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Special Features

The Incidence of Dysphagia Following Endotracheal Intubation

A Systematic Review

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Hospitalized patients are often at increased risk for oropharyngeal dysphagia following prolonged endotracheal intubation. Although reported incidence can be high, it varies widely. We conducted a systematic review to determine: (1) the incidence of dysphagia following endotracheal intubation, (2) the association between dysphagia and intubation time, and (3) patient characteristics associated with dysphagia. Fourteen electronic databases were searched, using keywords *dysphagia*, *deglutition disorders*, and *intubation*, along with manual searching of journals and grey literature. Two reviewers, blinded to each other, selected and reviewed articles at all stages according to our inclusion criteria: adult participants who underwent intubation and clinical assessment for dysphagia. Exclusion criteria were case series (n < 10), dysphagia determined by patient report, patients with tracheostomies, esophageal dysphagia, and/or diagnoses known to cause dysphagia. Critical appraisal used the Cochrane risk of bias assessment and Grading of Recommendations, Assessment, Development and Evaluation tools. A total of 1,489 citations were identified, of which 288 articles were reviewed and 14 met inclusion criteria. The studies were heterogeneous in design, swallowing assessment, and study outcome; therefore, we present findings descriptively. Dysphagia frequency ranged from 3% to 62% and intubation duration from 124.8 to 346.6 mean hours. The highest dysphagia frequencies (62%, 56%, and 51%) occurred following prolonged intubation and included patients across all diagnostic subtypes. All studies were limited by design and risk of bias. Overall quality of the evidence was very low. This review highlights the poor available evidence for dysphagia following intubation and hence the need for high-quality prospective trials. ***CHEST 2010; 137(3):665–673***

Abbreviations: CSE = clinical swallowing evaluation; FEES = fiberoptic endoscopic evaluation of the swallow; GRADE = Grading of Recommendations, Assessment, Development and Evaluation; VFS = videofluoroscopic swallowing study

Endotracheal intubation and ventilatory support are life-sustaining procedures often required during the course of a patient's hospitalization, but their presence can complicate resumption of oral intake.[1,2] Artificial airways often have negative effects on laryngeal competence and overall swallowing physiology.[1,2] It remains to be determined whether oropharyngeal dysphagia, if present, is attributed to the artificial airway alone or in part to the underlying medical conditions that precipitated its placement. Notwithstanding this uncertainty, patients on prolonged ventilation compose a diagnostic group at increased risk for oropharyngeal dysphagia.[1-4]

Oropharyngeal dysphagia, also referred to as dysphagia or disordered swallowing, is an abnormality of the swallow physiology of the upper aerodigestive tract. It occurs frequently in patients with structural or neurologic disruption to the head and neck area from diseases such as stroke,[5] head and neck cancer,[6] and/or necessary medical treatments, including cervical spine surgery,[7] prolonged intubation,[3,4] tracheotomy,[2,8] and

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mechanical ventilation.[1,2,9] Although dysphagia is itself not a disease but rather a symptom of another medical condition and/or the interventions required to treat the condition, it can lead to a variety of medical complications. Common consequences of dysphagia include dehydration; malnutrition[10,11]; aspiration of

oral secretions,[12] food, or fluid[13,14]; and eventually death.[10] Aspiration often leads to pneumonia.[5,14-17] In fact, the risk of developing pneumonia is 11 times greater in patients who aspirate compared with similar patients with no aspiration.[5]

Although the literature reports a high incidence of dysphagia following intubation, these reports vary widely from 3%[18] to 83%.[1] Studies have also shown that prolonged intubation can be an independent predictor of dysphagia.[19,20] Artificial airways increase the risk of upper airway injury and concomitant laryngeal pathologies,[21-23] which in turn affect upper airway mechanics, aerodynamics, and protective reflexes.[1,2] These laryngeal pathologies include, but are not limited to, epithelial/mucosal abrasions, tracheoesophageal fistula formation, tracheal stenosis, and granulation tissue.[22,23] Multiple ventilation cycles can further exacerbate the dysphagia by disrupting the delicate synchrony between swallowing and breathing, leading to aspiration.[9] Although the cause of dysphagia in these patients is multifactorial and perhaps debatable,[24,25] it is clear from the available literature that artificial airways interfere with the ability to execute an efficient and safe swallow. What is not yet known is how frequently dysphagia occurs and how to avoid its ill effects.

