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Oropharyngeal dysphagia is strongly correlated with apparent life-threatening events

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Abstract

Objectives—The aim of this study was to investigate the prevalence of oropharyngeal dysfunction with resultant aspiration in patients admitted after apparent life-threatening event (ALTE) and to determine if historical characteristics could predict this oropharyngeal dysphagia and aspiration risk.

Methods—We retrospectively reviewed the records of all patients admitted to Boston Children's Hospital between 2012 and 2015 with a diagnosis of ALTE to determine the frequency of evaluation for oropharyngeal dysphagia using videofluoroscopic swallow studies (VFSS) and clinical feeding evaluations, to determine the prevalence of swallowing dysfunction in subjects admitted after ALTE and to compare presenting historical characteristics to swallow study results

Results—188 children were admitted with a diagnosis of ALTE of which 29% (n=55) had an assessment of swallowing by VFSS. Of those who had a VFSS, 73% (n=40) had evidence of aspiration or penetration on VFSS. Of all of the diagnostic tests ordered on patients with ALTEs, the VFSS had the highest rate of abnormalities of any test ordered. None of the historical characteristics of ALTE predicted which patients were at risk for aspiration. In patients that had

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Daniel R. Duncan: Dr. Duncan conceptualized and designed the study, collected data and carried out initial analysis, drafted the initial manuscript, and approved the final manuscript as submitted.
Janine Amirault: Ms. Amirault assisted in study design, collected data and carried out initial analysis, and approved the final manuscript as submitted.
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both clinical feeding evaluations and VFSS, observed clinical feedings incorrectly identified 26% of patients as having no oropharyngeal dysphagia when in fact aspiration was present on VFSS.

Conclusions—Oropharyngeal dysphagia with aspiration is the most common diagnosis identified in infants presenting with ALTEs. The algorithm for ALTE should be revised to include an assessment of VFSS as clinical feeding evaluations are inadequate to assess for aspiration.

Keywords

apparent life-threatening event; aspiration; gastroesophageal reflux

Introduction

Infants evaluated after an apparent life-threatening event (ALTE) often present a diagnostic challenge and frequently require admission for monitoring and further evaluation[1–4]. An apparent life-threatening event has been defined by the NIH as “an episode that is frightening to the observer and is characterized by some combination of apnea, color change, marked change in muscle tone, choking or gagging”[5]. As any pediatrician knows, these events are common, occurring in up to 6% of the general population and accounting for 1% of pediatric emergency room visits and 2% of all pediatric hospitalizations at an average cost of more than $15,000 per admission[4,6]. Patients have been found to have recurrence of ALTE in up to 24% of cases with a 30-day readmission rate of 2.5%; deaths have been reported in up to 0.8% of patients[1,4,7].

Numerous studies have attempted to outline management strategies for these patients but a major limitation of ALTE research is that populations included are often diverse[8]. No clear cause is found in up to 50% of patients and guidelines recommend limited testing based on history and physical exam[1,8,9]. As a result, most of these infants are discharged without a definitive diagnosis and, therefore, no data-driven approach to prevention. This leads to great frustration for parents and providers because of the unaddressed risk for future morbidity.

Gastroenterologists are frequently consulted on these patients to rule out gastroesophageal reflux (GER) as a cause for the ALTE and current guidelines recommend GER evaluation in the work-up of ALTE[1,10]. Up to 31% of patients are discharged with the diagnosis of GER despite studies which have shown that pH probes combined with polysomnography fail to show any correlation between apneic events or recurrent ALTEs with frequency, duration or acidity of reflux events[10–14]. Clinicians are frequently misled into thinking that ALTEs are a result of reflux because symptoms of gagging, choking, coughing, and blue spells frequently occur around meals but in reality, these symptoms of possible reflux are seen equally in patients with oropharyngeal dysfunction and resultant aspiration[15–17]. While ALTE symptoms are often treated with anti-reflux measures such as acid suppression and reflux surgery, none of these effectively treat oropharyngeal dysphagia and subsequent aspiration[16,18,19]. Furthermore, even though there is an overlap of symptoms of gastroesophageal reflux disease (GERD) and oropharyngeal dysphagia, no known prior attempts have been made to characterize the role of oropharyngeal dysphagia with resultant aspiration in the occurrence of ALTEs.

