

# Dysphagia After Stroke

## Incidence, Diagnosis, and Pulmonary Complications

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**Objective**—To determine the incidence of dysphagia and associated pulmonary compromise in stroke patients through a systematic review of the published literature.

**Methods**—Databases were searched (1966 through May 2005) using terms “cerebrovascular disorders,” “deglutition disorders,” and limited to “humans” for original articles addressing the frequency of dysphagia or pneumonia. Data sources included Medline, Embase, Pascal, relevant Internet addresses, and extensive hand searching of bibliographies of identified articles. Selected articles were reviewed for quality, diagnostic methods, and patient characteristics. Comparisons were made of reported dysphagia and pneumonia frequencies. The relative risks (RRs) of developing pneumonia were calculated in patients with dysphagia and confirmed aspiration.

**Results**—Of the 277 sources identified, 104 were original, peer-reviewed articles that focused on adult stroke patients with dysphagia. Of these, 24 articles met inclusion criteria and were evaluated. The reported incidence of dysphagia was lowest using cursory screening techniques (37% to 45%), higher using clinical testing (51% to 55%), and highest using instrumental testing (64% to 78%). Dysphagia tends to be lower after hemispheric stroke and remains prominent in the rehabilitation brain stem stroke. There is increased risk for pneumonia in patients with dysphagia (RR, 3.17; 95% CI, 2.07, 4.87) and an even greater risk in patients with aspiration (RR, 11.56; 95% CI, 3.36, 39.77).

**Conclusions**—The high incidence for dysphagia and pneumonia is a consistent finding with stroke patients. The pneumonia risk is greatest in stroke patients with aspiration. These findings will be valuable in the design of future dysphagia research. (*Stroke*. 2005;36:2756-2763.)

**Key Words:** dysphagia ■ epidemiology ■ outcomes ■ risk factors

Dysphagia is a commonly documented morbidity after stroke, but its reported frequencies are widely discrepant, ranging between 19%<sup>1</sup> and 81%.<sup>2</sup> The presence of dysphagia has been associated with an increased risk for pulmonary complications<sup>3</sup> and even mortality.<sup>4</sup> There is emerging evidence that early detection of dysphagia in patients with acute stroke reduces not only these complications but also reduces length of hospital stay and overall healthcare expenditures.<sup>5</sup> An accurate estimate of the incidence of dysphagia and its increased risk for pulmonary consequences in the stroke population will be critical to guide the design of future research aiming to assess benefits of dysphagia interventions.

Cerebral, cerebellar, or brain stem strokes can impair swallowing physiology. Cerebral lesions can interrupt voluntary control of mastication and bolus transport during the oral phase.<sup>6,7</sup> Cortical lesions involving the precentral gyrus may produce contralateral impairment in facial, lip, and tongue

motor control, and contralateral compromise in pharyngeal peristalsis.<sup>8</sup> Cerebral lesions causing impairments in cognitive function such as concentration or selective attention may also impair control of swallowing.<sup>9</sup> Brain stem strokes are less common than cortical lesions but result in the largest swallowing compromise. Brain stem lesions can affect sensation of the mouth, tongue, and cheek, timing in the trigger of the pharyngeal swallow, laryngeal elevation, glottic closure, and cricopharyngeal relaxation.<sup>8,10</sup> Regardless of lesion location, because stroke is more common in the elderly,<sup>11</sup> normal age-related swallowing could further compound stroke-related dysphagia. The elderly poststroke patient might no longer be able to compensate for normal changes in skeletal muscle strength that reduce mastication<sup>12</sup> or diminish lingual pressure.<sup>13</sup> Therefore, single or multiple aspects of the swallow may be impaired depending on stroke type and patient age.

The presence of dysphagia is identified using 1 of 3 types of diagnostic techniques. An initial screening test is com-

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monly administered to a newly admitted stroke patient, which serves to identify the likely presence or absence of dysphagia.<sup>5</sup> This procedure is a cursory examination and therefore can be administered and interpreted with only basic clinical swallowing training. If the presence of dysphagia is suspected, a more comprehensive test is administered at bedside by a more extensively trained swallowing clinician.<sup>14</sup> This examination includes a cranial nerve assessment and swallowing trials using a variety of texture-modified liquids and solids.<sup>15</sup> Results from the clinical examination may indicate the need for further testing with instrumentation. The most common instrumental test assessing swallowing function is videofluoroscopy.<sup>16</sup> During the videofluoroscopic assessment of swallowing (VFS), the patient is placed in the sitting position and radiopaque materials of different liquid and food textures are presented. The VFS clearly shows the swallow physiology from the lips to the esophagus, thereby capturing even minor abnormalities in movement or frank aspiration.<sup>17</sup> Of these 3 diagnostic techniques, the VFS is the only technique that can visualize the entire swallow and, as a result, is often used as the gold standard by which the accuracy of the other techniques is compared.

