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ORIGINAL ARTICLES

Postextubation Dysphagia in Pediatric Populations: Incidence, Risk Factors, and Outcomes

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Objective To assess incidence, risk factors for, and impact on outcomes of postextubation dysphagia. We hypothesized that the incidence of postextubation dysphagia in pediatric patients would approximate or exceed that in adults, that age and duration of intubation would increase odds for postextubation dysphagia, and that the presence of postextubation dysphagia would negatively impact patient outcomes.

Study design We performed a retrospective, observational cohort study of patients aged 0-16 years admitted between 2011 and 2017. Patients were included if they were extubated in the intensive care unit and fed orally within 72 hours. Records were reviewed to determine dysphagia status and assess the impact of patient factors on odds of postextubation dysphagia. The impact of postextubation dysphagia on patient outcomes was then assessed.

Results Following application of inclusion and exclusion criteria, the sample size was 372 patients. Postextubation dysphagia was observed in 29% of patients. For every hour of intubation, odds of postextubation dysphagia increased by 1.7% ($P < .0001$). Age of <25 months increased odds of postextubation dysphagia more than 2-fold ($P < .05$). When we controlled for age, diagnosis, number of complex chronic conditions, and dysphagia status, patients with dysphagia had an increase in total length of stay of 10.95 days ($P < .0001$). Postextubation dysphagia increased odds of gastrostomy or nasogastric tube at time of discharge (aOR 22.22, $P < .0001$).

Conclusions This study found that postextubation dysphagia is associated with increased time between extubation and discharge and with odds of gastrostomy or nasogastric tube at time of discharge. *(J Pediatr 2019;■:1-8)*.

See editorial, p ••• and related article, p •••

Postextubation dysphagia is a well-documented phenomenon in adults,[1-23] with estimates ranging from 3% to 62%.[14] Postextubation dysphagia is associated with multiple negative outcomes, including pneumonia, in-hospital mortality, hospital length of stay, discharge status, and need for alternative means of nutrition, including nasogastric and gastrostomy tube placement.[7] Intubation has been shown to be associated with laryngeal injury, oropharyngeal trauma, muscular weakness, loss of sensation, delirium/sedation used in the context of intubation, reflux, and disorganized breathing with swallowing.[6] Each of these has the potential to negatively impact swallowing. Factors associated with increased risk of postextubation dysphagia in adults include duration of intubation, particularly intubation >48 hours, age, and functional status/medical fragility.[1-4,7,10,16,20]

There are considerable differences in swallowing anatomy and physiology between infants, children, and adults, and these differences are likely to be relevant to intubation and its impact on swallow function.[24] Furthermore, because swallowing and feeding are not yet fully developed during infancy and early childhood, any interruption of swallowing and feeding at critical developmental stages can result in significant negative outcomes that include maladaptive oral motor learning and oral aversion.[25]

Despite the potential for postextubation dysphagia to significantly influence health, mortality, and developmental outcomes in infants and children, its systematic investigation has been scarce.[26] Knowledge of the incidence of postextubation dysphagia, characterization of postextubation dysphagia, and the association between postextubation dysphagia and health outcomes in pediatric patients are not yet defined. To address these gaps in knowledge, we designed a retrospective, observational cohort study to describe the incidence of postextubation dysphagia, determine factors that may contribute to postextubation dysphagia, and assess the impact of postextubation dysphagia on patient outcomes in pediatrics. We hypothesized that the incidence of postextubation dysphagia in pediatric patients would approximate or exceed the incidence in adults, age and increased duration of intubation

CCC	Complex chronic conditions
FEES	Fiberoptic endoscopic evaluation of swallowing

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would have a strong association with diagnosis of dysphagia, and that the presence of postextubation dysphagia would have a significant impact on outcomes, including total length of stay and need for non-oral means of nutrition at discharge. To facilitate comparison with postextubation dysphagia literature in adults, subgroups of patients with only neurologic primary diagnoses and non-neurologic diagnoses were analyzed in addition to the full cohort.