The evaluation of oropharyngeal dysphagia typically takes place in two steps. The first is the clinical feeding evaluation in which the provider (often a speech language pathologist or occupational therapist trained in feeding therapy) observes the patient feeding with different consistencies, looking for signs and symptoms of aspiration[20,21]. If the provider has concerns for aspiration, the patient is then typically referred for video fluoroscopic swallow study (VFSS), also known as the modified barium swallow study (MBS), the gold standard in the evaluation of oropharyngeal dysphagia[15,22]. Unfortunately, the sensitivity of the clinical feeding evaluation compared to VFSS ranges from 33 to 92% and is particularly low for silent aspiration, which is present in 81% of children with aspiration, suggesting that clinical feeding evaluation alone may be inadequate to diagnose aspiration in this population[23–25].

We hypothesized that oropharyngeal dysphagia is a common cause of ALTE in children and that history and clinical observation of infants' feeding is inadequate to diagnose aspiration. To address this hypothesis, the goals of the current study were: (1) to investigate, in patients admitted after ALTE, the frequency with which swallowing evaluations were performed; (2) to determine the incidence of oropharyngeal dysphagia with aspiration in patients presenting with ALTE; and (3) to determine if historical characteristics of ALTE presentation could predict which patients aspirate.

Methods

We performed a retrospective review of all children from birth to one year old admitted to Boston Children's Hospital between 2012 and 2015 with the admission diagnosis of ALTE. We reviewed each subject's medical record to determine the frequency of evaluation for oropharyngeal dysphagia using VFSS and clinical feeding evaluations. We also recorded any other testing performed, the frequency of findings and interventions based on these results, the historical characteristics of each ALTE presentation, and the rate of readmission between patients who did and did not have an aspiration evaluation. VFSS results were considered abnormal if there was evidence of aspiration or penetration. Medical records were also reviewed to determine subjects' comorbidities. Exclusion criteria included any other admission for ALTE prior to the current ALTE admission and any pre-existing significant medical diagnosis (congenital heart disease, known neurologic impairment with or without seizure disorder, other congenital anomalies).

The primary outcome of the study was to determine, in patients admitted after ALTE, the frequency of swallowing evaluations and the historical features which would suggest that oropharyngeal dysphagia was present. Secondary outcomes were to assess the degree of agreement between observed feedings during clinical feeding evaluations and videofluoroscopic swallow evaluations and to determine the rates of readmission in patients who did and did not get swallowing evaluation. Data were analyzed using SPSS software. Outcomes were tested using the student t test, Fisher's exact test, and Wilcoxon rank-sum test.

The present study was approved by the Institutional Review Board at Boston Children's Hospital.

Results

We identified 188 subjects who presented from 2012 to 2015 with first-time ALTE. The mean age at presentation was 62.7±4.9 days and equal proportions of males and females were represented in our study group. Table 1 summarizes these subject demographics and the historical characteristics of each presentation. Data in all tables are presented as number of subjects (percent) or median value (interquartile range).

Table 2 shows a comparison of the presentation characteristics between subjects that did and did not have VFSS performed; the only historical features which predicted which patient received a VFSS were history of color change during the event (p=0.03), similar symptoms prior to presentation (p=0.0001), more than one episode in 24 hours (p=0.04), and symptoms during (p<0.0001) or after (p=0.02) feeds. Patients were less likely to receive a VFSS if they had fever (p=0.005) or URI symptoms (p=0.007).

As can be seen in Table 3, none of the historical characteristics showed any significant correlation with findings on VFSS, suggesting that the presence of oropharyngeal dysphagia with resultant aspiration cannot be predicted based on the initial history and physical examination.

Each patient had a mean of 3.2±0.1 tests performed at this initial admission and the rate of abnormal testing other than VFSS was low (Table 4). Oropharyngeal dysfunction with resultant aspiration was the most commonly abnormal test. Of the 29% (n=56) of subjects who had VFSS performed, 73% (n=40) had evidence of aspiration or penetration on VFSS. Of these, 40% (n=16) showed aspiration and 60% (n=24) penetration. Even when we eliminated patients with penetration, VFSS remained the most commonly abnormal test with 16 of the 56 VFSS tests (29%) showing aspiration. For any patients with symptoms of infection, VFSS studies were performed after resolution of infectious symptoms. A total of 5% (n=9) of subjects were discharged with a diagnosis of bronchiolitis and none of these subjects were found to have an abnormal VFSS. Only 3% (n=5) of 188 had reflux testing but 19% (n=35) were discharged with a diagnosis of GERD based on history and 38% (n=71) were sent home on acid suppression medications. The rate of abnormal results from the other testing modalities was low: 4 of the 131 EKG’s were abnormal (3 findings of supraventricular tachycardia and 1 finding of Wolff-Parkinson-White syndrome), 10 of the 120 chest x-rays were abnormal (9 with peribronchial cuffing consistent with bronchiolitis, 1 with an infiltrate consistent with pneumonia), and 4 of the 33 EEGs were abnormal (all showing evidence of seizure activity). No subjects included in the analysis had abnormal laboratory test results (data not shown).