In this systematic review of the published literature, we report on the frequency of dysphagia in the adult stroke patient and estimate the accompanying increased risk for pneumonia. Additionally, we examine how variations in study design, patient characteristics, and stroke type influence the reported dysphagia incidence rate.

## Methods

The primary condition of interest was “oropharyngeal dysphagia,” defined by abnormal swallowing physiology of the upper aerodigestive tract and as detected from clinician testing including screening, clinical bedside, or instrumental tests. Aspiration was defined to be a sign of dysphagia. Our premise was that dysphagic patients with aspiration have more severe dysphagia than dysphagic patients without aspiration. The primary outcome of interest was “pneumonia,” defined by abnormal lung status detected from clinical testing.

## Data Sources

An extensive search of peer-reviewed abstracts published from 1966 through May 2005 was conducted using multiple databases (Medline, Embase, Cochrane Database of Systematic Reviews, Mantis, Pascal, and Sci Search), the terms “deglutition disorders” and “cerebrovascular disorders,” and limited to “human” articles. To reduce investigator selection bias, all relevant search terms were defined a priori. Bibliographies of abstracted references and recent volumes of related journals (ie, *Dysphagia*, *Archives of Physical Medicine and Rehabilitation*, and *Stroke*) were manually searched. Relevant Internet addresses were also searched, such as the Agency for Health Care Policy and Research, Effective Stroke Care, Joint Commission on Accreditation of Healthcare Organizations, and the National Library of Medicine. Also included were additional articles known to the authors but not identified in the search.

## Inclusions/Exclusions

Only original research articles evaluating the swallowing ability of consecutively enrolled adult (ie,  $\geq 18$  years of age) patients with stroke treated in acute, rehabilitation, or chronic facilities and regardless of stroke type or location were included. Retrospective and prospective studies were included. The review was also restricted to articles that reported the incidence of dysphagia using clearly described method(s). If the incidence of pneumonia was reported, the criteria by which it was defined had to be reported.

Studies that enrolled patients after swallowing screening or referral to speech language pathology for swallowing assessment were considered to have a higher likelihood for dysphagia and were therefore excluded. Also excluded were editorials, review articles, and case series, including original reports that profiled  $<10$  patients. Patient-reported symptoms of dysphagia and pneumonia were not considered accurate or reliable and were excluded. Non-English articles were translated using standardized software and native speakers. Where necessary, authors were contacted to clarify ambiguities in study methods or data interpretation.

## Data Abstraction and Analysis

Two authors (R.M. and N.F.) independently reviewed all the accepted articles for study methodology and data extraction. Any differences were resolved by consensus. Every selected article was appraised for design strengths and flaws according to the criteria established by Sackett et al.<sup>18</sup> Overall, poorly designed studies were considered less persuasive and were rated lower than well-designed prospective studies. Proper methodology was considered to include blinding and documented reliability of diagnostic interpretations, along with proper accounting of all patients eligible and enrolled.

The incidence of dysphagia was compared between or within studies according to the evaluation method (ie, initial screening, or clinical or instrumental assessment) and according to recovery continuum (ie, acute or rehabilitation). Incidence was defined as the first identification of dysphagia from clinician testing. Any further follow-up identification in the same patients was not within the scope of this study. Likewise, pneumonia incidence was defined as the first identification from clinician testing. The software Review Manager (RevMan) 4.2<sup>19</sup> was used to calculate the relative risk (RR) and 95% CI of developing pneumonia associated with dysphagia and aspiration after stroke. A random-effects model, which produces wider and more conservative CIs, was chosen. Because the risk for pneumonia was expected to positively correlate with dysphagia severity, separate analyses were conducted to assess the pneumonia risk among all patients with dysphagia and only those with more severe dysphagia identified on the basis of confirmed aspiration. The RR of developing pneumonia was considered to be statistically significant if the 95% CI did not include one.

## Results

### Literature Retrieved

A total of 277 citations addressing swallowing and stroke patients were identified (Figure 1). Of these, 91 were eliminated because they were reviews, editorials, or nonpeer-reviewed publications, for a total of 186 original abstracts for review. Of these, 82 were eliminated because they were case series of  $<10$  patients, not all adult patients, or dysphagia was not a measured outcome. The articles of the remaining 104 citations were reviewed. Of these, 68 were eliminated because they included patients with known dysphagia or those referred for assessment because of suspected dysphagia. An additional 12 articles were eliminated: 5<sup>11,20–23</sup> had limited raw data for dysphagia or pneumonia; 2<sup>24,25</sup> reported only patient dysphagia symptoms; 3<sup>26–28</sup> used chart review without specifying clinician testing; and 2<sup>7,29</sup> repeated incidence data from another selected study. A total of 24 articles were accepted for review.

