Comparison of Aerodigestive and Nonaerodigestive Provider Responses to Clinical Case Vignettes

Suzanna Hirsch, MD[1], Joel A. Friedlander, DO[2], Hayat Mousa, MD[3], Valeria Cohran, MD[4], Jose M. Garza, MD[5], Rinarani Sanghavi, MD[6], Lusine Ambartsumyan, MD[7], Paul D. Mitchell, MS[8], Rachel Rosen, MD, MPH[1], on behalf of the NASPGHAN Aerodigestive Interest Group*

Objective To evaluate differences in practice patterns between aerodigestive and nonaerodigestive providers in pediatric gastroenterology when diagnosing and treating common aerodigestive complaints.

Study design A questionnaire comprised of clinical vignettes with multiple-choice questions was distributed to both aerodigestive and nonaerodigestive pediatric gastroenterologists. Vignettes focused on management of commonly encountered general gastroenterology and aerodigestive issues, such as gastroesophageal (GE) reflux, aspiration, and feeding difficulties. Tests of equal proportions were used to compare rates of testing and empiric therapy within and across groups. Multivariate analysis was used to assess differences in response rates between aerodigestive and nonaerodigestive providers.

Results A total of 88 pediatric gastroenterologists from 18 institutions completed the questionnaire. There were 35 aerodigestive gastroenterology providers and 53 nonaerodigestive gastroenterology providers. The nonaerodigestive group included 31 general gastroenterologists and 22 providers with self-identified subspecialty gastroenterology expertise. Aerodigestive specialists were more likely than nonaerodigestive gastroenterologists to pursue testing over empiric therapy in cases involving isolated respiratory symptoms ($P < .05$); aerodigestive providers were more likely to recommend pH-impedance testing, videofluoroscopic swallow studies, and upper gastrointestinal barium study ($P < .05$ for each test) depending on the referring physician. For vignettes involving infant GE reflux, both groups chose empiric treatments more frequently than testing ($P < .001$), although aerodigestive providers were more likely than nonaerodigestive providers to pursue testing like upper gastrointestinal barium studies ($P < .05$).

Conclusions Although some practice patterns were similar between groups, aerodigestive providers pursued more testing than nonaerodigestive providers in several clinical scenarios including infants with respiratory symptoms and GE reflux. *(J Pediatr 2021;232:166-75)*.

Aerodigestive disorders are frequently encountered in both general pediatrics and pediatric gastroenterology, with common gastrointestinal manifestations including gastroesophageal (GE) reflux, aspiration, and feeding difficulties.[1] In recent years, aerodigestive disorders have gained increasing attention, and there has been a corresponding increase in multidisciplinary aerodigestive centers nationally.[2] These centers provide coordinated patient care between multiple specialists (often gastroenterology, pulmonology, otolaryngology, speech language pathology, and nutrition), and they have been shown to increase patient satisfaction and reduce costs.[3,4] Despite this, research on the most common or effective care practices for aerodigestive symptoms remains limited.[1,5] Commonly performed diagnostic evaluations for aerodigestive complaints include imaging, such as an upper gastrointestinal (GI) barium contrast study or video fluoroscopic swallowing study (VFSS), motility testing,

GE	Gastroesophageal
GI	Gastrointestinal
GLMM	Generalized linear mixed model
NASPGHAN	North American Society for Pediatric Gastroenterology, Hepatology and Nutrition
pH-MII	Multichannel intraluminal impedance with pH
REDCap	Research Electronic Data Capture
VFSS	Video fluoroscopic swallowing study

From the [1]Aerodigestive Center, Center for Motility and Functional Gastrointestinal Disorders, Division of Gastroenterology, Hepatology and Nutrition, Boston Children's Hospital, Boston, MA; [2]Division of Gastroenterology, Colorado Children's Hospital, Aurora, CO; [3]Division of Gastroenterology, Children's Hospital of Philadelphia, Philadelphia, PA; [4]Division of Gastroenterology, The Ann and Robert H. Lurie Children's Hospital of Chicago, Chicago, IL; [5]Division of Gastroenterology, GI Care for Kids, Children's Healthcare of Atlanta, Atlanta, GA; [6]Division of Gastroenterology, UT Southwestern Medical Center, Children's Medical Center, Dallas, TX; [7]Division of Gastroenterology, Seattle Children's Hospital, Seattle, WA; and [8]Institutional Centers for Clinical and Translational Research, Boston Children's Hospital, Boston, MA

*List of additional members of the NASPGHAN Aerodigestive Interest Group is available at http://www.jpeds.com (**Appendix**).

Supported by National Institutes of Health (R01 DK097112-01) and the Translational Research Program Senior Investigator Award. J.F. is president/chief medical officer and co-founder of EvoEndo, Inc. and is co-inventor on patent pending US 62/732,272, US 62/680,798, PCT/US2019034954, US 14/428,408, US 16/573,567, PCT/US2019/051523, US 18/850,939, 15/853,521, PCT/US2018/0867152, US 15/8887,438, CA 2,990,182, AU 2016283112, EU 16815420.1, JA 2017-566710 related to endoscopic methods and technologies. J.G. was a speaker for Abbott Laboratories, Biogaia, and Medtronic, and served as a consultant for Medtronic. The other authors declare no conflicts of interest.

Portions of this study were presented at the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition Annual Meeting, October 17-19, 2019, Chicago, IL.

https://doi.org/10.1016/j.jpeds.2020.12.067

such as multichannel intraluminal impedance with pH (pH-MII) or gastric emptying studies, and procedures, such as esophagogastroduodenoscopy. Likewise, treatment options are numerous and include medication trials, dietary changes, and procedural or surgical interventions. Many of these tests and treatments, including changes to hypoallergenic formulas and initiation of acid suppression, are often initiated through primary care offices.[6-8]

The goal of the current study was to evaluate variations in practice patterns between aerodigestive and nonaerodigestive providers in management of common aerodigestive complaints. We hypothesized that there would be group differences regarding decisions on testing and treatment of various clinically relevant aerodigestive scenarios.

Methods

The study population was comprised of healthcare providers with a specialty in pediatric gastroenterology. Participants included attending physicians, nurse practitioners, and physician assistants. Physician trainees (eg, residents or fellows), other specialists within gastroenterology (eg, dieticians or speech language pathologists), and other aerodigestive specialists (eg, pulmonologists or otolaryngologists) were excluded from participating in the study, as the goal was to assess gastroenterologists' practice alone. The questionnaire was developed in Research Electronic Data Capture (REDCap) and distributed via email to healthcare providers at 6 institutions: Boston Children's Hospital, Children's Healthcare of Atlanta, Children's Medical Center Dallas, Colorado Children's Hospital, Lurie Children's Hospital of Chicago, and Seattle Children's Hospital. These institutions were chosen in an effort to capture various institution sizes, types (academic vs private practice), and geographic locations within the US. The same REDCap questionnaire was also distributed via email to the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN) Aerodigestive Special Interest Group. All questionnaire responses were anonymous, and responses were coded using an automatically generated study identifier within the REDCap platform.