Methods

We performed a retrospective, observational cohort study of infants and children to assess the incidence of postextubation dysphagia, contributing factors, and associations between postextubation dysphagia and health outcomes. Three types of documentation were analyzed to define patient characteristics, determine presence of dysphagia, and to describe outcomes. First, clinical flowsheet reports in the electronic medical record of the first feeding following extubation were reviewed. These flowsheets were designed by pediatric nurses and speech-language pathologists and are completed by nursing staff or a speech-language pathologist for every oral intake event. All nursing staff are trained by a clinical nurse specialist or a speech-language pathologist on quality-based feeding assessments and how to complete these flowsheets. Data contained in flowsheets include a quality-based feeding assessment with drop-down menus to describe aspects of feeding, including changes in respiratory status, signs of aspiration (described in Outcome Measures), oral motor coordination, volume of intake, and, for nipple-fed infants, organization with root and latch to the nipple.

There were instances in which flowsheet data were not completed. In these situations, the medical record was reviewed for clinical swallowing evaluations by the speech-language pathologist at the first feeding following extubation, including report of presence and description of signs of aspiration or absence of signs of aspiration. In the rare event that neither clinical flowsheets nor speech-language pathology swallow assessments were completed, nursing shift summaries and nursing notes were reviewed; if they contained documentation of overt signs of aspiration during the first feeding following extubation (explicitly stating that signs of aspiration were observed during the feeding, not separately from feeding), the patient was placed in the dysphagia group. If this was not documented, the patient was placed in the nondysphagia group. This study was approved by the institutional review board at the University of Wisconsin-Madison.

Sample

Patients were included if they were admitted to the American Family Children's Hospital between 2011 and 2017, were aged 0-16 years, were intubated and mechanically ventilated, were subsequently extubated in an intensive care unit at American Family Children's Hospital, and attempted oral feeding within 72 hours of extubation. The inclusion of patients who attempted oral feeding within 72 hours of extubation was performed to isolate the impact of intubation on dysphagia, as those who were not able to attempt oral feeding in the first 72 hours may have developed dysphagia related to factors other than intubation. Patients with a documented history of dysphagia before intubation, those with a history of head and/or neck cancer or head and/or neck surgery or radiation, and those with a history of tracheostomy were excluded. Exclusion criteria were chosen in an attempt to separate dysphagia specific to intubation from pre-existing dysphagia and from dysphagia that may have resulted from nonintubation insults to the swallowing mechanism.

Outcome Measures

The primary outcome measure was presence vs absence of signs of dysphagia at the first feeding following extubation, including feeding-related coughing, choking, wet and gurgling voice and breathing quality, and/or bradycardia with desaturation.[24,27-30] Those demonstrating these common signs of dysphagia were included in the postextubation dysphagia group. To more-precisely quantify the characteristics of patients with postextubation dysphagia, a secondary analysis assessed changing odds for postextubation dysphagia among patient attributes including dichotomized age (0-24 months and 25 or more months), duration of intubation, weight, sex, number of complex chronic conditions (CCC),[31,32] emergent vs planned intubation, and primary diagnosis. Primary diagnosis groups included traumatic brain injury, neurologic or neurosurgical, pulmonary (ie, respiratory syncytial virus bronchiolitis, status asthmaticus, and bronchopulmonary dysplasia), cardiac or cardiothoracic surgery (ie, hypoplastic left heart, tetralogy of Fallot, cardiac arrest), trauma, and systemic or other medical complexity. Factors were chosen for analysis a priori because they have been implicated as risk factors in studies with adults.[1-23] Tertiary analysis examined the effect of postextubation dysphagia on the following patient outcomes: total length of stay, need for gastrostomy or nasogastric tube at discharge, and time between extubation and discharge.

Associated Factors

The following factors and conditions were identified a priori and were analyzed for associations with postextubation dysphagia: sex, age as a continuous variable in months, age as a binary variable (0-24 months and 25 or more months), primary diagnosis, duration of intubation, weight, sex, number of CCC,[31] and emergent vs planned intubation.