### Methodological Quality and Characteristics of Included Studies

All 24 studies had consecutive enrollment of patients, 22 of which were prospective<sup>1,2,4,30–48</sup> and 2 retrospective.<sup>49,50</sup> Generally, data were complete for all enrolled patients with 2 exceptions.<sup>41,47</sup> Of all 24 studies, only 1 study<sup>34</sup>

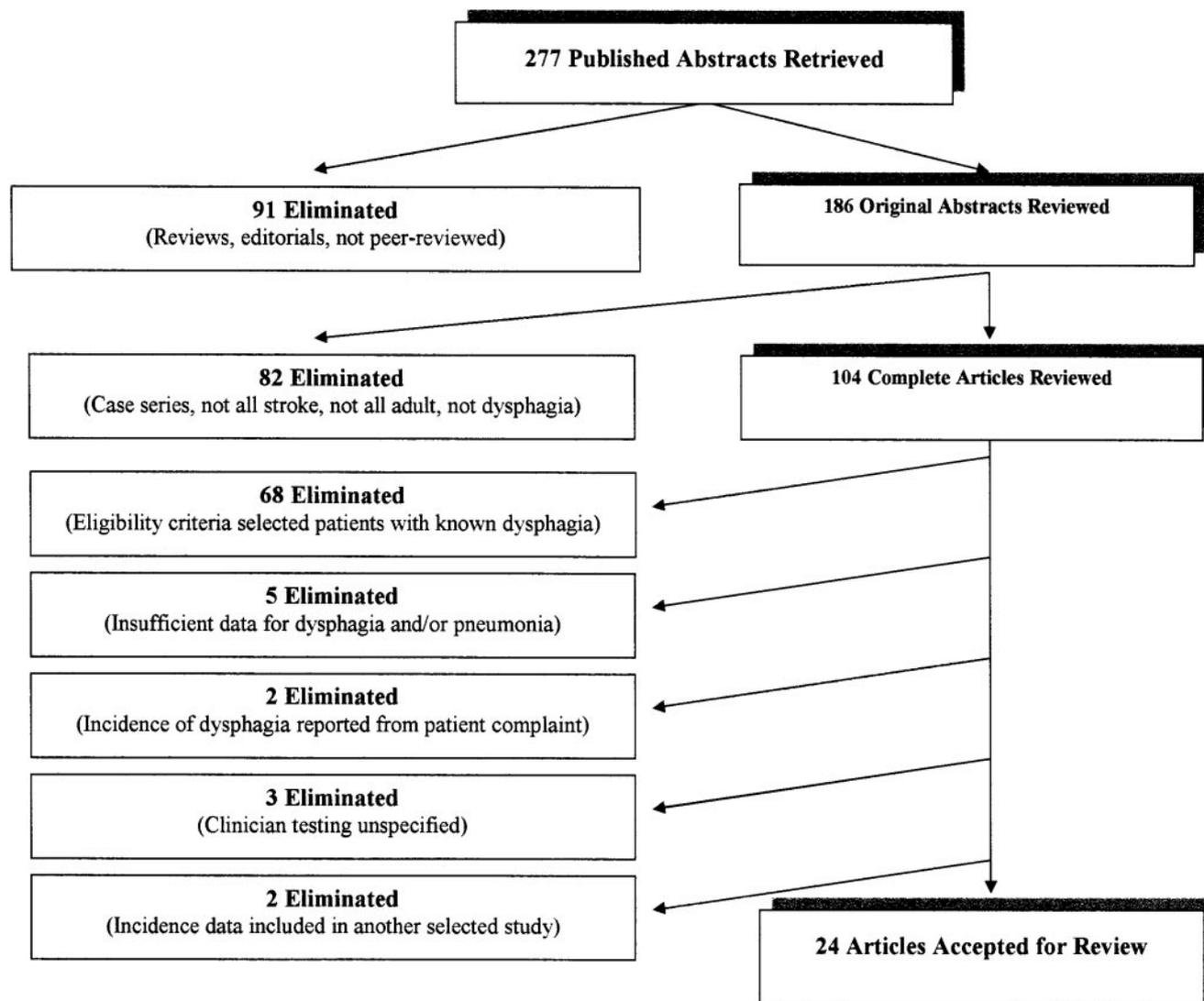


Figure 1. Data sources retrieved.