We next examined length of stay as measured by admission nights based on VFSS results and additional comorbidities. Patients who underwent VFSS all had more admission nights than those who did not regardless of the result (6.76±1.59 versus 3.52±0.37, p=0.003), perhaps suggesting that these patients may have had more dramatic presentations, triggering a more extensive and prolonged evaluation. There was no difference in the number of admission nights for patients who did and did not receive reflux treatment or those who did

or did not have pulmonary comorbidities (p>0.47). Premature infants also had significantly longer admissions (p=0.04).

For subjects who had both VFSS and clinical feeding evaluation, we compared the results of each to determine the agreement between these two types of swallow function testing and found poor agreement; the two approaches were found to be poorly concordant by McNemar's test (p=0.02) with a tetrachoric correlation score of 0.28, indicating low correlation. Clinical feeding evaluation alone incorrectly identified 26% of patients as having no oropharyngeal dysphagia when VFSS showed evidence of aspiration or penetration.

Discussion

Apparent life-threatening events are common in the general population, expensive for the medical system and can be frustrating for providers and families[1–4,10,12]. Historically, most of these patients are discharged without an evidence-based diagnosis and, therefore, no data-driven approach to prevention. Many patients are given a presumptive diagnosis of GERD and sent home with anti-reflux precautions and acid-suppressing medications even though prior studies have shown no correlation between reflux and apnea and increasing data suggests that acid suppression in itself can be harmful[16,19,26–29]. Therefore, the age-old approach of minimal testing based on history and physical for patients presenting after ALTE has resulted in the current clinical approach in which most patients receive minimal testing unless their history suggests another etiology of their event[8]. Patients are usually observed in a monitored setting overnight, often at significant expense, and then discharged home with a presumptive diagnosis that may result in harmful pharmacologic interventions.

This is the first study to address the role of oropharyngeal dysphagia with aspiration in the etiology of ALTEs. Our population was heterogeneous, as has been previously reported and likely stems from the vague definition of ALTE. Each patient received a variety of tests and many were sent home with a diagnosis of GERD but by far the VFSS was the most commonly abnormal test obtained, suggesting that VFSS is the most high yield potential test modality. When we analyzed each ALTE presentation, we found that, while patients with symptoms around feeds were more likely to have a VFSS performed, the historical characteristics were unable to identify which patients actually had oropharyngeal dysphagia on these studies; this suggests that the presence of aspiration cannot be predicted based on initial history and physical examination. This study also highlights that symptoms of oropharyngeal dysphagia exactly mimic symptoms of GERD and, unless the clinician is thinking about oropharyngeal dysphagia, the diagnosis will be missed. The high rates of VFSS testing in our hospital parallel the creation of an aerodigestive center which has drawn attention to the high frequency of aspiration in symptomatic infants and children and this awareness has permeated the gastroenterology practice at Boston Children's Hospital. While it is ethically impossible to perform VFSS in healthy infants to discover the rates of baseline swallowing dysfunction, we strongly believe that aspiration is not a normal phenomenon and that it is a major contributor to ALTEs in infants. This study lays the groundwork for future prospective trials of thickening feeds to prevent ALTEs in high-risk infants.

Another important finding is that there was poor agreement between clinical and the VFSS evaluation, suggesting that clinical evaluation with observed feeding alone is an inadequate test for the diagnosis of oropharyngeal dysphagia in infants with ALTEs. While the evaluation of swallow function has historically been a two-step process, with radiologic studies only being obtained after a clinical feeding evaluation raises sufficient concern, our data suggest this approach in high risk children is inadequate and VFSS should be performed in all children presenting with ALTEs to rule-out silent aspiration[20,21]. One of the arguments against performing VFSS is that more patients will be exposed to radiation. However, the dose of radiation can be as little as that of one to three chest x-rays, depending on the radiologist's approach and experience[30,31].

Making the diagnosis of oropharyngeal dysphagia with aspiration is not purely academic. Oropharyngeal dysphagia with aspiration is, in the majority of patients, treated with thickening of feeds without the need for gastric tubes and this continued oral feeding with thickened liquids even has superior outcomes than feeding with enteral tubes[32]. Thickening of oral feeding continues until, in the majority of patients, the swallowing dysfunction resolves as the infants mature or until the patient's clinical situation (such as underlying infection) improves[33]. Of note, in our study, none of the subjects with bronchiolitis were found to have abnormal swallow function even though aspiration has been found in other studies of children with bronchiolitis[34]. We feel that aspiration in the context of bronchiolitis is still clinically relevant and thickening of feeds should be pursued at least until the bronchiolitis has resolved.