In order to evaluate the available evidence and attempt to resolve these uncertainties, we conducted a systematic review to assess (1) the incidence of dysphagia following intubation across various patient diagnostic groups, (2) the association between dysphagia and the duration of endotracheal intubation, and (3) patient characteristics associated with dysphagia.

Materials and Methods

A detailed protocol directed the various stages of our search and appraisal of the literature on dysphagia and endotracheal intubation.

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Operational Definitions

We operationalized relevant terms *a priori*. *Endotracheal intubation* was defined as the presence of an endotracheal tube in the oropharynx. *Oropharyngeal dysphagia* was defined as any impairment or abnormality of the oral, pharyngeal, or upper esophageal stage of deglutition. The presence of oropharyngeal dysphagia was identified by either a bedside clinical swallow evaluation (CSE) or instrumental assessment, including videofluoroscopic swallow study (VFS) or fiberoptic endoscopic evaluation of the swallow (FEES).

Search Strategy

From the start of online availability to May 2009, we searched for eligible citations in 14 electronic databases (MEDLINE [1950-], EMBASE [1980-], CINAHL [1982-], PsycINFO [1960-], AMED [1985-], HealthSTAR [1966-], BIOSIS Previews [1980-], Cochrane DSR [1988-], ACP Journal Club [1991-], DARE [1991-], CCTR [1991-], CMR [1995-], HTA [2001-], and NHSEED [1995-]) using the search terms *deglutition disorders*, *swallowing disorders*, *dysphagia*, *swallowing*, and *intubation*. In addition, we manually searched for relevant citations in 20 content-related journals between 1988 and May 2009, conference proceedings, and gray/unpublished literature (GrayLIT Network, GraySource, OpenSigle, and Proquest Dissertations). We also reviewed citations from the accepted articles. A complete list of manually searched journals and conference proceedings is available from the authors upon request.

Eligibility Criteria

Of the identified citations, we included only articles with abstracts and those reporting the presence or absence of oropharyngeal dysphagia in adult patients (> 18 years old) who underwent endotracheal intubation during their hospitalization. We accepted retrospective or prospective study designs using only consecutive enrollment, provided that the sample size exceeded 10. We included articles published in any language. Specific to this study, we defined swallowing assessment method to be clinical or instrumental assessment. In order to avoid overestimating dysphagia incidence secondary to endotracheal intubation, we excluded articles with patients at high risk for dysphagia secondary to their primary diagnosis. These included patients with neurogenic or head and neck diagnoses as well as tracheostomized patients. Articles using only patient report to identify dysphagia were also excluded.

Study Selection

The first two authors, blinded to each other's results, reviewed all citations, abstracts, and articles to determine eligibility for inclusion. If the reviewers could not determine inclusion/exclusion based on the abstract alone, the citation was accepted. Articles of all accepted citations were retrieved and reviewed to determine the final studies for inclusion. Disagreements at all stages of the selection process were resolved by consensus.

Assessment of Methodological Quality

The same two reviewers, once again blinded to each other's results, assessed the included studies for risk of bias and quality using the risk of bias assessment tool and the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) approach as recommended by the Cochrane Collaboration.[26] All disagreements were resolved by consensus.

The risk of bias assessment tool[26] included sequence generation, allocation concealment, blinding, consecutive enrollment, and the completeness of outcome reporting. Study quality using the GRADE approach gave the highest rating (high-level evidence) to randomized trials, whereas observational studies were rated as low in quality as suggested by the Cochrane Collaboration.[26] Anticipating a large number of observational studies, we modified the Cochrane quality rating by downgrading in the presence of certain factors, including limitations in study design, indirectness of evidence (eg, indirect population or study's main outcomes), unexplained heterogeneity, or the imprecision of results. Conversely, study quality was upgraded if study design and results suggested little to no evidence of bias.