Subgroup Analysis

Data analysis was performed on all patients who met criteria, with subsequent analysis performed on subgroups identified a priori including patients with a neurologic condition as primary diagnosis and patients with a non-neurologic condition as primary diagnosis. These subgroups were chosen to facilitate comparison with studies of postextubation dysphagia in the adult literature, which sometimes consider these groups separately.[7,9,14]

Table I. Bivariate analysis of patient characteristics associated with postextubation dysphagia for all patients

Characteristics	Full cohort (n = 372)	Dysphagia (n = 108)	No dysphagia (n = 264)	*P* value
Age, mo (median (IQR)	29 (3.3-129.8)	3.5 (0-128.5)	59.5 (9-132.3)	Mann–Whitney *U*, $P < .001$*
Age (categorical)				χ^2, <.0001*
0-24 mo	181 (48.7%)	71 (65.7%)	110 (41.7%)	
25+ mo	191 (51.3%)	37 (34.3%)	154 (58.3%)	
Sex				χ^2, .3209
Female	149 (40.1%)	39 (36.1%)	110 (41.7%)	
Male	223 (59.9%)	69 (63.9%)	154 (58.3%)	
Emergent intubation				χ^2, .3326
Yes	104 (28%)	34 (31.5%)	70 (26.5%)	
No	268 (72%)	74 (68.5%)	194 (73.5%)	
Primary diagnosis (dysphagia n = 106, no dysphagia n = 261) (%)†				χ^2, .0016*
Traumatic brain injury	29 (7.9%)	7 (6.6%)	22 (8.4%)	
Neurologic (stroke, degenerative, other)	82 (22.3%)	17 (16%)	65 (24.9%)	
Pulmonary	78 (21.3%)	30 (28.3%)	48 (18.4%)	
Systemic or other medical complexity	78 (21.3%)	12 (11.3%)	66 (25.3%)	
Trauma	22 (6%)	9 (8.5%)	13 (5%)	
Cardiac diagnosis or cardiothoracic surgery	78 (21.3%)	31 (29.3%)	47 (18%)	
Weight, kg, median (IQR)	14 (6.1-37.9)	6.2 (4.2-32.2)	17.8 (8.6-40.2)	Mann–Whitney *U*, $P < .001$*
Duration of intubation, h, median (IQR)	25.3 (13.6-72.5)	92.3 (41-129.3)	19.3 (11-34.3)	Mann–Whitney *U*, $P < .001$*

*Significant difference between dysphagia and no dysphagia (alpha = .05).
†Five patients did not have a defined primary diagnosis.

Statistical Analyses

Categorical data (sex, primary diagnosis, age 0-24 vs 25 or more months, presence of postextubation dysphagia, need for emergent intubation) are reported in terms of frequencies and percentages, normally distributed data are presented as mean ± SD, and non-normally distributed data are presented as median and IQR.

Bivariate analysis was performed using the χ^2 test of independence for postextubation dysphagia status and categorical factors, and 2-sample *t* tests to identify continuous variables independently associated with postextubation dysphagia. When data were not normally distributed, Mann–Whitney rank-sum tests were performed. Logistic regression was used to identify factors associated with postextubation dysphagia, including sex, age, dichotomized age, weight, duration of intubation, primary diagnosis, and number of CCC. Logistic regression also was used to assess odds for need of alternative means of nutrition at discharge by postextubation dysphagia status, controlling for number of CCC and dichotomized age. Multiple linear regression was used to assess impact of postextubation dysphagia status on total length of stay and time between extubation and discharge, adjusting for number of CCC, dichotomized age, and primary diagnosis.

Results

After application of inclusion and exclusion criteria, 372 patients were included for analysis; 108 of 372 (29%, 95% CI 24.5%-33.9%) exhibited postextubation dysphagia (Table I). Of the subgroup of patients with a neurologic or neurosurgical primary diagnosis, 17 of 82 (20.7%, 95% CI 12.6%-31.1%) exhibited postextubation dysphagia. Of the subgroup of patients without a neurologic or neurosurgical diagnosis, 89 of 285 (31%, 95% CI 25.9%-37%) exhibited postextubation dysphagia. Of note, 5 patients were excluded from subsequent analysis because no clearly defined primary diagnosis was listed in the electronic medical record.