Questionnaire

This questionnaire was created by the members of the NASPGHAN Aerodigestive Special Interest Group to assess variations between pediatric gastroenterologists with and without subspecialty expertise in aerodigestive GI disorders. The questionnaire was comprised of demographic questions and clinical vignettes with accompanying multiple-choice questions about clinical management. Demographic questions included the provider's hospital, focus of practice (aerodigestive, general gastroenterology, or another subspecialty within gastroenterology), and length of time the provider has been in practice. The clinical vignettes focused on the evaluation and management of commonly encountered aerodigestive issues. Answer choices were comprised of multiple-choice options. Some questions required choosing one response and others allowed for selection of multiple responses. The questionnaire can be found in the **Table**.

Statistical Analyses

Questionnaire responses were described with percentages stratified by physician type (aerodigestive vs nonaerodigestive providers). Answer choices were grouped into those involving empiric treatments (eg, medications or dietary changes) or testing (eg, bloodwork, imaging studies, motility tests, or endoscopy). For each scenario, the percentage of aerodigestive providers vs nonaerodigestive providers who chose any empiric treatment was compared using a test of equal proportions (Pearson χ^2 test or Fisher exact test). Similarly, the percentage of aerodigestive providers vs nonaerodigestive providers who chose any type of testing was compared using a test of proportions. Within the aerodigestive and nonaerodigestive groups, the percentage of providers choosing any type of testing was also compared to the percentage of providers choosing any type of empiric treatment using the McNemar test.

In some cases, respondents were asked to "select all that apply" in response to a question, potentially inducing correlation among the response choices. In these cases, responses were analyzed with a generalized linear mixed model (GLMM) for a binary distribution with a logit link function. A random effect for respondent identification was included to account for within-respondent correlation among response choices. The covariance matrix was estimated by the empirical (sandwich) estimator. An interaction for physician type by response choice was used to test for differential response by physician type, with adjustment for multiple comparisons by the Tukey-Kramer method.

For the "select all that apply" questions, the OR and 95% CI from the generalized linear mixed model is reported. Because of low selection of some response choices, model separation was a common occurrence. For cases where no respondents among one (but not both) physician type selected a given choice, the OR (95% CI) is based on a 2×2 table after adding 0.5 to each table cell.

Some pairs of vignettes were related in topic. For these pairs, management between the percentage of providers choosing any test or any empiric treatment in one vignette was compared to the percentage of providers choosing any test or any empiric treatment in the other vignette using paired *t* tests.

All tests of significance were 2-sided with *P* value of $<.05$ indicating statistical significance. Data analysis was conducted with SAS v 9.4 (SAS Institute) and Stata Statistical Software, Release 16, 2019 (StataCorp LLC).

Results

Demographics

A total of 88 care providers completed the questionnaire from 18 hospitals across the US and Canada. This

Table. Study questionnaire

Where do you work? (Name of hospital)
How long have you been an attending physician or practitioner?
- 0-5 y
- 6-10 y
- 11-15 y
- 16-20 y
- 21-25 y
- 25+ y

Primary type of practice:
- General GI
- Subspecialty GI
- If subspecialty, please specify:

An infant presents to your gastroenterology clinic with isolated respiratory symptoms in whom a GI cause has been suggested by primary care. Which of the following tests/treatments would you routinely (>50% of the time) recommend in a patient with this presentation (check all that apply):
- None
- H2 antagonist trial
- PPI trial
- Hypoallergenic diet trial
- Bloodwork
- Trial of thickening of feeds
- Upper GI barium study
- Milk scan/Gastric emptying scan
- pH-impedance probe
- pH probe
- Upper GI endoscopy with biopsies
- Videofluoroscopic swallow study/modified barium swallow study
- Fiberoptic endoscopic swallow assessment (FEES)
- Brain MRI
- Trial erythromycin
- Trial cyproheptadine
- Specialist referral:
- Other:

An infant presents to your gastroenterology clinic with isolated respiratory symptoms in whom a GI cause has been suggested by Pulmonology or Otolaryngology. Which of the following tests/treatments would you routinely (>50% of the time) recommend in a patient with this presentation (check all that apply):
- None
- H2 antagonist trial
- PPI trial
- Hypoallergenic diet trial
- Bloodwork
- Trial of thickening of feeds
- Upper GI barium study
- Milk scan/Gastric emptying scan
- pH-impedance probe
- pH probe
- Upper GI endoscopy with biopsies
- Videofluoroscopic swallow study/modified barium swallow study
- Fiberoptic endoscopic swallow assessment (FEES)
- Brain MRI
- Trial erythromycin
- Trial cyproheptadine
- Specialist referral:
- Other:

In a patient in whom you suspect that there is impaired airway protection (i.e. aspiration risk), what tests/treatments would you recommend at your initial patient visit (check all that apply):
- Order a videofluoroscopic swallow study
- Order a head MRI
- Order a pH probe
- Order a pH-impedance probe
- Order a milk scan/GE scan
- Perform an endoscopy
- Perform an endoscopy as part of a triple scope
- Recommend an NG trial
- Prescribe an H2 antagonist
- Prescribe a PPI
- Prescribe erythromycin

(*continued*)

Table. Continued

- Prescribe cyproheptadine
- Thicken feeds
- Recommend a hypoallergenic diet
- Refer to a feeding specialist
- Refer to Neurology
- Refer to Pulmonology
- Refer to Otolaryngology
- Refer to an Aerodigestive clinic
- Other:

In an infant who is a poor feeder (eg, slow feeder, dream feeder, sputtering during feeds, discomfort during feeds) who is growing well, what medications/tests/treatments would you order frequently (>50% of the time)?
- None
- Order a videofluoroscopic swallow study
- Order a head MRI
- Order a pH probe
- Order a pH-impedance probe
- Order a milk scan/GE scan
- Order an abdominal ultrasound
- Order bloodwork
- Order stool studies
- Order indirect calorimetry
- Perform an upper GI endoscopy
- Perform a flexible sigmoidoscopy/colonoscopy
- Concentrate formula
- Recommend an NG trial
- Prescribe an H2 antagonist
- Prescribe a proton-pump inhibitor
- Prescribe erythromycin
- Prescribe cyproheptadine
- Thicken feeds
- Recommend a hypoallergenic diet
- Refer to a feeding specialist
- Refer to Neurology
- Refer to Pulmonology
- Refer to Otolaryngology
- Refer to an Aerodigestive clinic
- Other:

In an infant who is a poor feeder (eg, slow feeder, dream feeder, sputtering during feeds, discomfort during feeds) who is NOT growing well, what medications/tests/treatments would you order frequently (>50% of the time)?
- None
- Order a videofluoroscopic swallow study
- Order a head MRI
- Order a pH probe
- Order a pH-impedance probe
- Order a milk scan/GE scan
- Order an abdominal ultrasound
- Order bloodwork
- Order stool studies
- Order indirect calorimetry
- Perform an upper GI endoscopy
- Perform a flexible sigmoidoscopy/colonoscopy
- Concentrate formula
- Recommend an NG trial
- Prescribe an H2 antagonist
- Prescribe a proton-pump inhibitor
- Prescribe erythromycin
- Prescribe cyproheptadine
- Thicken feeds
- Recommend a hypoallergenic diet
- Refer to a feeding specialist
- Refer to Neurology
- Refer to Pulmonology
- Refer to Otolaryngology
- Refer to an Aerodigestive clinic
- Other:

What symptoms would prompt you to be concerned about gastroesophageal reflux disease?
- Cough before feeds

(*continued*)

Table. Continued

- Cough during feeds
- Cough after feeds
- Nasal congestion
- Poor feeding
- Poor growth
- Spitting up
- Family history of GERD
- Erythema of the airway
- Noisy breathing
- Abdominal pain
- Wheezing
- Nausea
- Recurrent pneumonia
- Dysphagia
- Otitis media
- Sinusitis
- Postnasal drip
- Pharyngitis
- Throat clearing
- Other:

In an infant (<12 months old) in whom you think GERD is suspected, which tests/treatments do you order routinely (>50% of the time) at your FIRST visit?

- None
- H2 antagonist trial
- PPI trial
- Erythromycin trial
- Cyproheptadine trial
- Hypoallergenic diet trial
- Bloodwork
- Trial of thickening of feeds
- Upper GI barium study
- Milk scan/Gastric emptying scan
- pH-impedance probe
- pH probe
- Upper GI endoscopy with biopsies
- Videofluoroscopic swallow study/modified barium swallow study
- Fiberoptic endoscopic swallow assessment (FEES)
- Brain MRI
- Specialist referral
- Other:

In an infant (<12 months old) in whom you think GERD is suspected, which tests/treatments do you order routinely (>50% of the time) at your SECOND visit if symptoms persisted?

- None
- H2 antagonist trial
- PPI trial
- Erythromycin trial
- Cyproheptadine trial
- Hypoallergenic diet trial
- Bloodwork
- Trial of thickening of feeds
- Upper GI barium study
- Milk scan/Gastric emptying scan
- pH-impedance probe
- pH probe
- Upper GI endoscopy with biopsies
- Videofluoroscopic swallow study/modified barium swallow study
- Fiberoptic endoscopic swallow assessment (FEES)
- Brain MRI
- Specialist referral
- Other:

What percentage of your endoscopies do you perform on acid suppression?

- 0%-10%
- 10%-25%
- 25%-50%
- 50%-5%
- 75%-100%

(*continued*)

Table. Continued

What percentage of your patients that were referred for a "GERD assessment" only had respiratory signs/symptoms such as a cough, a red airway, stridor, asthma, pneumonia (NO GI SYMPTOMS)?

- 0%-10%
- 10%-25%
- 25%-50%
- 50%-75%
- 75%-100%

If you have a 4 month old, exclusively breastfed patient with noisy breathing who is found to aspirate thin liquids during videofluoroscopic swallow study but is safe for nectar thick liquids, what intervention would you recommend? (Choose one)

- None, continue breastfeeding
- Only give pumped breast milk, thickened with oatmeal
- Only give pumped breast milk, thickened with a commercial thickener (Gelmix)
- Recommend formula thickened with cereal
- Recommend formula thickened with commercial thickener (Gelmix)
- Refer to feeding team, defer recommendations until then
- Place NG tube to be able to give breast milk
- Place G-tube
- Recommend G-tube/Nissen
- Place NJ tube
- Place GJ tube
- Start acid suppression
- Start erythromycin
- Start cyproheptadine
- Other:

If you have a 4-month-old, breastfed infant with noisy breathing who is found to aspirate all textures (aspirates thin liquids, nectar thick, and honey thick liquids) but is cleared to take purees during videofluoroscopic swallow study, what intervention would you recommend? (Choose one)

- None, continue breastfeeding
- Only give pumped breast milk, thickened with oatmeal
- Only give pumped breast milk, thickened with a commercial thickener (Gelmix)
- Recommend formula thickened with cereal
- Recommend formula thickened with commercial thickener (Gelmix)
- Refer to feeding team, defer recommendations until then
- Place NG tube to be able to give breast milk
- Place G-tube
- Recommend G-tube/Nissen
- Place NJ tube
- Place GJ tube
- Start acid suppression
- Start erythromycin
- Start cyproheptadine
- Other:
- None, continue breastfeeding

A 14-year-old with developmental delay and cerebral palsy comes to your office because they had a videofluoroscopic swallow study that revealed aspiration of all textures (thins, nectar, honey and purees were aspirated). The patient does not take solids other than purees. The study was mandated by the school system to "update their records." Patient has been orally fed their whole life with no pneumonias. The family wants to continue to feed the child orally. You recommend:

- Continuing oral feeding with no changes to management
- Starting acid suppression
- Starting erythromycin
- Starting cyproheptadine
- Thickening of all liquids
- Referring to feeding team for feeding therapy
- Placing an NG tube and keeping patient NPO
- Placing an NG tube for liquids; allowing patient to eat some purees by mouth.
- Placing G-tube
- Placing G-tube/Nissen
- Placing NJ tube
- Placing GJ tube
- Other:

GERD, GE reflux disease; *GJ*, gastrojejunostomy; *MRI*, magnetic resonance imaging; *NG*, nasogastric; *NJ*, nasojejunal; *NPO*, nothing by mouth; *PPI*, proton pump inhibitor.

included 35 self-identified aerodigestive providers and 53 nonaerodigestive providers. Of the nonaerodigestive providers, 31 providers identified general gastroenterology as their primary practice type, and 22 providers identified having an additional subspecialists area, including inflammatory bowel disease (n = 5), motility (n = 4), intestinal failure (n = 4), hepatology (n = 2), nutrition (n = 1), eosinophilic GI diseases (n = 2), endoscopy (n = 1), or unspecified (n = 2). Information on the amount of time the provider had been in practice was available for 54 providers. Twelve providers (22%) had practiced between 0 and 5 years, 13 providers (24%) had practiced between 6 and 10 years, 8 providers (15%) had practiced between 11 and 15 years, 10 providers (19%) had practiced between 16 and 20 years, 5 providers (9%) had practiced between 21 and 25 years, and 6 providers (11%) had practiced over 25 years. There was no difference in the length of time in practice between aerodigestive specialists and nonaerodigestive providers ($P = .98$ by χ^2 test). There also was no difference in the length of time in practice and the average total number of responses to questions allowing "select all that apply" ($P > .05$ by ANOVA for each question). All nonaerodigestive providers worked at institutions containing an aerodigestive center; these centers ranged considerably in size with respondents estimating that they see 12 to 160 aerodigestive patients per month.