Data Extraction

One reviewer using a form determined *a priori* extracted data regarding study design, sample size, patient diagnoses, incidence of dysphagia, method of dysphagia assessment, intubation duration, and patient comorbidities. A second reviewer checked all extracted data for accuracy. Because of the heterogeneity of patient diagnoses, study methodology, and outcomes across accepted studies, we summarized the results descriptively. All risk of bias analyses were conducted using the Cochrane Collaboration software program Review Manager (RevMan, version 5.0.20; The Nordic Cochrane Centre; Copenhagen, Denmark). Quality assessment ratings were adapted from GRADEprofiler (GRADEpro, version 3.2.2; available from http://www.gradeworkinggroup.org).

Results

Literature Retrieved

We retrieved 1,489 citations through database and manual searching (Fig 1). Of these, 351 did not have abstracts and were eliminated. We reviewed the remaining 1,138 titles and abstracts. An additional 848 abstracts were eliminated because they were case series with sample sizes of < 10, did not enroll patients consecutively, included pediatric patients, did not report swallowing outcomes, or included patients following tracheotomy. Two articles were not retrievable.[27,28] We retrieved and reviewed the full text articles of the remaining 288 citations. Of these, 14 languages were represented, including English. Following full article review, 274 articles were eliminated because they did not meet our inclusion criteria. Of those, 58 articles used only patient report of dysphagic symptoms, 31 articles included patients with esophageal diagnoses, 27 articles included patients with primary diagnoses of head and neck cancer and/or neurogenic diagnoses (eg, stroke, traumatic brain injury, and neurosurgical patients), and eight articles did not describe their method for assessing the swallow. Other article eliminations included three duplicate publications[29-31] using patients from studies accepted for this review,[3,32] two articles[33,34] with study samples based on only patients referred for suspected dysphagia, and one article[35] that enrolled only patients with confirmed dysphagia. A total of 50 citations (45 articles, and five abstracts) were retrieved from manual searches. Six studies were accepted following manual searching: three articles[18,20,36] from content-related journals, two articles[37,38] from the bibliographic references of accepted studies, and one article[39] from review of gray literature databases. In the end, a total of 14 articles were accepted and underwent further analysis (Table 1). A comprehensive list of articles not accepted for full review is available from the authors on request.

Study Characteristics and Quality Assessment

Of the 14 accepted articles (Table 1), 11 were prospective, including two randomized trials,[40,41] three cohort studies,[4,37,38] one case-control study,[32] and five case series.[3,18,19,36,42] Of the retrospective studies, two articles[20,43] were case series and one article[39] was a cohort design. Patient diagnoses varied across studies. A total of eight studies[18-20,36-38,40,43] enrolled surgical patients, and of these, five articles[18-20,38,43] enrolled cardiovascular surgery patients and the remaining three articles[36,37,40] enrolled patients with mixed surgical diagnoses. Three other studies[4,32,39] enrolled patients with mixed medical diagnoses. An additional three studies[3,41,42] enrolled patients with a variety of both medical and surgical diagnoses.

According to Cochrane methodology,[26] we assessed each study for risk of bias and poor study design to generate a quality GRADE (Table 2). Of the 14 included studies, one study[42] had the lowest risk of bias, with only one area receiving a rating of unclear. Of the three randomized trials, one study[41] had adequate sequence generation and allocation concealment. Only one other study[40] declared blinding. All 14 studies accounted for their outcomes, but only eight specifically declared consecutive enrollment.[3,4,18-20,36,42,43] Outcomes were operationally defined in four studies,[4,20,41,42] whereas only eight studies[3,4,32,37-40,42] conducted the same swallow assessment for all study enrollees. All studies received a high or unclear risk of bias rating in at least one area. Additionally, each study had factors that decreased the quality of the evidence such as insensitive swallowing assessment measures,[32,37,38,40] small sample size of fewer than 50 enrollees,[3,32,37,39,40,42] and different types of swallowing assessment for enrollees.[18-20,36,43] As a result, each study in this review was assigned a GRADE of very low.

