’s interventions? | Can’t determine |
|  | (9) Was the loss to follow up after baselines 20% or less? | NR |
|  | (10) Did the statistical methods examine changes in outcome measures from before to after the intervention? Were statistical tests done that provided p values for the pre-to-post test changes | Yes – P=001 time to dysphagia screening, P= 0.004 rate of pneumonia |
|  | (11) Were the outcome measures of interest taken multiple times before the intervention and multiple times after the intervention (i.e. did they use an interrupted time-series design)? | No |
|  | (12) If the intervention was conducted at a group level - did the statistical analysis take into account the use of individual level data to determine effects at a group level? | Yes – Group were compared. |

**Perry and McLaren (2000)**

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| NIH National Heart, Lung, and Blood Institute Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group – Quality Rating - Fair | (1) Was the study question or objective clearly stated? | Yes - Evaluation of impact of implementing guidelines on dysphagia screening, assessment and patient outcomes. |
|  | (2) Were the eligibility/selection for the study population pre specified and clearly defined? | Yes - Patients admitted with a diagnosis of ischemic stroke |
|  | (3) Were the participants in the study representative of those who would be eligible for the intervention in clinical population of interest | Yes – Clinical diagnosis of acute stroke (ICD 10 codes 160-164) |
|  | (4) Were all eligible participants that met the pre specified entry criteria enrolled? | Yes - As far as I can tell. |
|  | (5) Was the sample provided sufficiently large to provide confidence in the findings? | Can’t determine - Power calculation not specified |
|  | (6) Was the intervention clearly described**?** | Yes – Standardised Swallow Assessment (SSA), although SLP assessment not described. |
|  | (7) Were the outcome measures pre specified? | Yes – Adherence to guidelines for dysphagia screening, referral and assessment, and pneumonia. |
|  | (8) Were the people assessing the outcomes blinded to the participant’s interventions? | Can’t determine |
|  | (9) Was the loss to follow up after baselines 20% or less? | NR |
|  | (10) Did the statistical methods examine changes in outcome measures from before to after the intervention? Were statistical tests done that provided p values for the pre-to-post test changes | Yes – P=<005 incidence of chest infections |
|  | (11) Were the outcome measures of interest taken multiple times before the intervention and multiple times after the intervention (i.e. did they use an interrupted time-series design)? | No |
|  | (12) If the intervention was conducted at a group level - did the statistical analysis take into account the use of individual level data to determine effects at a group level? | Yes – Group were compared. |