International Pediatric Otolaryngology Group (IPOG) consensus on approach to aspiration

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ABSTRACT

Objective:

To provide recommendations for a comprehensive management approach for infants and children presenting with symptoms or signs of aspiration.

Methods:

Three rounds of surveys were sent to authors from 23 institutions worldwide. The threshold for the critical level of agreement among respondents was set at 80%. To develop the definition of "intractable aspiration," each author was first asked to define the condition. Second, each author was asked to complete a 5-point Likert scale to specify the level of agreement with the definition derived in the first step.

Results:

Recommendations by the authors regarding the clinical presentation, diagnostic considerations, and medical and surgical management options for aspiration in children.

Conclusion:

Approach to pediatric aspiration is best achieved by implementing a multidisciplinary approach with a comprehensive investigation strategy and different treatment options.

Keywords: Infant, Child, Delphi Method, Aspiration

1. Consensus objectives

To provide recommendations for a comprehensive management approach for infants and children presenting with symptoms or signs of aspiration.

2. Target population

Pediatric patients with symptoms or signs of aspiration.

3. Intended users

These recommendations are intended to:

1. Provide initial guidance and diagnostic recommendations to physicians and health care providers who evaluate young infants and children with possible aspiration.

2. Provide comprehensive care and management recommendations to otolaryngologists who manage these patients.

4. Methods

The mission of the International Pediatric Otolaryngology Group (IPOG) is to develop recommendations for the management of pediatric otolaryngological disorders and improve patient care. Based on a thorough literature review, we identified a pediatric otolaryngology-related topic with a knowledge gap, identified the scope and population of interest, and recruited a panel. The authors were selected based on their clinical expertise, publications, national/international presentations, and/or leading programs.

Recommendations were obtained from physicians in 23 institutions worldwide through three rounds of web-based surveys. The threshold for the critical level of agreement among respondents was set at 80%. To develop the definition of "intractable aspiration," each author was asked to define it separately; then in the

second round, the authors were asked to specify their level of agreement on the developed definition on a 5-point Likert scale. Consensus was defined as a mean score of 3.89 (77.8%) or higher and one or fewer outliers [1]. Outliers were defined as any deviation from the mean score of two or more Likert points [1]. The approach to aspiration algorithm was developed by the first and senior authors based on the results of the first 2 rounds. All authors provided a critical review of the algorithm.

5. Recommendations and justification

• **Section 1:** Clinical presentation

This section aimed to guide physicians in the detection of pediatric patients with possible aspiration. Early detection and initiation of the investigation algorithm are valuable, along with timely referral to a pediatric otolaryngologist within a multidisciplinary team.

Children with aspiration may present with choking, coughing, recurrent respiratory infections, a wet voice, inefficient feeding, and/or poor weight gain [2,3] (Table 1). The laryngeal cough reflex in term infants matures by 1-2 months of age, and its maturation may be delayed up to 12 months [4]. Before the development of the cough reflex, infants protect their airways from aspiration via the laryngeal adductor reflex [4]. Thus, infants with aspiration more commonly present with stridor, apnea/desaturation, and/or bradycardia during feeding rather than the classic cough [4].

Recurrent pneumonia was defined as two or more episodes in a year or more than three episodes in a lifetime [3]. Recurrent aspiration leads to progressive respiratory morbidity (lower respiratory tract infections, bronchiectasis, and respiratory failure/supplemental oxygen requirement), recurrent hospitalization, and possibly mortality [5]. There was unanimous support for pneumonia as a red flag for aspiration, followed by choking and wet voice/gurgling. Other

symptoms or signs mentioned by the group but not listed in the table included low baseline saturation without other known lung diseases, bronchiectasis, or sialorrhea. Sialorrhea can be defined as either anterior or posterior drooling; we discuss posterior drooling in this manuscript as anterior drooling was covered by a previous IPOG consensus [6].

Table 1. Red flags identified by the authors as concerns for possible aspiration

SYMPTOMS AND SIGNS OF CONCERN FOR ASPIRATION	PERCENTAGE OF RESPONDENTS IN AGREEMENT
Pneumonia	100%*
Choking	96.3%*
Wet voice/gurgling	96.3%*
Coughing	92.6%*
Apnea/desaturation or bradycardia with feeding	88.9%*
Noisy breathing while feeding	85.2%*
Deteriorating pulmonary status	81.5%*
Abnormal pulmonary auscultation	55.6%
Inefficient feeding	55.6%
Noisy breathing	44.4%
Poor weight gain	44.4%

*Reached agreement between authors.

Section 2: Workup for aspiration

The authors identified important investigative considerations. The variation in practice among current group members remains, and this section aimed to provide a list of reasonable options based on the authors' opinions.

Investigations that reached 80% agreement by the authors regarding their helpfulness in the workup of aspiration included fiberoptic endoscopic evaluation of swallowing (FEES), videofluoroscopic swallowing study (VFSS), clinical bedside feeding evaluation, and direct laryngoscopy and bronchoscopy (Figure 1). The other investigations did not reach a consensus but remained reasonable options available for use (Table 2). Most investigations help to confirm the diagnosis of aspiration, and some also identify the underlying cause.