Dysphagia Following Endotracheal Intubation

Duration of Intubation and the Frequency Dysphagia: Seven of the included studies[3,4,19,20,41-43] reported mean durations of intubation in those with and without dysphagia (Table 3). Leder and colleagues[42] reported the lengthiest intubation duration in the dysphagic

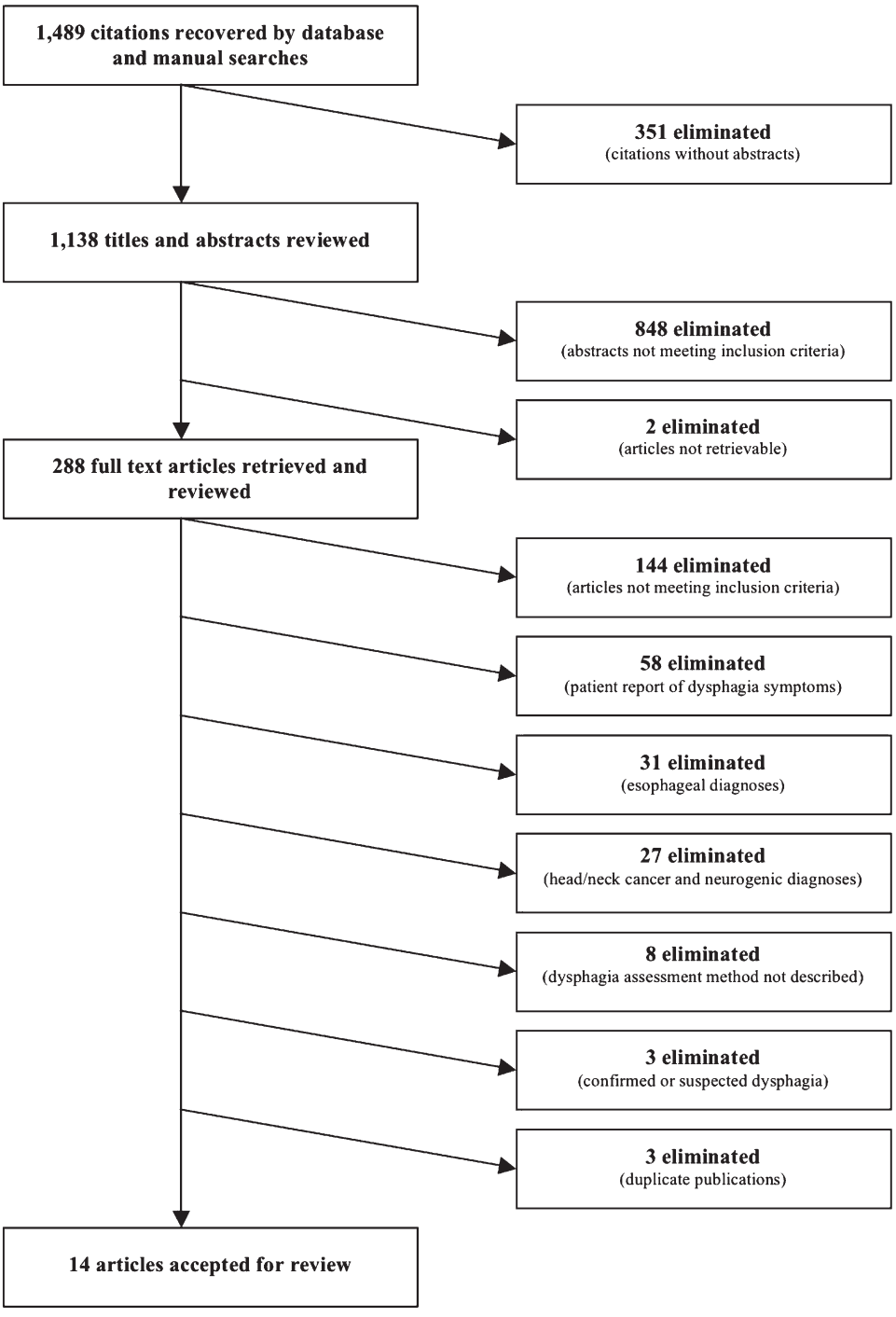

FIGURE 1. Study selection process.