Characteristics of Patients with Postextubation Dysphagia

Full Cohort. Bivariate analysis of patient characteristics (continuous and dichotomized age, weight, primary diagnosis, duration of intubation, sex, and need for emergent intubation) with postextubation dysphagia was completed for 3 patient cohorts: all patients, those patients with a neurologic or neurosurgical primary diagnosis, and those patients without a neurologic or neurosurgical diagnosis. In analysis of all patients, patients with dysphagia were significantly more likely to be 0-24 months vs 25 months or more (65.7% of patients with dysphagia vs 41.7% of patients without dysphagia were aged 0-24 months, $P < .0001$) and were intubated for a significantly greater amount of time than patients with no dysphagia (92.3. hours vs 19.3 hours, $P < .001$). The categorical variable of primary diagnosis also differed between patients with and without postextubation dysphagia ($P < .01$), with pulmonary, cardiac, and trauma diagnoses representing a greater percentage of patients with postextubation dysphagia than those without. Table I provides additional characteristic outcomes.

Neurologic Cohort. Patients with a neurologic or neurosurgical primary diagnosis with dysphagia had significantly greater number of emergent intubations (47.1% vs 21.5%, $P = .04$) than those without dysphagia and were intubated for a significantly greater time (56.2 hours vs 17.6 hours, $P < .001$). Those with dysphagia did not differ significantly from those without dysphagia in age (58.7 months vs 65.7 months, $P = .73$), weight (22 kg vs 24.8 kg, $P = .67$), or sex (47% female vs 49.1% female, $P = .87$).

Table II. Multivariable logistic regression to assess odds of patient characteristics for postextubation dysphagia for all patients

Characteristics	aOR	P value	95% CI
Age (0-24 mo vs 25+ mo)	2.627	$P = .0218$*	1.151-5.997
Primary diagnosis (compared with systemic or other medical complexity)			
Traumatic brain injury	1.549	$P = .4803$	0.460-5.261
Neurologic (stroke, degenerative, other)	1.317	$P = .5637$	0.517-3.354
Pulmonary	0.858	$P = .7591$	0.323-2.281
Trauma	5.058	$P = .0067$*	1.567-16.321
Cardiac diagnosis or cardiothoracic surgery	2.235	$P = .0859$	0.893-5.596
Weight, kg	1.004	$P = .6703$	0.987-1.021
Duration of intubation, h	1.017	$P < .0001$*	1.012-1.023
CCC (1 or more vs 0)	0.869	$P = .6791$	0.447-1.690

*Significant (alpha = .05).

Non-Neurologic Cohort. Patients without a neurologic or neurosurgical diagnosis and dysphagia were significantly younger (3 months vs 59 months, $P < .001$), had significantly lower weight (6 kg vs 17.5 kg, $P = .001$), and were intubated for a longer period of time (94.4 hours vs 20.6 hours, $P < .001$) than patients with no dysphagia. Primary diagnoses were also significantly different between groups ($P < .01$), with pulmonary (34%), trauma (10%), and cardiac/cardiothoracic surgery (35%) diagnoses being more common in those with dysphagia than those without dysphagia. Those with dysphagia did not differ significantly from those without dysphagia in need for emergent intubation (71.9% vs 71.4%, $P = .93$) or sex (35.8% female vs 39.1% female, $P = .47$).

Risk Factors for Postextubation Dysphagia

Full Cohort. Multivariable logistic regression was used to assess the odds of postextubation dysphagia controlling for age, weight, number of CCC, duration of intubation, and primary diagnosis, described in Table II. When we analyzed all patients, odds of dysphagia increased 2.63 times for patients aged 0-24 months vs patients aged 25 months or older (95% CI 1.2-6, $P = .02$). Odds of dysphagia increased by 5.06 times for patients with a primary diagnosis of trauma vs patients with a primary diagnosis of systemic or other medical complexity (95% CI 1.6-16.3, $P < .01$). No other primary diagnosis resulted in a significant increase in odds of dysphagia. Every hour of intubation resulted in increased odds of dysphagia by 1.7% ($P < .0001$). Weight and number of CCC did not influence odds for postextubation dysphagia. The Figure visualizes the increase in risk of postextubation dysphagia as a function of duration of intubation for 3 patient populations: patients with a trauma diagnosis aged 25 or more months, patients with nonspecific diagnosis aged 0-24 months, and patients with nonspecific systematic diagnosis aged 25 or more months.

Neurologic Cohort. Of patients with a primary neurologic or neurosurgical diagnosis, when we controlled for age, weight, and number of CCC, every hour of intubation was observed to increase odds of dysphagia by 4.7% ($P < .01$). Weight, age, and number of CCC did not influence odds for postextubation dysphagia.