FEES confirms the diagnosis of aspiration and provides information on both the anatomical and physiological components of swallowing as well as the sensory function and protective mechanism [7]. Awake flexible laryngoscopy allows the identification of anatomical abnormalities in the nasopharynx, oropharynx, and hypopharynx, all of which can contribute to swallowing dysfunction in the pediatric population [7]. In particular, the laryngeal anatomy and normal vocal fold mobility are assessed, allowing for the diagnosis of laryngomalacia and/or vocal fold immobility, both of which can contribute to aspiration [8,9]. The addition of colorants during FEES helps to identify pooling within the piriform sinus, laryngeal penetration, or aspiration. FEES is valid and safe for both infants and children, even those who are primarily breastfed [10]. It is best performed in a multidisciplinary collaboration with a speech-language pathologist or an occupational therapist. It has an additional advantage in that it is readily accessible and can be performed in an outpatient clinic or at the bedside [7,10]. FEES can be used as an adjunct to VFSS or as an alternative to short-interval repeated VFSS to limit radiation

exposure [7,11]. However, it is important to emphasize that this exam can be affected by a lack of cooperation from the infant/child, the degree of crying, and movement. In addition, the glottic view is occasionally difficult to obtain, and FEES does not provide an adequate assessment of the oral phase or, to some extent, the pharyngeal phase of swallowing.

VFSS involves an integrated dynamic evaluation of the oral, pharyngeal, and esophageal phases of swallowing and is the most reliable method for detecting silent aspiration [2,11,12]. During VFSS, the safe liquid and solid consistencies are established for each patient to reduce the likelihood of aspiration [13]. There is controversy in the literature in regards to the impact of the presence of a nasogastric tube on the VFSS results [13,14].

Clinical feeding evaluation is a non-invasive complementary assessment that provides important clinical information [4]. It involves general and neurodevelopmental examinations and the assessment of oral motor control, sucking reflex, and voice quality after feeding. It can also detect signs of coughing, gagging, stridor, increased work of breathing, desaturation, and nasal regurgitation after feeding [2,4]. Although valuable, bedside swallowing assessments may be falsely negative for aspiration because 80% of pediatric aspirations are silent without overt clinical signs [2,15]. This should be performed when the child is in optimal condition, as the level of alertness, fatigue, agitation, and clinical stability may influence the results. This is of particular concern because undetected chronic aspiration can lead to pulmonary sequelae.

In patients with aspiration, microlaryngoscopy and bronchoscopy (MLB) provide a higher diagnostic yield for aspiration-related airway lesions than flexible laryngoscopy [9]. A history of recurrent pneumonia is an important predictor of identifying airway lesions on MLB related to aspiration [9]. The MLB aids in identifying anatomical contributions to aspiration,

such as the presence of a deep interarytenoid groove, laryngeal cleft, or tracheoesophageal fistula, which can be surgically repaired [8,9].

Flexible bronchoscopy allows visualization of the airway until the segmental and subsegmental bronchi and is useful for diagnostic and therapeutic bronchoalveolar lavage (BAL) [16]. Diagnostic BAL provides information on the degree of airway inflammation and underlying microbiological pathogens in the aspirated fluid [17]. However, BAL cultures have low sensitivity for detecting pathogens, which can be enhanced by implementing a multiplex polymerase chain reaction detection method [18]. Measurement of lipid-laden macrophages and pepsin detection from BAL fluid are utilized in the diagnosis of aspiration of gastroesophageal reflux (indirect aspiration) [19,20]. However, there is no significant correlation between pepsin positivity in BAL and pH impedance parameters or upper gastrointestinal (GI) pathology [20].

For the indirect aspiration workup, pH-study, impedance manometry, and upper GI endoscopy may provide additional information. The Modified Evans Blue Dye test is a diagnostic option for children with tracheostomy tubes. Despite being supported by only 59.3% of the authors, it remains a valuable screening tool for aspiration [21].

Table 2: Investigations helpful in a child suspected of aspiration

INVESTIGATIVE OPTION	PERCENTAGE OF RESPONDENTS IN AGREEMENT
Functional endoscopic evaluation of swallow	96.3%*
Videofluoroscopy	88.9%*
Clinical bedside feeding evaluation	88.9%*
Direct laryngoscopy and bronchoscopy	85.2%*
Awake fiberoptic laryngoscopy	74.1%
Flexible bronchoscopy & bronchoalveolar lavage	70.4%
Dye study in the presence of tracheostomy	59.3%
Chest Computed Tomography scan	51.9%
Chest X-ray	40.7%
pH-study & impedance manometry	18.5%

*Reached agreement between authors.

• **Section 3:** Management of pediatric aspiration

The management of pediatric aspiration is best accomplished with the involvement of a multidisciplinary team. Multidisciplinary teams exist in many forms ranging from comprehensive programs to ad hoc groups of specialists. Ideally, teams include or have access to pediatric otolaryngologists, speech and language pathologists, occupational therapists, pulmonologists, gastroenterologists, pediatric surgeons, nutritionists, radiologists, and general pediatricians. Collective perspectives of expertise in different specialties can improve diagnostic processes and guide management decisions. Management of pediatric aspiration includes diet modification and medical and/or surgical interventions (Figure 1).