patients (mean, 346.6 ± 298.6 h) with a dysphagia frequency of 45%. Ajemian and colleagues[3] reported the highest dysphagia frequency with a mean intubation duration of 192.0 h in patients with dysphagia. One study[41] reported longer intubation durations in patients without dysphagia (mean, 288.0 ± 235.2 h) compared with those with dysphagia (mean, 254.4 ± 175.2 h). Five of these studies[3,4,20,41,42] included only enrollees with prolonged intubation defined as greater than 48 h.

Swallowing Assessment Methods: The methods used to assess swallowing function were variable. All studies but one[39] used instrumental methods to determine the presence or absence of dysphagia and/or aspiration. Seven studies[3,4,32,37,38,40,42] conducted

Table 1—*Study Characteristics and Frequency of Dysphagia According to Patient Diagnosis*

Study	Study Design	No.[a]	Swallowing Assessment Method	Timing of Assessment Postextubation	Dysphagia Frequency
Surgical, cardiovascular only					
Barker et al[20]	Case series	254	Screening, CSE, and/or VFS	NR	130/254 (51%)
Burgess et al[38]	Cohort	64	Chest radiograph[b]	Immediately to 8 h	13/64 (20%)[c]
Ferraris et al[18]	Case series	1,042	Screening, VFS	NR	31/1,042 (3%)[d]
Hogue et al[19]	Case series	844	Screening, barium cineradiography	NR	28/844 (3%)[d]
Rousou et al[43]	Case series	838	Screening, barium cineradiography	NR	23/838 (3%)[d]
Surgical mixed[e]					
Davis and Cullen[37]	Cohort	26	Chest radiograph[b]	10 and 15 min	9/26 (35%)[c]
Keeling et al[36]	Case series	133	CSE, VFS	Within 48 h	19/133 (14%)[c]
Stanley et al[40]	Randomized	40	Chest radiograph[b]	NR	1/40 (3%)[c]
Mixed medical[f]					
de Larminat et al[32]	Case control	34	Swallow latency measurements	Immediately	21/34 (62%)[g]
El Solh et al[4]	Cohort	84	FEES	Within 48 h	37/84 (44%)[c]
Padovani et al[39]	Cohort	23	CSE	1-5 d	8/23 (35%)
Mixed medical-surgical[h]					
Ajemian et al[3]	Case series	48	FEES	Within 48 h	27/48 (56%)[c]
Barquist et al[41]	Randomized	70	CSE and FEES	48 ± 2 h[i], 24 ± 2 h[j]	7/70 (10%)[c]
Leder et al[42]	Case series	20	FEES	24 ± 2 h	9/20 (45%)[c]

CSE = clinical swallowing evaluation; FEES = fiberoptic endoscopic evaluation of the swallow; NR = not reported; VFS = videofluoroscopic swallowing study.
[a]Includes only patients meeting inclusion criteria for this review.
[b]With administration of oral contrast agent.
[c]Dysphagia defined as aspiration only.
[d]Instrumental assessment conducted with only those patients failing dysphagia screening.
[e]Includes limb arthroplasty, thoracotomy or pulmonary resection, abdominal or vascular surgery.
[f]Includes patients with respiratory illnesses, sepsis, liver failure, and/or other medical illness.
[g]Dysphagia defined as swallowing latency on day 0.
[h]Includes surgical/medical intensive care patients, critically ill trauma, burns, and/or elective surgical patients.
[i]CSE only.
[j]FEES only.

instrumentation on all study enrollees. Three studies[3,4,42] used FEES, three studies[37,38,40] used chest radiography following administration of an oral contrast agent, and one study[32] measured swallowing latency via submental electromyography. Three studies[18,19,43] used VFS or barium cineradiography only on those patients who failed swallowing screening. CSE was the sole method used to assess dysphagia in one study,[39] whereas another study[41] used either CSE or FEES, depending on the arm of their randomized trial.