reported investigator reliability of diagnostic interpretations, and 6 studies<sup>30,34,35,37,38,44</sup> declared blinding for outcome assessments. The characteristics of enrolled patients varied among selected studies. Half (12 of 24) of the studies included patients with mixed acute ischemic strokes. The exceptions were the following: 3 studies<sup>1,36,37</sup> enrolled patients with acute single hemispheric strokes; 3 studies<sup>2,49,50</sup> enrolled rehabilitation brain stem strokes; 2 studies<sup>41,43</sup> enrolled rehabilitation mixed ischemic strokes; 1 study<sup>38</sup> enrolled acute brain stem stroke; and 1 study<sup>4</sup> enrolled acute ischemic and hemorrhagic strokes. Two studies<sup>32,33</sup> did not declare stroke type characteristics. Seventeen studies limited enrollment to only conscious patients, whereas 4 studies<sup>4,30,42,48</sup> included patients who were obtunded. Of these, 3 studies<sup>30,42,48</sup> provided the number of obtunded dysphagic patients. If known, obtunded patients were excluded from the calculations. Our premise was that obtunded patients would naturally not be able to swallow; therefore, by eliminating them, a more conservative estimate of dysphagia was possible.

## Incidence of Dysphagia After Stroke

### Studies Using Swallowing Screening Tests

Nine of the selected articles used screening tests (Table 1). All but 1 study<sup>32</sup> used a water swallowing technique to identify the presence of dysphagia. Across studies, there were differences in the administration and interpretation of the swallowing test. Two studies<sup>41,42</sup> defined a positive screening result with choking or coughing while drinking; 1 study<sup>31</sup> added the element of a wet vocal quality immediately after drinking; 1 study<sup>45</sup> extended the monitoring for choking or wet vocal quality to 5 minutes after water intake; and 1 study<sup>30</sup> monitored choking or wet vocal quality immediately after drinking but added the variables of swallowing volume and drinking time.

The acute study by Barer et al<sup>1</sup> reported the lowest incidence of dysphagia. This study likely under-reported dysphagia events because it restricted enrollment to patients who were able to swallow pills and did not, by definition, have a severe dysphagia. Two other studies<sup>30,45</sup> reported the highest incidence of dysphagia. The study by Lim et al<sup>45</sup>

TABLE 1. Frequency of Dysphagia Among Studies Using Screening

Study	n	Eligibility Criteria	Stroke Type (mean age)	Screening Evaluation	How Scored	Time of First Screening	Dysphagia Outcome % of Patients (n/N)
Barer <sup>1</sup>	357	Consecutive; conscious; able to take oral medications; acute stroke	Single hemisphere (median 70 years)	Drink 10 mL mouthful of water from a cup	Dichotomous (collapsed from 3-point scale)	Within 48 hours	29% (105/357)
DePippo et al <sup>41</sup>	139	Consecutive; rehab stroke	Mixed (71±10 years)	Drink 3 oz of water without coughing	Dichotomous	Mean 5±3 weeks	45% (62/139)
Gordon et al <sup>42</sup>	91	Consecutive; acute stroke (12 eliminated because obtunded)	Mixed (median 70 years)	Drink 50 mL of water without choking	Dichotomous	Within 13 days	37% (29/79)
Gottlieb et al <sup>43</sup>	180	Consecutive; rehab stroke	Mixed (74±8 years)	Drink 50 mL of water without coughing	Dichotomous	Mean 14±7 days	25% (45/180)
Hinds et al <sup>30</sup>	115	Consecutive; acute stroke (22 eliminated because obtunded)	Mixed (74.9±12.3 years)	Drink 150 mL of water without coughing or wet-hoarse voice and with established volumes	Dichotomous	Within 72 hours	67% (62/93)
Kidd et al <sup>31</sup>	60	Consecutive; conscious; acute stroke	Mixed (72±9.5 years)	Drink 10×5 mL aliquots without coughing or wet-hoarse voice	Dichotomous	Within 24 hours	42% (25/60)
Lim et al <sup>45</sup>	50	Consecutive; conscious; acute stroke	n/a* (67.5±11.73)	Drink 5×10 mL aliquots without coughing or wet-hoarse voice	Dichotomous	Mean 5±3.6 days	56% (28/50)
Odderson et al <sup>32</sup>	124	Consecutive; nonhemorrhagic acute stroke	n/a (75.2±1.5)	Swallowing screen protocol	Dichotomous	Within 24 hours	39% (48/124)
Wade et al <sup>33</sup>	452	Consecutive; conscious; acute stroke	n/a†	Drink water from a cup	Dichotomous	Within 7 days	43% (194/452)

\*Stroke type data not available; †stroke type and age data not available.

monitored for screening failure for up to 5 minutes after water intake, thereby increasing the likelihood of detecting failure. Likewise, the study by Hinds et al<sup>30</sup> increased its likelihood for detecting failure by adding the elements of swallowing speed and drinking volume. Despite these 2 outliers, there were 5 other studies that reported similar incidence rates ranging between 37% and 45%. Four of these studies enrolled acute stroke patients,<sup>31–33,42</sup> and 1 study enrolled rehabilitation patients.<sup>41</sup>

#### Studies Using Comprehensive Swallowing Tests

Sixteen of the selected articles estimated dysphagia incidence using more in-depth assessment techniques, such as clinician testing alone,<sup>4,36,39,48,50</sup> videofluoroscopic testing alone,<sup>31,35,38</sup> clinical and videofluoroscopic testing,<sup>2,34,37,40,46,47,49</sup> or endoscopic testing alone<sup>45</sup> (Table 2). Of the 7 studies using clinician and videofluoroscopic assessment,<sup>42,40,47,49</sup> administered videofluoroscopic testing to only those patients suspected to have dysphagia from clinician testing. Instrumental data from these 4 studies did not meet the inclusion criteria for review and was therefore not included in calculations for dysphagia incidence.