Isolated Respiratory Symptoms

The percentage of providers recommending any empiric treatment or any test are shown by group in Figure 1. Providers were asked about management of a patient with isolated respiratory symptoms referred either by primary care or pulmonology/otolaryngology. The percentage of providers who chose any test was compared between groups, and the percentage of providers who chose any empiric treatment was compared between groups. Aerodigestive providers were more likely than nonaerodigestive providers to pursue testing in each vignette ($P = .01$ for the vignette in which the patient was referred by primary care and $P = .03$ when referred by pulmonary/otolaryngology; each by χ^2 test).

Response rates for specific answer options are shown in Figure 2. When the referral came from primary care, the multivariate (GLMM) analysis found that aerodigestive providers were more likely than nonaerodigestive providers to pursue VFSS (83% of aerodigestive providers vs 59% of nonaerodigestive providers, OR 3.62 [95% CI 1.24-10.58]) or pH-MII (26% of aerodigestive providers vs 8% of nonaerodigestive providers, OR 4.45 [95% CI1.21-16.30]). When the referral came instead from pulmonary or otolaryngology, aerodigestive providers were more likely than nonaerodigestive providers to perform an upper GI barium contrast study (37% of aerodigestive providers vs 13% of nonaerodigestive providers, OR 4.39 [95% CI 1.43-13.41]).

When comparing rates of testing and empiric treatment between the 2 vignettes about isolated respiratory symptoms, nonaerodigestive providers were more likely to choose a test if the referral came from pulmonary/otolaryngology vs if the referral came from primary care (79% chose at least 1 test when the referral was from pulmonary/otolaryngology vs 66% when the referral was from primary care, $P = .02$). The rates of testing and empiric treatment did not change significantly between vignettes for aerodigestive providers.

Aspiration Practice Patterns

Providers were asked about the general scenario of a patient with suspected aspiration. The percentage of providers who chose any test was compared between groups, and the percentage of providers who chose any empiric treatment was compared between groups (Figure 1). Aerodigestive providers were less likely than nonaerodigestive providers to pursue empiric treatments ($P = .01$ by χ^2 test).

On multivariate (GLMM) analysis, aerodigestive providers were less likely than nonaerodigestive providers to trial thickening feeds (40% of aerodigestive providers vs 66% of nonaerodigestive providers, OR 0.32[95% CI 0.12-0.83]) and more likely to recommend referral to aerodigestive clinic (51% of aerodigestive providers vs 17% of nonaerodigestive providers, OR 5.64 [95% CI 2.03-15.7]). Almost all providers chose to complete a VFSS in the initial evaluation regardless of provider group (94% in the overall sample).

Feeding Difficulty Practice Patterns

Providers were asked about management of an infant with poor feeding (eg, slow feeding, dream feeding, sputtering during feeds, or discomfort during feeds) with either normal growth or poor growth. The percentage of providers who chose any test was compared between groups, and the percentage of providers who chose any empiric treatment was compared between groups (Figure 1). There was no significant difference between aerodigestive and nonaerodigestive providers for either scenario in the rate of testing ($P = .46$ for normal growth and $P = .72$ for poor growth; each by χ^2 test) or empiric treatment ($P = .69$ for normal growth and $P = .11$ for poor growth; by χ^2 test and Fisher exact tests, respectively).

On multivariate (GLMM) analysis in the normal growth vignette, aerodigestive providers were more likely than nonaerodigestive providers to refer to a feeding specialist (74% of aerodigestive providers vs 49% of nonaerodigestive providers, OR 3.25 [CI 1.19-8.88]) or to refer to aerodigestive clinic (20% of aerodigestive providers vs 4% of nonaerodigestive providers, OR 6.93 [CI 1.32-36.31]). On multivariate (GLMM) analysis in the poor growth vignette, aerodigestive providers were also more likely to recommend referral to aerodigestive clinic (31% of aerodigestive providers vs 4% of nonaerodigestive providers, OR 13.78 [CI 2.83-67.02]).

When comparing rates of testing and empiric treatment between the good growth and poor growth vignettes, aerodigestive and nonaerodigestive providers were both more likely to perform testing in the poor growth scenario than in the good growth scenario (80% of aerodigestive providers and 83% of nonaerodigestive providers chose at least one test when the infant had poor growth vs 49% and 57% when the infant had good growth, $P = .001$ and .002). Both groups were also more likely to pursue empiric treatments in the

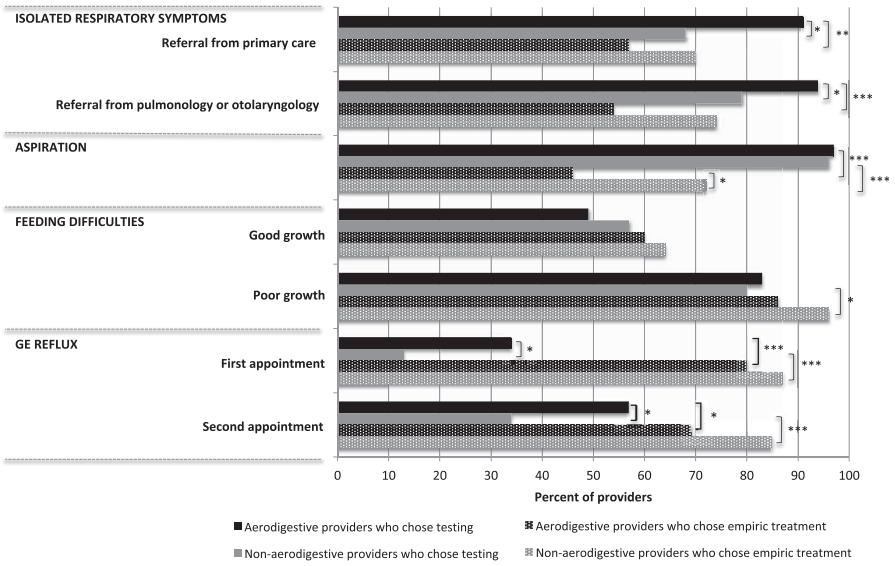

Figure 1. Rates of testing and empiric treatment in different clinical scenarios among aerodigestive and nonaerodigestive providers.

poor growth scenario than in the good growth scenario (86% of aerodigestive providers and 96% of nonaerodigestive providers chose at least 1 treatment when the infant had poor growth vs 60% and 65% when the infant had poor growth, $P = .001$ and $<.001$).

Figure 3 (available at www.jpeds.com) shows a comparison across all providers of management of poor feeding in normal growth and poor growth scenarios. In comparison to an infant with poor feeding and normal growth, when the infant had poor feeding and poor growth the response rates for several management options increased significantly in both groups, including concentrating formula, placing a nasogastric tube, performing bloodwork, performing upper endoscopy, or performing VFSS ($P < .05$).