There are several limitations to our study. First, our data are retrospective so it is possible that there were other characteristics of the subjects' history, physical exam, or hospital course that drove providers' decision-making that were not documented in the medical record. For example, in some patients, a feeding history was not always thoroughly documented, suggesting that this is an area for improvement, especially if, based on our results, swallowing dysfunction likely plays a role in ALTEs. A second limitation is that our hospital is a tertiary referral center so it is possible that our study population is not completely representative of the general population of children presenting with ALTEs at community hospitals where other causes for ALTE may be more common. It is the common practice at Boston Children's Hospital to admit these patients for overnight observation but it is possible that some patients were not admitted and thus not captured in our dataset. Third, not every patient presenting with ALTE had VFSS performed so our data may be biased towards a higher rate of abnormal results; infants with symptoms around feeds were more likely to have a VFSS and more likely also to have an abnormal VFSS because of a higher pretest probability. However, even if every one of the untested patients had normal swallow function, the VFSS would still have the highest yield by far of any of the tests. And, if diagnosing oropharyngeal dysphagia in infants who are symptomatic around meals reduces use of acid suppression medications, we consider this a tremendous improvement in quality of care since these medications are still being prescribed in high rates despite mounting evidence of significant risk. The present study was unfortunately not powered to detect differences in outcomes such as repeat readmissions between those who did and did not have swallow evaluations but this is a very important area for future investigation to determine if patients who do not get a VFSS have different outcomes than patients that do.

Lastly, we assumed that aspiration and penetration pose similar risks to patients though we recognize that other hospitals may not approach both equally. We chose to combine the findings of aspiration and penetration in our analysis for two reasons: (1) in our clinical experience, symptomatic patients with evidence of penetration alone improve symptomatically with thickening; and (2) since the VFSS is just a single snapshot in time, penetration may be a harbinger of aspiration missed by the VFSS. However, even when we eliminate patients with penetration in our analysis, VFSS remained the most commonly positive test with 29% of the swallow studies showing aspiration.

Despite these limitations, we feel that the results of this study are striking and we suggest that the algorithm for ALTE should be redefined to include an assessment of swallow function and in so doing we could reduce potential future morbidity from undiagnosed oropharyngeal dysphagia. This study opens the door for prospective studies to determine the incidence of swallowing dysfunction in children presenting with ALTEs and for swallowing interventions to determine if the incidence of repeat ALTE events or admissions are reduced.

Conclusion

Aspiration is a common, under-diagnosed cause of ALTEs. Historical characteristics of a patient's ALTE presentation cannot reliably be used to predict aspiration. VFSS have the highest yield of any test ordered for patients presenting with ALTE. The algorithm for ALTE should be revised to include an assessment of VFSS, as clinical feeding evaluations are inadequate to assess for aspiration.

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What is Known

- Apparent life-threatening events (ALTE) present a diagnostic challenge.
- Reflux is the most frequent reported explanation for these events despite studies failing to show any correlation.
- No prior studies have examined the frequency of oropharyngeal dysphagia with resultant aspiration in ALTE's.

What is New

- Aspiration is a common, under-diagnosed cause for ALTE's.
- Historical characteristics cannot reliably be used to predict aspiration.
- Video fluoroscopic swallow studies are the highest yield test for patients with ALTE.
- The algorithm for ALTE should be revised to include assessment of swallowing dysfunction.

Table 1

Subject Characteristics

Characteristic	N	Overall
Age (days)	188	49 (19, 89)
Female sex	188	94 (50%)
>1 episode in 24 hours	188	96 (51%)
Number of episodes	60	2.5 (2.0, 3.0)
Color change	188	
None		32 (17%)
Red		19 (10%)
Blue		122 (65%)
Pale		15 (8%)
Tone change	132	
None		57 (43%)
Limp		51 (39%)
Shaking		3 (2%)
Rigid		21 (16%)
Febrile	188	17 (9%)
URI symptoms	188	44 (23%)
Duration of ALTE symptoms (seconds)	108	30 (10, 120)
ALTE upright (vs. flat)	61	12 (20%)
Relationship to feeds	159	
No		72 (45%)
During		31 (20%)
After		56 (35%)
Time since last feeding (minutes)	39	60 (20, 120)
Associated emesis	188	
None		153 (81%)
Yes, before		23 (12%)
Yes, after		12 (6%)
Mucus or foaming at mouth	188	26 (14%)
Interventions in the field	188	102 (54%)
Appeared well in ED	188	161 (86%)
Admitted to ICU or NICU	188	53 (28%)