Table 2—*Risk of Bias and Methodologic Quality Across Studies*

Study	Sequence Generation	Allocation Concealment	Blinding	Consecutive Enrollment	All Outcomes Addressed	Outcomes Operationally Defined	Consistent Assessment for All Enrollees	GRADE Strength
Ajemian et al[3]	N/A	N/A	Unclear	Yes	Yes	Unclear	Yes	Very low
Barker et al[20]	N/A	N/A	Unclear	Yes	Yes	Yes	No	Very low
Barquist et al[41]	Yes	Yes	No	N/A	Yes	Yes	N/A	Very low
Burgess et al[38]	Unclear	Unclear	Unclear	Unclear	Yes	No	Yes	Very low
Davis and Cullen[37]	N/A	N/A	Unclear	Unclear	Yes	No	Yes	Very low
deLarminat et al[32]	N/A	N/A	Unclear	Unclear	Yes	No	Yes	Very low
El Solh et al[4]	N/A	N/A	No	Yes	Yes	Yes	Yes	Very low
Ferraris et al[18]	N/A	N/A	Unclear	Yes	Yes	No	Unclear	Very low
Hogue et al[19]	N/A	N/A	No	Yes	Yes	No	Unclear	Very low
Keeling et al[36]	N/A	N/A	Unclear	Yes	Yes	No	No	Very low
Leder et al[42]	N/A	N/A	Unclear	Yes	Yes	Yes	Yes	Very low
Padovani et al[39]	N/A	N/A	Unclear	Unclear	Yes	No	Yes	Very low
Rousou et al[43]	N/A	N/A	Unclear	Yes	Yes	No	Unclear	Very low
Stanley et al[40]	Unclear	Unclear	Yes	Unclear	Yes	No	Yes	Very low

GRADE = Grading of Recommendations, Assessment, Development and Evaluation; N/A = not applicable.

Table 3—*Intubation Duration According to Presence of Dysphagia*

Study	Targeted Intubation Time, h	Intubation Duration, h (mean ± SD)[a]		Dysphagia Frequency, %
		Dysphagia	No Dysphagia	
Leder et al[42]	> 48	346.6 ± 298.6	283.7 ± 192.0	45
Barquist et al[41]	> 48	254.4 ± 175.2	288.0 ± 235.2	10
Rousou et al[43]	NR	200.9 ± 75.0	15.3 ± 1.6	3
El Solh et al[4,b]	> 48	223.2 ± 156.0	184.8 ± 112.8	36
Ajemian et al[3]	> 48	192.0	184.8	56
El Solh et al[4,c]	> 48	187.2 ± 165.6	148.8 ± 127.2	52
Barker et al[20]	> 48	142.4 ± 63.0	87.1 ± 43.3	51
Hogue et al[19]	NR	124.8 ± 40.8	50.4 ± 4.8	3

See Table 1 for expansion of abbreviation.
[a]Where reported.
[b]Young age cohort (< 65 y old).
[c]Elderly age cohort (> 65 y old).

Across studies, swallowing assessments were conducted at various time periods following extubation. Six studies[3,4,36,41,42] conducted their swallowing assessment between 24 and 48 h following extubation. Studies using chest radiographs[37,38,40] administered oral contrast at various time points with radiographs taken at 2 min,[40] 30 min,[38] and 1 h[37] following the contrast ingestion. The study using electromyography[32] measured swallow latency immediately (day 0), and at 1, 2, and 7 days following extubation. One study[39] assessed swallowing between days 1 and 5 following extubation. For another five studies[18-20,40,43] the timing of swallowing assessment was not reported.

Frequency of Dysphagia Following Intubation: The incidence of dysphagia across studies included in this review ranged widely from 3%[18,19,40,43] to 62%.[32] Those studies reporting the highest dysphagia frequencies,[3,4,20,32,42] between 44% and 62%, had prolonged intubation periods. The three studies[18,19,43] reporting the lowest dysphagia frequency did not report findings from screening and/or CSE and only reported dysphagia in those patients with abnormal VFS or barium cineradiography. One study[20] used either CSE or VFS to determine dysphagia frequency but did not stratify according to assessment method.