GE Reflux Practice Patterns

Providers were asked about symptoms that would raise concern for GE reflux. There were no significant differences in response rates between aerodigestive providers and nonaerodigestive providers. Eighteen percent of providers identified one or more extraesophageal symptom (wheezing, otitis media, sinusitis, pharyngitis, postnasal drip, or erythema of the airway) with no difference between groups by χ^2 test ($P = .44$).

Providers were asked about management of an infant less than 12 months old with suspected GE reflux at both a first appointment and second appointment. The percentage of providers who chose any test was compared between groups, and the percentage of providers who chose any empiric treatment was compared between groups (**Figure 1**). Aerodigestive providers were more likely than nonaerodigestive providers to pursue testing at both visits ($P = .02$ at a first appointment and $P = .03$ at a second appointment; each by χ^2 test).

Response rates at a first appointment and second appointment for suspected infant GE reflux are shown in **Figure 4**. On multivariate (GLMM) analysis of the first appointment, aerodigestive providers were more likely than general GI providers to obtain an upper GI barium study (29% of aerodigestive providers vs 11% of general GI providers, OR 3.13 [95% CI 1.02-9.58]) and less likely than general GI providers to trial thickening feeds (26% aerodigestive providers vs 51% of general GI providers, OR 0.33 [95% CI 0.13-0.88]). At a follow-up appointment, aerodigestive providers were less likely than general GI providers to trial a hypoallergenic diet (9% aerodigestive providers vs 34% of general GI providers, OR 0.18 [95% CI 0.05-0.68]) or an H2 antagonist (9% aerodigestive providers vs. 30% of general GI providers, OR 0.22 [95% CI 0.06-0.82]).

When comparing rates of testing and empiric treatment between the first and second appointments, aerodigestive and nonaerodigestive providers were both more likely to perform testing at the second appointment compared with the first appointment (57% of aerodigestive providers and 34% of nonaerodigestive providers chose at least 1 test at the second appointment vs 34% and 13% at the first appointment, $P = .04$ and .01, respectively).

To assess the frequency with which esophagitis may be missed or masked by an acid suppression trial preceding endoscopy, clinicians were asked how often they performed endoscopies on acid suppression. There was a significant difference between response choice and whether the respondent was an aerodigestive provider ($P = .02$ by Fisher exact test). In comparison to nonaerodigestive providers, aerodigestive

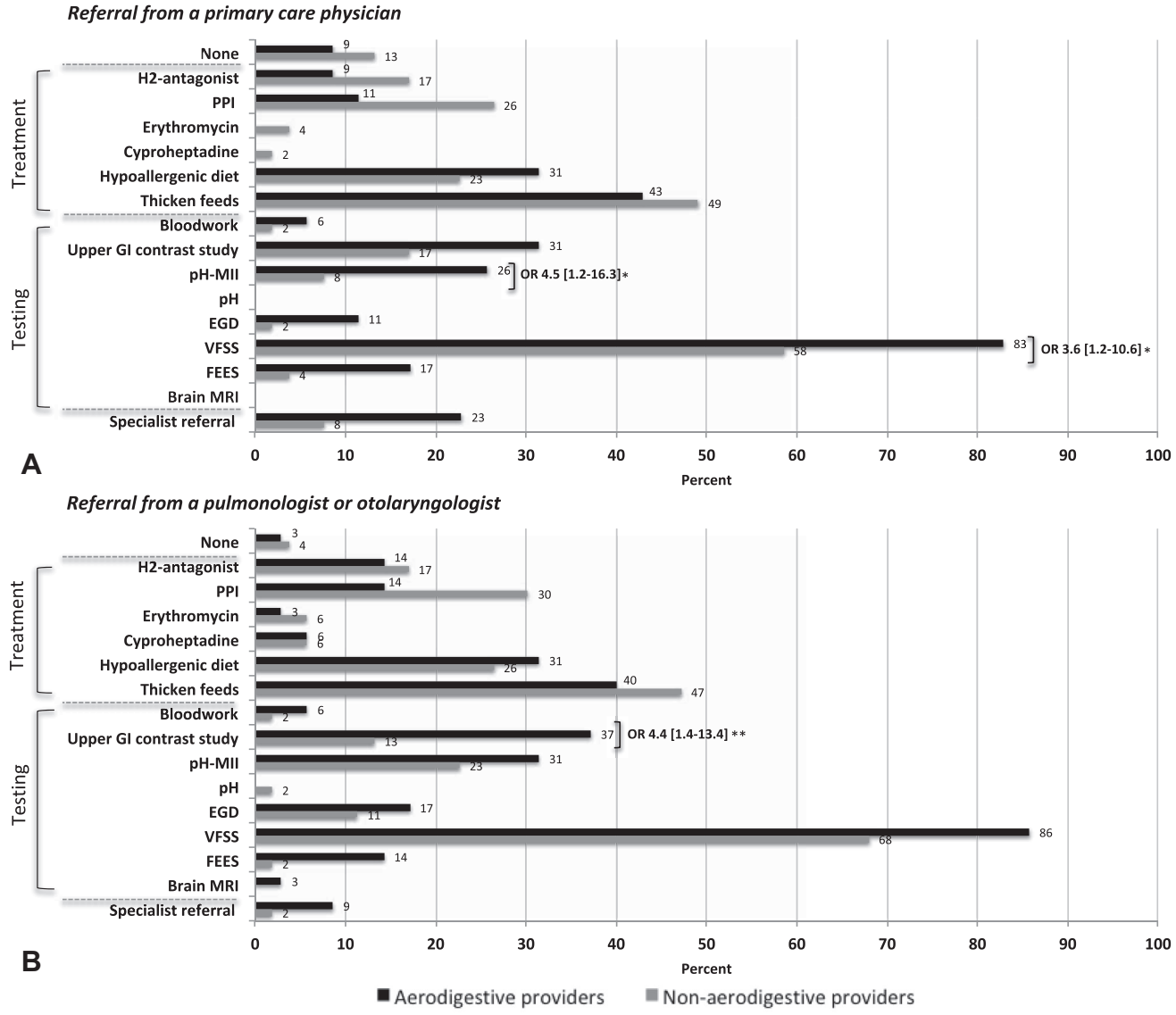

Figure 2. Comparison of aerodigestive and nonaerodigestive provider management of an infant who presents to gastroenterology clinic with isolated respiratory symptoms in whom a GI cause has been suggested either by **A,** a primary care physician or **B,** a pulmonologist or otolaryngologist. *FEES*, fiberoptic evaluation of swallowing; *MRI*, magnetice resonance imaging; *PPI*, proton pump inhibitor. Gastric emptying scan omitted from graphs as no respondents chose this option. Shown are percentages for each response choice, with OR [95% CI] from a generalized linear mixed model with empirical SEs shown for statistically significant response choices. Statistical significance is indicated by $^{*}P < .05$, $^{**}P < .01$, and $^{***}P < .001$.

providers perform more of their endoscopies off acid suppression.