Thirteen studies assessed for the incidence of dysphagia. Of these, 10 studies<sup>4,34–37,39,40,46–48</sup> included acute patients, and 3 studies<sup>2,49,50</sup> included rehabilitation patients. The incidence for dysphagia among the acute studies was the

highest (64% to 78%) if testing included videofluoroscopy.<sup>34,35,37,46</sup> In acute studies using only clinician testing, the reported incidence rates ranged from as low as 30% to as high as 55%. Two acute studies<sup>36,39</sup> with low incidence rates restricted enrollment to patients with hemispheric strokes, thereby excluding patients with severe neurological impairment likely to have dysphagia. Four of the remaining acute studies assessing for dysphagia using only clinician testing<sup>4,40,46,47</sup> were similar in study design and patient inclusion and reported almost equivalent dysphagia incidence rates between 51% and 55%. One of these studies<sup>46</sup> scored high for study quality because it implemented rater blinding and detailed diagnostic pass/fail criteria.

The incidence for dysphagia among the 3 rehabilitation studies<sup>2,49,50</sup> ranged widely from 40% to 81%. All 3 studies restricted enrollment to patients with brain stem strokes and tested for dysphagia using only clinician testing. The 2 lower rates were derived retrospectively from chart review data<sup>49,50</sup> and the highest rate from a prospectively designed cohort study.<sup>2</sup> None of these studies incorporated investigator blinding or assessed for stability among diagnostic ratings.

Six of the selected studies reported on the incidence of aspiration in acute strokes: 5 enrolled patients with mixed lesions<sup>31,34,45,46</sup> and 1 with only brain stem lesions.<sup>38</sup> Aspira-

**TABLE 2. Frequency of Dysphagia Among Studies Using Clinical and/or Instrumental Assessments**

Study	n	Eligibility Criteria	Stroke Type (mean age)	Assessments	How Scored	Time of First Assessment	Dysphagia Outcomes* % of Patients (n/N)
Chua et al <sup>50</sup>	53	Consecutive; rehab stroke	Brain stem ischemic and hemorrhagic (57.9+11.9 years)	Clinical	Dysphagia or no dysphagia	n/a†	40% (21/53)
Daniels et al <sup>34</sup>	55	Consecutive; conscious; male; new acute stroke	Mixed (66±11 years)	Clinical; videofluoroscopy	4-point dysphagia scale; aspiration or no aspiration	Within 5 days	Dysphagia: 65% (36/55) aspiration: 38% (21/55)
Daniels et al <sup>35</sup>	54	Consecutive; conscious; male; new acute stroke	Mixed (n/a‡)	Videofluoroscopy	4-point dysphagia scale	Within 5 days	78% (42/54)
Hamdy et al <sup>36</sup>	20	Consecutive; conscious; acute stroke	Single hemisphere (74 years)	Clinical	Dysphagia or no dysphagia	Mean 19 days, range 5–40	40% (8/20)
Hamdy et al <sup>37</sup>	28	Consecutive; conscious; acute stroke	Single hemisphere (67 years)	Clinical; videofluoroscopy	4-point dysphagia scale	Mean 4±2 days	71% (20/28)
Kidd et al <sup>31</sup>	60	Consecutive; conscious acute stroke	Mixed (72±9.5 years)	Videofluoroscopy	Aspiration or no aspiration	Within 72 hours	42% (25/60)
Kim et al <sup>38</sup>	23	Consecutive; conscious acute stroke	Brain stem	Videofluoroscopy	Aspiration or no aspiration	Aspirators: mean 4.9 days; nonaspirators: mean 7.7 days	44% (10/23)
Lim et al <sup>45</sup>	50	Consecutive; conscious; acute stroke	n/a§ (67.5±11.73 years)	Fiberoptic endoscopic examination of swallowing	Aspiration or no aspiration	Mean 6±3.6 days	52% (26/50)
Mann et al <sup>46</sup>	128	Consecutive; conscious; new acute stroke	Mixed (n/a‡)	Clinical; videofluoroscopy	Clinical 4-point dysphagia and aspiration scale; instrumental 5-point dysphagia and aspiration scale	Clinical: median 3 days instrumental: median 10 days	Clinical dysphagia: 51% (65/128) clinical aspiration: 50% (64/128) instrumental dysphagia: 64% (82/128) instrumental aspiration: 22% (28/128)
Meng et al <sup>2</sup>	36	Consecutive; rehab stroke	Brain stem ischemic and hemorrhagic (62.8 years)	Clinical (videofluoroscopy to a subgroup, n=20)	Dysphagia or no dysphagia	Median 20 days	81% (29/36)**
Parker et al <sup>39</sup>	70	Consecutive; conscious; acute stroke	Hemispheric (median split among 3 groups: 71.5, 66, 69 years)	Clinical	Dysphagia or no Dysphagia	Within 72 hours	39% (27/70)
Sala et al <sup>48</sup>	187	Consecutive; acute stroke (17 eliminated because obtunded)	Mixed (73.3±9.5 years)	Clinical	Clinical 4-point Dysphagia scale	Mean 1.14 days	30% (51/170)
Schelp et al <sup>40</sup>	102	Consecutive; conscious; acute stroke	Mixed (62.2 years)	Clinical (videofluoroscopy to subgroup, n=61)	Dysphagia or no Dysphagia	Median 6 days	76% (78/102)**
Sharma et al <sup>4</sup>	202	Consecutive; acute stroke	Mixed ischemic and hemorrhagic (median 73 years)	Clinical	Dysphagia or no Dysphagia	Within 3 days	51% (104/202)‡‡
Smithard et al <sup>47</sup>	121	Consecutive; conscious; acute stroke	n/a (median 79 years)	Clinical (videofluoroscopy to subgroup, n=94)	Dysphagia or no dysphagia	Mean 14 hours, range 0.5–50	51% (61/121)**
Teasell et al <sup>49</sup>	20	Consecutive; conscious; rehab stroke	Brain stem (56 years)	Clinical (videofluoroscopy to subgroup, n=9)	Dysphagia or no dysphagia	n/a	55% (11/20)**