Swallowing impairment as an outcome was defined differently across studies, either as any level of dysphagia severity,[18-20,39,43] only aspiration,[3,4,36-38,40-42] or only swallowing latency.[32] Regardless of the definition, the dysphagia frequencies varied widely. Studies reporting on any level of dysphagia severity[18-20,39,43] had frequencies ranging from 3%[18,19,43] to 51%.[20] Those studies reporting only aspiration also had wide-ranging frequencies from 3%[40] to 56%.[3]

Several of the included studies identified patient risk factors, surgical and/or medical, associated with dysphagia (Tables 4 and 5). Some risks were consistently associated with dysphagia, whereas others were consistently not associated (Table 4). In contrast, some studies reported association with several risk factors, whereas others reported no association for the same risk factors (Table 5).

Discussion

This systematic review verifies that reported dysphagia frequency following endotracheal intubation is variable, ranging from 3%[18,19,40,43] to 62%.[32] More than one-half of the studies[3,4,20,32,37-39,42] reported a dysphagia frequency exceeding 20%. The highest dysphagia

Table 4—*Surgical and Medical Risk Factor Association With Dysphagia*

Associated with dysphagia
Congestive heart failure[18,20]
Functional status[4]
Increased hospital LOS[18-20,43]
Hypercholesterolemia[18]
Increased ICU LOS[4,19]
Multiple intubations[20]
Increased operative time[43]
Perioperative TEE[19,43]
Sepsis[20]
Not associated with dysphagia
APACHE scores[4,32]
COPD[3,18-20]
Circulatory shock[18,20]
Elevated CPB time[18,19,43]
GERD[3]
Hypertension[18-20]
ICU readmission[20]
Myocardial infarction[19,20]
NYHA > 2[18,20]
Peripheral vascular disease[18]
Preoperative CVA[18-20]
Smoking[20]
Surgery urgency[20]

APACHE = Acute Physiology and Chronic Health Evaluation; CPB = cardiopulmonary bypass; CVA = cerebral vascular accident; GERD = gastroesophageal reflux disease; LOS = length of stay; NYHA = New York Heart Association staging (heart failure); TEE = transesophageal echocardiography.

Table 5—*Studies Either Supporting or Not Supporting Risks for Dysphagia*

Risk Factors	Association with Dysphagia	
	Supporting	Not Supporting
Age	Barquist et al[41] Ferraris et al[18] Hogue et al[19]	Ajemian et al[3] de Larminat et al[32] Leder et al[42] Rousou et al[43]
Decreased cardiac output	Hogue et al[19]	Ajemian et al [3]
Diabetes mellitus	Ferraris et al[18]	Barker et al[20] Ajemian et al[3] Barker et al[20] Hogue et al[19]
Intubation duration	Barker et al[20] Hogue et al[19] Rousou et al[43]	Ajemian et al[3] Barquist et al[41] de Larminat et al[32] El Solh et al[4] Leder et al[42]
Left ventricle ejection fraction	Rousou et al[43]	Hogue et al[19]
Perioperative CVA	Rousou et al[43]	Barker et al[20] Hogue et al[19]
Postoperative pulmonary complications	Hogue et al[19]	Leder et al[42]
Preoperative/ postoperative IABP	Hogue et al[19,a]	Barker et al[20]
Renal risks	Ferraris et al[18]	Barker et al[20] Hogue et al[19]
Surgery type	Barker et al[20,b] Ferraris et al[18,c]	Hogue et al[19] Rousou et al[43]
Tube feeding	Barker et al[20]	Ajemian et al[3] El Solh et al[4] Leder et al[42]

IABP = intraaortic balloon pump. See Table 4 for expansion of other abbreviations.
[a]Postoperative IABP only.
[b]Coronary artery bypass.
[c]Noncoronary procedures.

frequencies of 62%,[32] 56%,[3] and 51%[20] included patients experiencing prolonged intubation (>24 h) across all diagnostic subtypes, mixed medical, mixed medical-surgical, and cardiovascular surgical groups, respectively. Hence, no single diagnosis appeared to be associated with greater risk of dysphagia. The wide range of dysphagia frequency identified in this review is more likely attributed to variations in study design, such as method and timing of swallowing assessment. Many studies were observational and few declared blinding or operational definitions. Together, design variability and poor quality resulted in studies with a high risk of bias, thereby weakening the available evidence on dysphagia frequency following endotracheal intubation.