Table III. Multiple linear regression was used to assess the impact of postextubation dysphagia on patient outcomes for all patients

Characteristics	Increase in length of stay, d	Time between extubation and discharge, d
Age 0-24 mo (compared with 25+ mo)	−1.15 d	−1.45 d
P value (95% CI)	$P = .314$ (−3.4 to 1.1)	$P = .16$ (−3.4 to 0.56)
Dysphagia (compared with no dysphagia)	10.95 d	8.65 d
P value (95% CI)	$P < .0001$* (8.7-13.2)	$P < .0001$* (6.6-10.7)
1 or more CCC (compared with none)	1.72 d	0.911 d
P value (95% CI)	$P = .177$ (−0.8 to 4.2)	$P = .425$ (−1.3 to 3.2)
Primary diagnosis (compared with systemic or other medical complexity)		
Traumatic brain injury	2.57 days	2.78 days
P value (95% CI)	$P = .213$ (−1.5 to 6.7)	$P = .13$ (−0.9 to 6.4)
Neurologic	1.05 days	1.57 days
P value (95% CI)	$P = .506$ (−2.1 to 4.2)	$P = .26$ (−1.2 to 4.4)
Pulmonary	1.0 d	−1.04 d
P value (95% CI)	$P = .536$ (−2.2 to 4.2)	$P = .47$ (−3.9 to 1.8)
Trauma	−0.42 d	0.41 d
P value (95% CI)	$P = .857$ (−5.0 to 4.2)	$P = .84$ (−3.7 to 4.5)
Cardiac diagnosis or cardiothoracic surgery	2.09 d	2 d
P value (95% CI)	$P = .22$ (−1.3 to 5.4)	$P = .19$ (−1.0 to 5.0)

*Significant (alpha = .05).