\*All data converted to dichotomous outcome; †assessment time data not available; ‡mean age data not available; §stroke type data not available; \*\*videofluoroscopic testing not administered to all patients therefore not included; ‡‡includes obtunded patients.

tion is considered a severe level of dysphagia, whereby all patients with aspiration have dysphagia, but not all patients with dysphagia aspirate. The incidence for aspiration among the studies with mixed stroke lesions using only instrumental testing<sup>31,45,46</sup> ranged between 22% and 52%. Reported aspiration rates in studies using only clinician testing<sup>46</sup> and clinician and instrumental testing<sup>34</sup> were 50% and 38%, respectively. The 1 study that assessed for aspiration using only videofluoroscopy in acute patients with brain stem lesions reported an incidence of 44%.<sup>38</sup>

### Pneumonia and Dysphagia After Stroke

Nine articles met the criteria for estimating pneumonia incidence, of which only 1 study<sup>50</sup> was retrospective in design (Table 3). Two studies<sup>46,47</sup> reported investigator blinding for the diagnosis of pneumonia. The majority of studies declared an operational definition for the diagnosis of pneumonia; albeit some definitions were vague,<sup>44,48,50</sup> whereas others were more precise and detailed abnormal laboratory values.<sup>41,45–47</sup> Two studies provided no details on how pneumonia was identified beyond stating that clinician testing was required.<sup>42,43</sup>

TABLE 3. Frequency of Pneumonia in Patients With Dysphagia and Patients Without Dysphagia

Study	n	Stroke Type/Setting	Study Design	Blinding	Operational Definition for Pneumonia	Pneumonia Follow-Up	Pneumonia Outcome % of Patients (n/N)
Chua et al <sup>50</sup>	53	Brain stem/rehab	Retrospective	No	Fever associated with focal chest and radiological signs	Hospital stay	Dysphagic: 29% (6/21)
DePippo et al <sup>41</sup>	139	Mixed/rehab	Prospective	No	Chest x-ray or 3 of the following: fever, rales on chest auscultation, drop in arterial P <sub>O</sub> <sub>2</sub> , sputum with leukocytes or respiratory pathogen	Mean 9±5 weeks	Dysphagic: 7% (10/82)* Nondysphagic: 2% (1/57)
Gordon et al <sup>42</sup>	91	Mixed/acute	Prospective	No	Clinical detection of chest infection	Within 1 week	Dysphagic: 19% (7/37)† Nondysphagic: 8% (4/50)
Gottlieb et al <sup>43</sup>	180	Mixed/rehab	Prospective	No	Clinical detection of chest infection	Hospital stay	Dysphagic: 18% (9/50) Nondysphagic: 7% (9/130)
Kidd et al <sup>44</sup>	60	Mixed/acute	Prospective	No	Sputum with crackles on auscultation	Within 14 days	Aspirators: 68% (17/25) Nonaspirators: 6% (2/35)
Lim et al <sup>45</sup>	50	Acute	Prospective	No	Chest x-ray or three of the following: fever, productive cough, tachycardia, positive sputum, clinical signs of chest consolidation	12.7±11.5 days	Aspirators: 19% (5/26) Nonaspirators: 0% (0/24)
Mann et al <sup>46</sup>	128	Mixed/acute	Prospective	Yes	Three of the following: fever, purulent sputum, tachycardia tachypnea, inspiratory crackles, bronchial breathing, abnormal chest x-ray, arterial hypoxemia, positive stain and culture	Within 6 months	Dysphagic: 19% (24/82) Nondysphagic: 2% (2/46)
Smithard et al <sup>47</sup>	121	Acute	Prospective	Yes	Two of the following: tachypnea, inspiratory crackles, bronchial breathing, antibiotics	Within 7 days	Dysphagic: 33% (20/60) Nondysphagic: 16% (9/57)‡
Sala et al <sup>48</sup>	187	Mixed/acute	Prospective	No	Fever with abnormal clinical respiratory signs or chest x-ray	Within 6 months	Dysphagic: 16.2% (11/68) Nondysphagic: 1.7% (2/119)