Aspiration Clinical Scenarios

Providers were asked about 3 clinical scenarios related to cases of newly discovered aspiration. Two vignettes looked at the management of a 4-month-old breastfed infant found to have aspiration on VFSS. In the first vignette, the infant was found to aspirate thin liquids but not nectar thick (ie, mildly thick using the International Dysphagia Diet Standardization Initiative classification) liquids. Providers most commonly chose to thicken pumped breast milk (73% across both groups). In the second vignette, a 4-month-old infant was found to aspirate all consistencies other than purees. In this vignette, providers most commonly chose to place an nasogastric tube for breast milk and allow purees by mouth (72% across both groups). A third vignette described a 14-year-old orally fed patient with developmental delay and cerebral palsy with no history of pneumonia who was found to have aspiration of all textures (thins, nectar thick, honey thick, and purees). There was wide variability in response rates to this scenario with 24% continuing feeding orally with no changes to management, 3% thickening oral feeds, 15% placing a nasogastric tube, 17% placing a gastric tube,

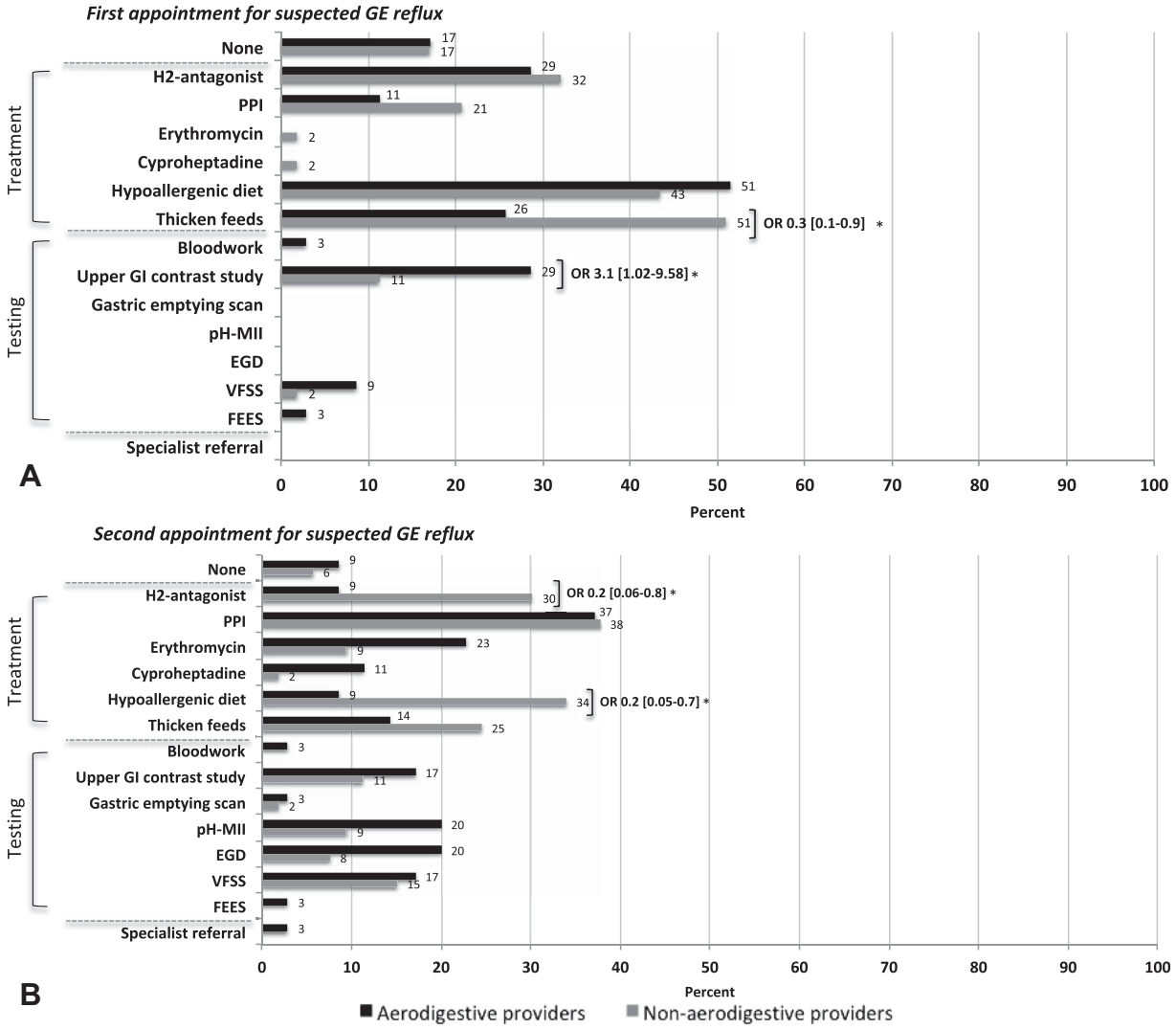

Figure 4. Comparison of aerodigestive and non-aerodigestive provider management of an infant with suspected GE reflux at **A,** a first appointment and **B,** a second appointment if symptoms persisted. *FEES*, fiberoptic evaluation of swallowing; *PPI*, proton pump inhibitor. pH and brain MRI omitted from graphs as no respondents chose these options. Shown are percentages for each response choice, with OR [95% CI] from a generalized linear mixed model with empirical SEs shown for statistically significant response choices. Statistical significance is indicated by **P* < .05, ***P* < .01, and ****P* < .001.

20% referring to feeding team, and 21% choosing "other." Those who chose "other" wrote in answers involving using shared decision making (10%) performing lung imaging (6%), referring to aerodigestive (2%), or needing more information to answer (2%). Interestingly, there were no differences in response rates between aerodigestive and nonaerodigestive providers on the Fischer exact test for any of these aspiration scenarios ($P = .08–.98$).

Discussion

Aerodigestive symptoms such as reflux, spitting up, aspiration, and feeding difficulties are common and represent frequent reasons for referral to pediatric gastroenterology.[9,10] Multidisciplinary aerodigestive centers have been shown to increase patient satisfaction and cost effectiveness, but little is known about how GI management within these centers differs from management outside of aerodigestive centers.[3,4] We found that aerodigestive providers pursued more testing and less empiric treatment in comparison to nonaerodigestive providers, and they were less likely to perform endoscopies on acid suppression.