Table 2

VFSS Testing by Historical Characteristics

		VFSS		
Characteristic	**N**	**No (n=132)**	**Yes (n=56)**	***P***
Age (days)	188	49 (19, 90)	52 (21, 88)	0.92
Female sex	188	70 (53%)	24 (43%)	0.20
>1 episode in 24 hours	188	61 (46%)	35 (63%)	0.04
Number of episodes	60	3.0 (2.0, 3.0)	2.0 (2.0, 3.0)	0.31
Color change	188			0.03
None		29 (22%)	3 (5%)	
Red		14 (11%)	5 (9%)	
Blue		77 (59%)	45 (80%)	
Pale		12 (9%)	3 (5%)	
Tone change	132			0.88
None		41 (43%)	16 (43%)	
Limp		38 (40%)	13 (35%)	
Shaking		2 (2%)	1 (3%)	
Rigid		14 (15%)	7 (19%)	
Febrile	188	17 (13%)	0 (0%)	0.005
URI symptoms	188	38 (29%)	6 (11%)	0.007
Duration of ALTE symptoms (seconds)	108	35 (10, 120)	30 (10, 75)	0.40
ALTE upright (vs. flat)	61	10 (23%)	2 (11%)	0.48
Relationship to feeds	159			0.02
No		55 (51%)	17 (33%)	
During		15 (14%)	16 (31%)	
After		38 (35%)	18 (35%)	
Time since last feeding (minutes)	39	60 (30, 120)	83 (15, 120)	0.95
Associated emesis	188			0.97
None		108 (82%)	45 (80%)	
Yes, before		16 (12%)	7 (13%)	
Yes, after		8 (6%)	4 (7%)	
Mucus or foaming at mouth	188	22 (17%)	6 (11%)	0.43
Interventions in the field	188	74 (56%)	30 (54%)	0.82
Appeared well in ED	188	107 (81%)	54 (96%)	0.006
Admitted to ICU or NICU	188	40 (30%)	13 (23%)	0.32

Table 3

Oropharyngeal Dysphagia by Historical Characteristics

		Aspiration or Penetration on VFSS		
Characteristic	**N**	**No (n=15)**	**Yes (n=41)**	***P***
Age (days)	56	46 (22, 83)	58 (19, 91)	0.85
Female sex	56	9 (60%)	15 (37%)	0.12
>1 episode in 24 hours	56	10 (67%)	25 (61%)	0.70
Number of episodes	18	2.0 (2.0, 3.0)	2.0 (2.0, 3.0)	0.87
Color change	56			0.29
None		0 (0%)	3 (7%)	
Red		3 (20%)	2 (5%)	
Blue		11 (73%)	34 (83%)	
Pale		1 (7%)	2 (5%)	
Tone change	37			0.81
None		4 (36%)	12 (46%)	
Limp		4 (36%)	9 (35%)	
Shaking		0 (0%)	1 (4%)	
Rigid		3 (27%)	4 (15%)	
Febrile	56	0 (0%)	0 (0%)	--
URI symptoms	56	1 (7%)	5 (12%)	1.00
Duration of ALTE symptoms (seconds)	28	60 (20, 90)	30 (10, 60)	0.56
ALTE upright (vs. flat)	18	0 (0%)	2 (15%)	1.00
Relationship to feeds	51			0.84
No		5 (42%)	12 (31%)	
During		3 (25%)	13 (33%)	
After		4 (33%)	14 (36%)	
Time since last feeding (minutes)	10	240 (n=1)	45 (15, 120)	0.32
Associated emesis	56			0.63
None		11 (73%)	34 (83%)	
Yes, before		3 (20%)	4 (10%)	
Yes, after		1 (7%)	3 (7%)	
Mucus or foaming at mouth	55	3 (20%)	3 (8%)	0.33
Interventions in the field (yes vs. no)	56	8 (53%)	22 (54%)	0.98
Appeared well in ED	56	15 (100%)	39 (95%)	1.00
Admitted to ICU or NICU	56	1 (7%)	12 (29%)	0.15

Table 4

ALTE Testing Results

Test	EKG	CXR	EEG	VFSS
% (n) of patients tested	70% (131)	64% (120)	18% (33)	29% (55)
% (n) abnormal	3% (4)	5% (10)	12% (4)	72% (40)