\*One patient was eliminated from the numerator because the pneumonia status was unclear; †4 patients not included (2 had died; 2 had been discharged); ‡4 patients were eliminated from denominator because dysphagia status was unclear.

Seven studies assessed the incidence of pneumonia in patients with dysphagia. Of these, 4 studies<sup>42,46–48</sup> enrolled acute patients and 3<sup>41,43,50</sup> enrolled rehabilitation patients. Three of the acute studies<sup>42,46,48</sup> reported similar incidence of pneumonia, which ranged between 16% and 19%. The reported pneumonia incidence for the fourth acute study<sup>47</sup> was almost double, at 33%. This baseline pneumonia incidence of the study in the nondysphagic patients was also higher (16% versus 8%, 2%, and 2%), suggesting either a higher level of patient acuity or more aggressive diagnostic follow-up strategy.

The incidence for pneumonia in patients with dysphagia among the 3 rehabilitation studies<sup>41,43,50</sup> ranged widely from 7% to 29%. The highest incidence was reported in the study that enrolled only brain stem stroke patients,<sup>50</sup> a group known to have more severely impaired swallowing physiology. The other 2 rehabilitation studies had similar design and patient characteristics. Of these, the study that defined pneumonia

more conservatively<sup>41</sup> reported a lower pneumonia incidence rate than the study using a more general definition.<sup>43</sup>

The 2 acute studies<sup>44,45</sup> assessing pneumonia incidence in patients with confirmed aspiration reported widely discrepant rates. Similar to other acute studies, the lowest rate was reported in the study<sup>45</sup> using a more conservative definition for pneumonia.

A small number of studies contained sufficient data to enable pooled analyses. The risk of pneumonia was higher among patients with dysphagia compared with patients without dysphagia (RR, 3.17; 95% CI, 2.07, 4.87) and higher still among patients with confirmed aspiration compared with patients without aspiration (RR, 11.56; 95% CI, 3.36, 39.77; Figures 2 and 3).

## Discussion

This systematic review confirms that there is a high incidence of dysphagia after stroke, which is also associated with an

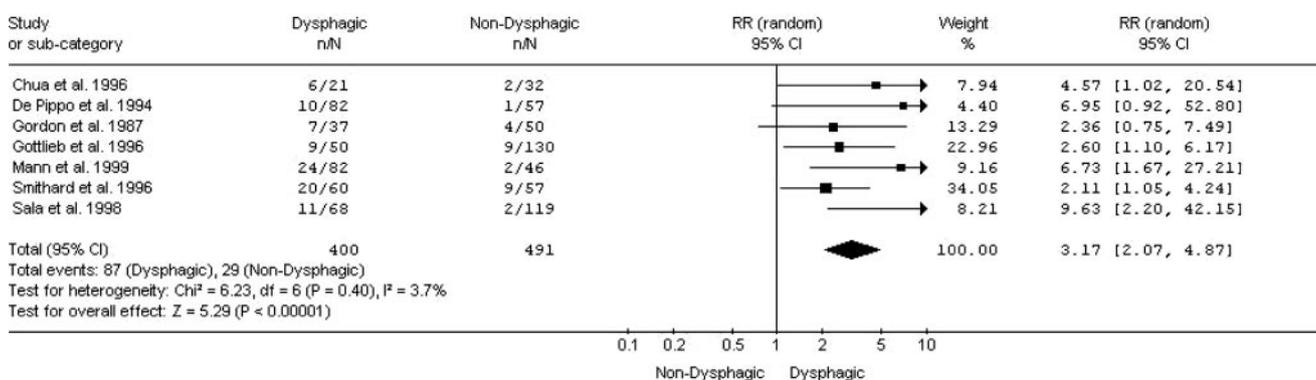


Figure 2. Pneumonia frequency in stroke patients with dysphagia and no dysphagia.