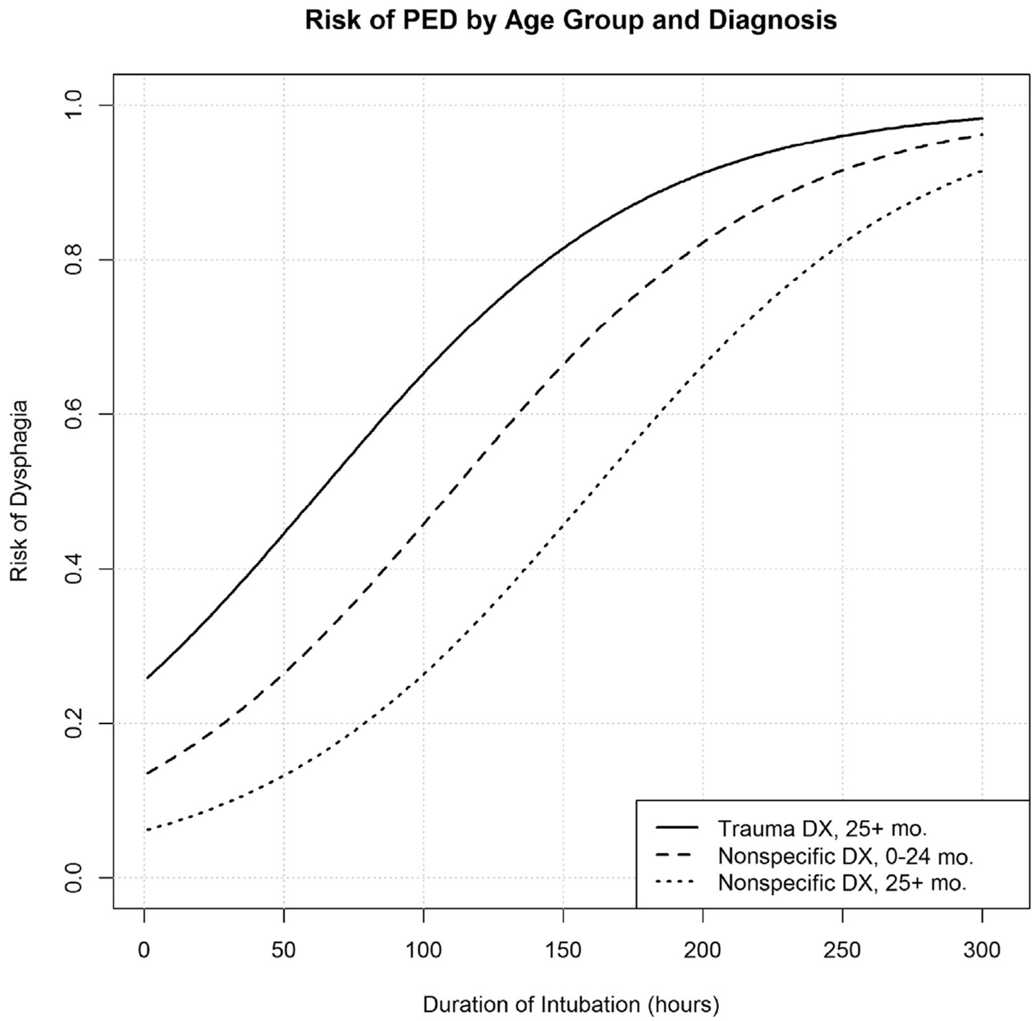

Figure. Presented is the risk of postextubation dysphagia for observed levels of duration of intubation for 3 populations: those aged 0-24 months with a nonspecific diagnosis, those aged 25+ months with a nonspecific diagnosis, and those aged 25+ months with a primary diagnosis of trauma (there were no patients aged 0-24 months with a primary diagnosis of trauma in this study). For each population, risk at 300 hours is nearly 1, indicating a high risk of postextubation dysphagia. *DX*, diagnosis; *PED*, postextubation dysphagia.

Non-Neurologic Cohort. Of patients without a primary neurologic or neurosurgical diagnosis, age of 0-24 months increased odds of dysphagia 2.59 times compared with patients aged 25+ months (P = .04). Primary diagnosis of trauma increased odds of dysphagia 4.87 times compared with primary diagnosis of systemic or other medical complexity (P < .01). Every hour of intubation was observed to increase odds of dysphagia by 1.016% (P < .0001). Weight and number of CCC did not influence odds for postextubation dysphagia.

Postextubation Dysphagia and Patient Outcomes

Full Cohort. Multiple linear regression was used to assess the impact of postextubation dysphagia on patient outcomes of total length of stay and time between extubation and discharge, and logistic regression was used to assess impact of postextubation dysphagia on need for alternative means of nutrition at time of discharge. Analysis of need for alternative means of nutrition for patients with a neurologic or neurosurgical primary diagnosis was not completed because the event count was insufficient for analysis. When we controlled for age, primary diagnosis, number of CCC, and dysphagia status for all patients, postextubation dysphagia was associated with an increase in total length of stay of 10.95 days (P < .0001, 95% CI 8.7-13.2) as well as an increase in time between extubation and discharge of 8.65 days (P < .0001, 95% CI 6.6-10.7) compared with patients without dysphagia. Age, primary diagnosis, and number of CCC did not significantly influence length of stay or time between extubation and discharge (Table III). Presence of dysphagia (OR 22.22, 95% CI 6.4-77.6, P < .0001) and having 1 or more CCC (OR 3.1, 95% CI 1.3-7.6, P = .012) were found to be associated with an increase in odds of need for alternative means of nutrition at time of discharge. Age of

0-24 months vs 25 or more months (OR 2.84, 95% CI .981-8.19, $P > .05$) did not significantly change odds of need for alternative means of nutrition. **Table IV** (available at www.jpeds.com) describes frequency of need for alternative means of nutrition at time of discharge by dysphagia status.

Neurologic Cohort. Of patients with a primary neurologic or neurosurgical diagnosis, when we controlled for age, number of CCC, and dysphagia status, postextubation dysphagia was associated with an increase in total length of stay of 16.7 days (95% CI 11.6-21.9, $P < .0001$) as well as an increase in time between extubation and discharge of 14.6 days (95% CI 9.6-19.6, $P < .0001$). In contrast, age of 0-24 months vs 25 or more months was associated with decreased length of stay by 4.8 days (95% CI −9.1 to −0.5, $P = .028$) and decreased time between extubation and discharge by 4.9 days (95% CI −9 to −0.8, $P = .02$). Number of CCC did not significantly influence length of stay or time between extubation and discharge.