Across all studies, poor study quality and high risk of bias likely led to either underreporting or overreporting of dysphagia. Oddly, studies reporting the longest intubation durations did not report the highest dysphagia frequencies.[41-43] However, their large standard deviations,[41,42] coupled with failure to use the same instrumental assessments for all enrollees,[43] seriously question the accuracy of these frequency estimates. In contrast, the three studies reporting the lowest dysphagia frequencies had the largest sample sizes.[18,19,43] We also question the accuracy of these frequency estimates because they appeared to include patients with relatively short intubation durations who consequently were not expected to have dysphagia. Across studies, the timing of swallowing assessments ranged from immediately[32,38] to five days[39] following extubation. In general, one would expect the highest dysphagia frequency in patients with prolonged intubation durations and assessments conducted immediately following extubation. However, due to the poor study quality and variability of the included studies, our findings could not corroborate this premise.

A wide assortment of swallowing assessment methods, including screening, clinical swallowing evaluations, and a variety of instrumental assessments, were included in the accepted studies. Dysphagia frequency varied regardless of assessment type. Although heterogeneity across studies did not permit a statistical association of dysphagia frequency and swallow assessment, studies using FEES on all enrollees reported some of the highest frequencies of dysphagia from 44%[4] to 56%.[3] In contrast, other studies assessing the swallow with static chest radiographs[37,38,40] or clinical measures[39] detected a lower incidence of dysphagia, from 3%[40] to 35%.[37,39] When compared with other swallowing assessment methods, direct visualization of pharyngeal and laryngeal swallowing structures (eg, FEES) may be a more sensitive measure.[44,45]

Studies varied in how swallowing outcomes were defined. More than one-half of the included studies[3,4,36-38,40-42] used aspiration as their main swallowing outcome. Aspiration is only one aspect across the spectrum of swallowing impairments. Although aspiration is considered dysphagia in its most severe form, defining dysphagia as such would limit diagnostic scope and potentially miss other significant swallowing findings. For example, one study[41] reporting a low incidence of dysphagia (10%) also commented on other pharyngeal aspects of the swallow. These findings were reported only qualitatively, thereby explaining, in part, their low reported frequency.

Although we used stringent selection criteria and rigorous methodology while excluding confounding diagnoses for dysphagia, this review is limited by many factors. Most limitations were imposed by the design, quantity, and quality of the original research. The few included studies were heterogeneous, differing in regard to their outcomes, study design, and patient diagnoses. Consequently, instead of combining outcome data with a metaanalysis, we chose to use descriptive methods. We found insufficient evidence to calculate the relative risk of dysphagia

following a range of intubation durations or to determine the effect of intubation duration on the frequency of dysphagia across all studies. We propose that using sensitive swallow assessments on all enrollees, while reporting on all aspects of swallowing function, would best represent the frequency and characteristics of dysphagia following extubation. Future research endeavors should include homogeneous patient populations or larger sample sizes and rigorous methodology. This research is necessary to permit clinicians to identify patients who are at greater risk for dysphagia and enable more appropriate interventions.

In conclusion, there are relatively few studies with specific outcomes that focus on dysphagia following intubation. The majority of identified studies are of very low quality with high risk of bias. Although variable, most studies with prolonged intubation durations and those that conducted instrumental assessments on the entire study population reported higher frequencies of dysphagia. Given the high likelihood of serious medical complications of dysphagia, particularly pneumonia, we recommend that swallowing assessments should be conducted on patients undergoing prolonged intubation durations. In the meantime, we call for high-quality studies using homogeneous patient populations to assess the influence of prolonged intubation on dysphagia and to determine whether select medical comorbidities put patients at greater risk.

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