increased risk for pneumonia in adults. Differences in reported dysphagia incidences between studies were attributed to variations in the method of identification, time after stroke, and lesion location. The reported incidence for dysphagia in studies enrolling acute stroke patients regardless of lesion location was lowest with screening identification (37% to 45%), higher with clinical testing (51% to 55%), and highest with instrumental testing (64% to 78%). Instrumental testing is a better technique to visualize biomechanical information not seen with screening methods, thus increasing its likelihood of capturing movement patterns that reflect the effects of aging on the swallowing mechanism but not necessarily swallowing pathophysiology. Unfortunately, the authors of these selected studies did not use definitions for the presence or absence of dysphagia that differentiated the presence of dysphagia from normal aging effects on swallowing. As a result, instrumental testing may have mislabeled these changes as dysphagia, thereby explaining the lower incidence of dysphagia from less specific testing such as screening. Future research is required to develop standardized tools by which to interpret instrumental findings that account for normal aging changes.

Regardless of the identification method, studies enrolling only patients with hemispheric lesions tended to report lower dysphagia incidence (39% to 40%) than those enrolling patients with mixed lesions (51% to 55%). Of the few studies that reported the incidence of dysphagia among rehabilitation stroke patients, all used clinical testing and enrolled only brain stem stroke patients. A direct comparison of the rehabilitation studies with those enrolling acute patients with mixed lesions was therefore not possible. Despite this, the rehabilitation brain stem studies by themselves report a high incidence of dysphagia (between 40% and 80%), confirming

the prominence of this impairment in the recovering brain stem stroke patient.

In this review, we defined dysphagia broadly to capture any impairment in swallowing efficiency and safety, including delays in timing of movements, reduced range of movements, or frank aspiration of food or liquids.<sup>5</sup> Aspiration was defined more specifically as a severe subset of dysphagia and only if confirmed from instrumental assessment. Therefore, by definition, it is not surprising that this review identified rates from instrumental identification that were higher for dysphagia (64% to 78%) than aspiration alone (22% to 50%). In addition, this review assessed the increased risk for pneumonia given the presence of either dysphagia or aspiration. There was a  $\geq 3$ -fold increase in pneumonia risk among stroke patients with dysphagia and an 11-fold increase in risk among a subset of more severely impaired patients with confirmed aspiration, suggesting that these are 2 important predictors for the development of pneumonia.

The small pool of original research articles available for examination and the lack of reporting detail limited the scope of the review. Specifically, there was not sufficient evidence to examine the influence of age, stroke type (ischemic versus hemorrhagic), or stroke severity on the incidence of either dysphagia or pneumonia, although these are known to be important modifiers. Future research assessing the influence of these variables is necessary. Authors of original research need to diligently report on these variables and how they relate to swallowing impairment.

### Conclusions

This review identified the evidence for the high incidence of dysphagia and the increased risk of pneumonia in adult stroke patients. Considering that a variety of therapy techniques are

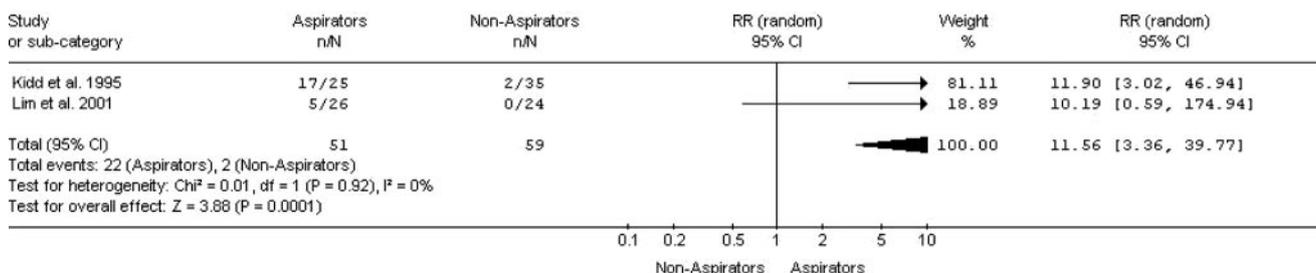


Figure 3. Pneumonia frequency in stroke patients with aspiration and no aspiration.

now emerging aiming to reduce the severity of the dysphagia and its pulmonary complications, the estimates derived in this review will enable the proper design of future research assessing pulmonary benefit from therapeutic dysphagia interventions.

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## Dysphagia After Stroke: Incidence, Diagnosis, and Pulmonary Complications

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