Non-Neurologic Cohort. Of patients without a primary neurologic or neurosurgical diagnosis, when we controlled for primary diagnosis, age, number of CCC and dysphagia status, postextubation dysphagia was associated with an increase in total length of stay of 9.6 days (95% CI 7.1-12, $P < .0001$) as well as with an increase in time between extubation and discharge of 7.3 days (95% CI 5.1-9.4, $P < .0001$). In addition, having 1 or more CCC was associated with increased length of stay by 4.3 days (95% CI 1.2-7.4, $P < .01$) and with increased time between extubation and discharge by 3.3 days (95% CI 0.6-6.0, $P = .02$). Age did not significantly influence length of stay or time between extubation and discharge. After we adjusted for dysphagia status, dichotomized age, and number of CCC, the presence of dysphagia (OR 13.7, CI 3.8-49, $P < .0001$) and having 1 or more CCC (OR 2.8, CI 1-7.9, $P = .05$) were found to be associated with increase in odds of need for alternative means of nutrition at time of discharge.

Discussion

Because of the significant negative impact of postextubation dysphagia on patient outcomes, early identification and intervention are essential. A preliminary step to executing early identification and intervention is the scientific description of the phenomenon of postextubation dysphagia in pediatric populations, which is distinct from the phenomenon in adult populations. Such systematic exploration has, to date, been limited. A single study of a specific population (neurologically intact children with respiratory illness) found that children with moderate-severe dysphagia were significantly more likely to have been intubated than those with no dysphagia, and of children who were intubated, those with no dysphagia were intubated for a significantly shorter duration than those with moderate-severe dysphagia.[26]

With an overall incidence of 29%, postextubation dysphagia in pediatric patients is common and exceeds the 23% incidence in adults reported by Malandraki et al.[9] Factors that increased odds for postextubation dysphagia in this study, including age and duration of intubation, generally agreed with reports in literature studying postextubation dysphagia in adults, although age has a negative association with odds of postextubation dysphagia in infants and children, as opposed to a positive association in adults.[7,9,16] The increase in odds of postextubation dysphagia for certain pediatric populations is striking: age of 0-24 months increases odds of dysphagia 2.63 times; every hour of intubation increases odds of dysphagia by 1.7%, or about 50% per day of intubation. For patients with a neurologic or neurosurgical diagnosis, every hour of intubation increases odds of dysphagia by 4.7%. Furthermore, postextubation dysphagia is associated with negative outcomes of increased total length of stay, increased length of stay after extubation, and increased odds of alternative means of nutrition. Patients with postextubation dysphagia had an average total length of stay in the hospital of 16.3 days vs 5.4 days for patients without postextubation dysphagia, even when we controlled for primary diagnosis and number of CCCs. By way of comparison, children with high-impact conditions with moderate illness severity and extreme illness severity have an average length of stay of 9.8 and 32.8 days, respectively.[33] The impact of these negative outcomes on pediatric health and well-being is significant, as need for nasogastric and gastrostomy tube feeding in children has been shown to increase food refusal and increase emergency department visits and hospital admissions related to tube feeding.[34-37]

Patients with a neurologic or neurosurgical primary diagnosis demonstrated a lower incidence of postextubation dysphagia than those without a primary neurologic or neurosurgical diagnosis. This contrasts with the adult literature.[7] It is possible that institutions that have different distributions of neurosurgical patients (for example, a greater number of brainstem or posterior tumor excisions) may have different outcomes, particularly as they relate to structures responsible for respiration and deglutition. In addition, severity of neurologic injury across different neurologic diagnoses may directly impact duration of intubation and timing of initial oral feeding following extubation; these factors could conceivably have a significant impact on the results for this neurologic subgroup. Future studies would benefit from multicenter designs to ensure greater representation of pediatric neurosurgical subspecialties, mitigating the potential for institution-specific confounds.

An additional element that must be considered when discussing dysphagia in infants and children is the fact that swallowing and feeding change dramatically in physiology and behavior over the course of the first several years of life. Interruption of this development can lead not only to maladaptive swallowing function that compromises patient safety and efficiency or oral intake but also can lead to food refusals and oral aversion.[24,25,38] The psychosocial, economic, and healthcare burden of dysphagia and feeding difficulty in adults is tremendous.[39,40] To help mitigate the potential negative impact of postextubation dysphagia, routine screening for postextubation dysphagia and referral to speech-language pathologists with specialization in pediatric dysphagia should be considered, allowing for early diagnosis and treatment through diet modification and behavioral intervention.