The variable rate of testing found in our study, with higher rates by the aerodigestive providers, highlights the need for further research regarding the timing of the many tests available in the workup of aerodigestive symptoms. For example, our study found that aerodigestive providers were more likely than nonaerodigestive providers to recommend an upper GI barium contrast study as part of the evaluation of an infant with GE reflux. Although the reason for these differences

cannot be definitively determined from this study, it is possible that the results are at least partially driven by the high rates of patients with associated congenital anomalies, such as tracheoesophageal fistulae, seen in aerodigestive centers. Similarly, in patients with isolated respiratory symptoms, aerodigestive providers in our study were more likely than nonaerodigestive providers to recommend pH-MII and VFSS, both of which may be useful for this indication in certain scenarios. Although these vignettes also did not delve into the reasons behind testing, 1 possible explanation for these group differences is that the pretest probability may differ based on differences in daily clinical practice; for example, given that the goal of many aerodigestive centers is to "un-diagnose" or exclude GE reflux as a cause for extraesophageal symptoms, pH-MII testing may be earlier in the diagnostic algorithm for aerodigestive providers. Similarly, because many aerodigestive centers see high volumes of aspirating patients, VFSS may be performed early because of the high likelihood of a positive test in this selective referral population. Further research would be needed to distinguish between these possibilities and to establish the overall utility and cost effectiveness of different approaches to testing and treatment.

When treating suspected GE reflux in an infant, providers in both groups more commonly chose empiric treatments over testing. At a first appointment for GE reflux, providers most frequently chose to switch to a hypoallergenic diet or to thicken feeds. Acid suppression was the most common recommendation at a second appointment for continued GE reflux symptoms. This management generally mirrors the algorithm in the 2018 Pediatric GE Reflux Clinical Guidelines from NASPGHAN/European Society for Pediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN), which recommends thickening feeds followed by switching to a hypoallergenic diet as the initial steps in management of infants with suspected GE reflux disease.[11] However, some providers' responses to these questions deviated from the guidelines. For example, a subset of providers from both groups recommended acid suppression at the first appointment for suspected infant reflux (29% of aerodigestive providers and 32% of nonaerodigestive providers recommended H2-antagonists, and 11% of aerodigestive providers and 21% of nonaerodigestive providers recommended proton pump inhibitor). This continued early use of acid suppression for infant GE reflux in a subset of providers may be a focus for additional quality studies to reduce acid suppression use in this population, as randomized controlled studies have failed to show a benefit of acid suppression for symptom control in infants.[12-15] Patients often also are referred to GI providers already on acid suppression started by primary care, so this could be another area of future focus in terms of care standardization for these patients. In addition, as discussed above, there was a high rate of testing in the aerodigestive group, particularly with upper GI contrast studies, which could represent excessive testing depending on the clinical scenario. Further research is needed to understand the reasoning behind these testing choices and the yield of testing in aerodigestive populations.

Symptoms of GE reflux vary and can be particularly nonspecific in infants and nonverbal children.[11,16] Notably, when identifying symptoms that would raise concern for GE reflux, a minority of providers in both groups chose options involving extraesophageal signs and symptoms, such as wheezing, otitis media, sinusitis, postnasal drip, pharyngitis, or erythema of the airway. The role of GE reflux in these types of extraesophageal symptoms remains controversial; no study has definitively shown a relationship between these symptoms or signs and GE reflux events by pH probe or pH-impedance.[17-19] Our findings indicate that most pediatric gastroenterologists put less weight on extraesophageal symptoms when considering whether a patient has GE reflux.

When asked about evaluation of suspected aspiration risk, providers in both groups overwhelmingly chose VFSS as a first step in evaluation. However, there was notable variability in subsequent management in 3 clinical scenarios. Particularly for a case of a teenager with cerebral palsy without history of pneumonias who was found to have aspiration of all textures, there was a large range of responses, from continuing oral feeding to placement of a gastric tube. Many providers importantly identified in the free response section that they would use shared decision making with the family in this situation, underscoring the complexity and potentially subjectivity of this scenario. Further research on the risks and benefits of these options, as well as ethical considerations, would be helpful in guiding providers and families.[20]

There are a few limitations to this study. First, given that this was a voluntary questionnaire, there may be a response bias in terms of which providers chose to respond. Also, given that the questionnaire was distributed on general email lists, we were unable to calculate the response rate, which limits our ability to assess generalizability. We did attempt to mitigate response bias by widely distributing the survey at multiple institutions with differing characteristics. A related limitation is that we received responses from a diversity of gastroenterologists, ranging from generalists to subspecialists, which may effect generalizability. We also did not have responses from smaller private practices, which may have different management patterns from larger practices or academic institutions. Another limitation was that we had minimal ability to understand the reasoning behind certain responses given that most questions involved multiple-choice; this would be an important next study to understand the rationale behind decision-making. Finally, given that the questionnaire is not validated and was purposefully designed with questions that may have more than one correct answer or no clear correct answer, we are unable to determine from this study which patterns of practice are more desirable.

In conclusion, our study identified several areas of divergent practices between aerodigestive and nonaerodigestive pediatric gastroenterology providers, with aerodigestive providers performing more testing and less empiric treatment. These findings highlight opportunities for additional research related to aerodigestive management and creation

of future clinical practice guidelines to increase standardization of care. ■

Submitted for publication Sep 11, 2020; last revision received Dec 18, 2020; accepted Dec 22, 2020.

Reprint requests: Rachel Rosen, MD, Aerodigestive Center, Boston Children's Hospital, 300 Longwood Ave, HUN Ground, Boston, MA 02115. E-mail: Rachel.Rosen@childrens.harvard.edu