There are some differences between the current study and studies examining postextubation dysphagia in adults. The current study defined postextubation dysphagia as the presence of overt signs of dysphagia including feeding-associated coughing, choking, wet and gurgling voice and breathing quality, and/or bradycardia with desaturation at the first feeding following extubation. These signs were reported by a speech-language pathologists, nursing staff, or a physician, which contrasts with several studies that use a diagnosis of dysphagia by a speech-language pathologist to define postextubation dysphagia.[7,9] Although very specific, the use of a dysphagia diagnosis by a speech-language pathologist in this retrospective study would have produced a biased sample, as only patients who demonstrated sufficient swallowing or feeding difficulty as assessed by nursing or other providers would have received a referral to speech-language pathology service, whereas those with minimal but clinically significant dysphagia could have been excluded. Our methods also differed from previous studies in adults in that we only assessed subjects who attempted oral feeding within 72 hours of extubation, as opposed to studies that considered presence of dysphagia at any point between extubation and discharge from the hospital to constitute postextubation dysphagia.[7,9]

Limitations to this study include those inherent to its retrospective nature, and the fact that the primary outcome measure required clearly observable signs of dysphagia without use of instrumented assessments of swallowing (ie, fiberoptic endoscopic evaluation of swallowing [FEES] or videofluoroscopic swallow study). Studies in adults that have used FEES, which can detect passage of a bolus into the trachea without a cough or other airway-protective response (silent aspiration), have shown that 38%-44% of subjects who aspirate are silent aspirators.[5,12] Further, in a 2010 systematic review, Skoretz et al reported studies that used FEES describe frequency of dysphagia ranging from 44% to 56%, much greater than those that used noninstrumented assessments of swallowing.[14] This implies that the sensitivity of noninstrumented assessments of swallowing may be reduced and that the actual incidence of postextubation dysphagia in pediatric populations may be greater.

An additional limitation of this study is that it is not able to investigate the mechanisms postextubation dysphagia, such as laryngeal injury, sedation, muscular weakness, and disorganized breathing.[6] Use of instrumented assessments of swallowing would help to clarify mechanisms of postextubation dysphagia, and in doing so would either support or contrast with the current regression models. For example, absence of any obviously laryngeal or pharyngeal trauma in a patient with a neurologic primary diagnosis would imply that the mechanism of dysphagia was associated with neurologic status rather than with intubation, contrasting with our regression models.

An additional limitation of this initial investigation into postextubation dysphagia in pediatric populations is that the primary diagnosis categories are broad and do not account for severity of injury or illness. As such, the possibility remains that severity of injury or illness, and differences between more specific diagnoses, may function as confounding variables. For example, a cardiac surgery that involves manipulation of the aortic arch and the recurrent laryngeal nerve may result in increased risk of dysphagia vs other cardiac surgeries. In future studies, larger sample sizes from multiple institutions would allow for more-discrete categories and help to account for these factors.

Our data support the hypotheses that incidence of postextubation dysphagia in pediatric patients exceeds the incidence in adults; age and increased duration of intubation and timing of initial oral feeding have a strong association with diagnosis of dysphagia, with additional factors not reaching statistical significance; and presence of postextubation dysphagia has a significant impact on odds for outcomes, including total length of stay and need for non-oral means of nutrition at discharge. Our data show that postextubation dysphagia is common in pediatrics, and that age of 0-24 months, increased duration of intubation, and primary diagnosis of trauma substantially increase odds of postextubation dysphagia. Routine screening and early referral to speech-language pathologists and other providers specializing in dysphagia for evaluation and treatment may mitigate negative outcomes. ■

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Table IV. Distribution of need for alternative means of nutrition by dysphagia status

Outcomes	Dysphagia (n = 108)	No dysphagia (n = 264)
Alternative means of nutrition at discharge		
Yes	n = 24 (22%)	n = 3 (1%)
No	n = 84 (78%)	n = 261 (99%)