References

1. Boesch RP, Balakrishnan K, Acra S, Benscoter DT, Cofer SA, Collaco JM, et al. Structure and functions of pediatric aerodigestive programs: a consensus statement. Pediatrics 2018;141:e20171701.
2. Gumer L, Rosen R, Gold BD, Chiou EH, Greifer M, Cohen S, et al. Size and Prevalence of pediatric aerodigestive programs in 2017. J Pediatr Gastroenterol Nutr 2019;68:e72-6.
3. Ruiz AG, Bhatt JM, DeBoer EM, Friedlander J, Janosy N, Peterson MB, et al. Demonstrating the benefits of a multidisciplinary aerodigestive program. The Laryngoscope 2020;130:521-5.
4. Skinner ML, Lee SK, Collaco JM, Lefton-Greif MA, Hoch J, Au Yeung KJ. Financial and health impacts of multidisciplinary aerodigestive care. Otolaryngol Neck Surg 2016;154:1064-7.
5. DeBoer EM, Kinder S, Duggar A, Prager JD, Soden J, Deterding RR, et al. Evaluating the yield of gastrointestinal testing in pediatric patients in aerodigestive clinic. Pediatr Pulmonol 2018;53:1517-24.
6. Cosme-Blanco W, Arroyo-Flores E, Ale H. Food allergies. Pediatr Rev 2020;41:403-15.
7. Barron JJ, Tan H, Spalding J, Bakst AW, Singer J. Proton pump inhibitor utilization patterns in infants. J Pediatr Gastroenterol Nutr 2007;45:7.
8. Slaughter JL, Stenger MR, Reagan PB, Jadcherla SR. Neonatal histamine-2 receptor antagonist and proton pump inhibitor treatment at United States children's hospitals. J Pediatr 2016;174:63-70.e3.
9. Lightdale JR, Gremse DA. Section on gastroenterology, hepatology, and nutrition. Gastroesophageal reflux: management guidance for the pediatrician. Pediatrics 2013;131:e1684-95.
10. Nelson SP. Prevalence of symptoms of gastroesophageal reflux during childhood: a pediatric practice-based survey. Arch Pediatr Adolesc Med 2000;154:150.
11. Rosen R, Vandenplas Y, Singendonk M, Cabana M, DiLorenzo C, Gottrand F, et al. Pediatric Gastroesophageal Reflux Clinical Practice Guidelines: joint recommendations of the North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition and the European Society for Pediatric Gastroenterology, Hepatology, and Nutrition. J Pediatr Gastroenterol Nutr 2018;66:516-54.
12. Moore DJ, Tao BS-K, Lines DR, Hirte C, Heddle ML, Davidson GP. Double-blind placebo-controlled trial of omeprazole in irritable infants with gastroesophageal reflux. J Pediatr 2003;143:219-23.
13. Orenstein SR, Hassall E, Furmaga-Jablonska W, Atkinson S, Raanan M. Multicenter, double-blind, randomized, placebo-controlled trial assessing the efficacy and safety of proton pump inhibitor lansoprazole in infants with symptoms of gastroesophageal reflux disease. J Pediatr 2009;154:514-20.e4.
14. Cohen S, Bueno de Mesquita M, Mimouni FB. Adverse effects reported in the use of gastroesophageal reflux disease treatments in children: a 10 years literature review: Gastroesophageal reflux disease in children. Br J Clin Pharmacol 2015;80:200-8.
15. Malchodi L, Wagner K, Susi A, Gorman G, Hisle-Gorman E. Early acid suppression therapy exposure and fracture in young children. Pediatrics 2019;14:e20182625.
16. Sherman PM, Hassall E, Fagundes-Neto U, Gold BD, Kato S, Koletzko S, et al. A Global, evidence-based consensus on the definition of gastroesophageal reflux disease in the pediatric population. Am J Gastroenterol 2009;104:1278-95.
17. Thakkar K, Boatright RO, Gilger MA, El-Serag HB. Gastroesophageal reflux and asthma in children: a systematic review. Pediatrics 2010;125:e925-30.
18. Rosen R, Mitchell PD, Amirault J, Amin M, Watters K, Rahbar R. The edematous and erythematous airway does not denote pathologic gastroesophageal reflux. J Pediatr 2017;183:127-31.
19. Jettté ME, Gaumnitz EA, Birchall MA, Welham NV, Thibeault SL. Correlation between Reflux and multichannel intraluminal impedance pH monitoring in untreated volunteers. The Laryngoscope 2014;124:2345-51.
20. Rosen R, Kamin D, Simoneau T, Larson K, Hotz A, Mauskar S, et al. The ethics of feeding the aspirating child in an age of increasing patient complexity. J Pediatr Gastroenterol Nutr 2020. Published ahead of print.

Appendix

Additional members of the NASPGHAN Aerodigestive Interest Group

Sari Acra, MD, MPH, Division of Pediatric Gastroenterology, Hepatology and Nutrition, Vanderbilt University Medical Center, Nashville, TN

Vrinda Bhardwaj, MD, FAAP, Division of Gastroenterology and Nutrition, Children's Hospital Los Angeles, Los Angeles, CA

Eric H. Chiou, MD, Division of Gastroenterology, Hepatology and Nutrition, Baylor College of Medicine, Houston, TX

Jason E. Dranove, MD, Division of Gastroenterology, Hepatology and Nutrition, Atrium Health Levine Children's, Charlotte, NC

Benjamin D. Gold, MD, Division of Gastroenterology, GI Care for Kids, Children's Healthcare of Atlanta, Atlanta, GA

Melanie Greifer, MD, Aerodigestive Center, Hassenfeld Children's Hospital, NYU Langone Health, New York City, NY.

Lindsey Gumer, MD, Division of Pediatric Gastroenterology, Hepatology and Nutrition, Children's Hospital Colorado, Aurora, CO

Diana G. Lerner, MD, Division of Pediatric Gastroenterology, Hepatology and Nutrition, Medical College of Wisconsin, Children's Wisconsin, Milwaukee, WI

Dominique Lévesque, MD, FRCPC, Division of Gastroenterology, Montreal Children's Hospital, Montreal, Quebec, Canada

Meredith Lind, MD, Department of Pediatric Otolaryngology, Nationwide Children's Hospital, Columbus, OH

Dana I. Williams, MD, Division of Gastroenterology, Phoenix Children's Hospital, Phoenix, AZ

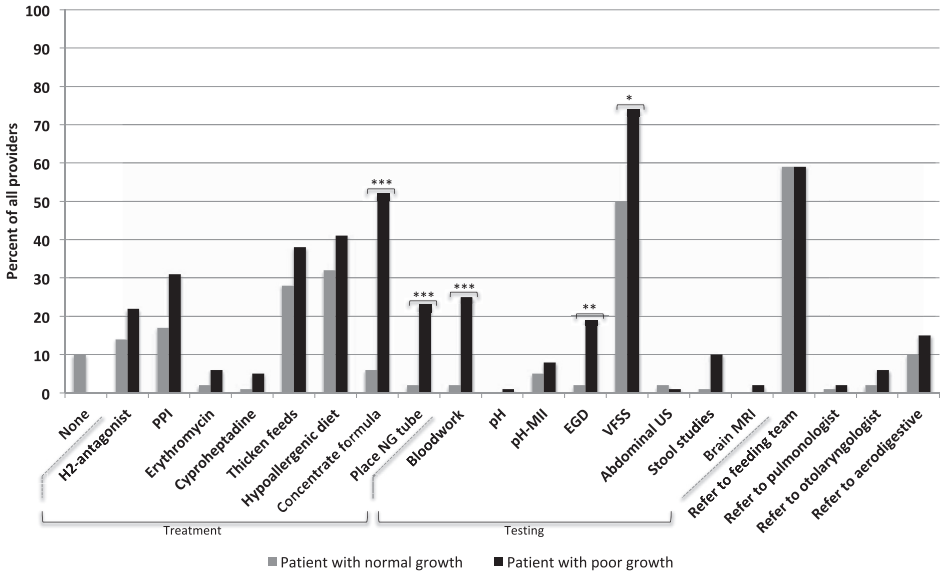

Figure 3. Management of an infant with poor feeding in all providers compared across normal growth and poor growth scenarios. *MRI*, magnetice resonance imaging; *PPI*, proton pump inhibitor. Statistical significance is indicated by $^{*}P < .05$, $^{**}P < .01$, and $^{***}P < .001$.