3.1. Conservative/medical interventions:

The role of conservative management is highlighted as silent aspiration in children can spontaneously resolve over time [22]. In pediatric patients with normal upper airway anatomy, feeding and swallowing therapy may result in resolution of aspiration [9]. Additionally, targeted feeding therapy can provide a foundation to maximize success of procedures.

The respondents were asked to list all the conservative/medical treatment options that their team offer for aspiration. All authors supported the use of diet modification and positioning during feeding in pediatric patients with aspiration as a first-line intervention. Other conservative/medical treatment options that were agreed upon included temporary gavage feeding and, in patients with drooling, salivary gland botulinum toxin injections (Table 3). Neuromuscular electrical stimulation can be helpful in children with aspiration who also have oropharyngeal dysphagia, as it improves swallowing function throughout repeated sessions lasting 1-6 months [23].

The medical management of posterior drooling includes anticholinergic medications that reduce salivary volume. Glycopyrrolate is effective in reducing drooling in children; however, 35%–83% of children may develop adverse effects requiring its discontinuation [24]. The side effects of anticholinergic medications include behavioral changes, excessive oral dryness, urinary retention, changes in bowel habits, thickened secretions, and blurry vision [24].

Table 3: Conservative/medical treatment options for aspiration listed by authors

CONSERVATIVE/MEDICAL INTERVENTION	PERCENTAGE OF RESPONDENTS IN AGREEMENT
Diet modification	100%*
Positioning during feeding	100%*
NGT/GT feeding	96.2%*
Salivary glands botulinum toxin injection	92.3%*
Anticholinergic drugs for sialorrhea	19.2%
Reflux treatment	11.5%

*Reached agreement between authors.

Abbreviations: Nasogastric tube (NGT); gastrostomy tube (GT)

3.2 Surgical Management:

Various surgical options are available and tailored to the underlying cause: whether aspiration is secondary to a known anatomical airway anomaly (Table 4) or to other etiologies that are often neurological or physiological (Table 5).

3.2.1 Surgical management of aspiration secondary to a known anatomic airway anomaly:

Airway anomalies that may contribute to aspiration and can be addressed surgically include laryngeal cleft, laryngomalacia, vocal cords paresis/paralysis, tracheoesophageal fistula (TEF), oropharyngeal or lingual tonsil obstruction, cricopharyngeal dysfunction, or esophageal stricture. The respondents were asked to list all surgical treatment options that their team offer for aspiration secondary to anatomic airway anomaly (Table 4).

Table 4: Surgical treatment options identified by the authors as being performed at their institutions to address aspiration secondary to anatomic airway anomaly

DIAGNOSIS	SURGICAL PROCEDURES	PERCENTAGE
Laryngeal cleft	Laryngeal cleft injection	69.2%
	Laryngeal cleft suture repair	96.2%
Laryngomalacia	Supraglottoplasty	92.3%
Vocal fold paralysis	Vocal fold injection augmentation	84.6%
	RLN reinnervation procedure	53.8%
Tracheoesophageal fistula	Endoscopic TEF repair	65.4%
	Open TEF repair	76.9%
Oropharyngeal or lingual tonsils obstruction	Palatine or lingual tonsillectomy	90.9%
Cricopharyngeal dysfunction	Cricopharyngeal myotomy	81.8%
Esophageal stricture	Esophageal dilation	100%

Abbreviations: Recurrent laryngeal nerve (RLN); tracheoesophageal fistula (TEF)

3.2.2 Surgical management of salivary aspiration:

The authors were asked to list all surgical treatment options that their team offer for salivary aspiration (Table 5). Excision of the bilateral submandibular glands with ligation of the parotid ducts was agreed upon by the authors as the surgical intervention of choice for saliva aspiration. Direct resection or ligation of the submandibular glands reduces the incidence of nonviral respiratory infections, respiratory-related emergency visits, and hospitalizations [25].

Table 5: Surgical treatment options for salivary aspiration

SURGICAL INTERVENTION		PERCENTAGE OF RESPONDENTS IN AGREEMENT
Salivary gland surgery	Excision of the submandibular glands with ligation of the parotid ducts	81.5%*
	Excision of the submandibular glands only	55.6%
	4-Duct ligation	37.0%
	Excision of the submandibular and sublingual glands, and ligation of the parotid ducts	33.3%
	Excision of the submandibular and sublingual glands	29.6%
	3-Duct ligation (2 submandibular ducts and 1 parotid duct)	18.5%
Other surgeries	Tracheostomy	70.4%
	Laryngotracheal separation	40.7%

*Reached agreement between authors.

Section 4: Postoperative assessment

The authors were asked to list all potential post-operative investigation(s) they might perform to determine the success of a surgical intervention for pediatric aspiration. VFSS was the most valued by the authors (21 responses, 77.8%). Of these 21 respondents, some reported that they used VFSS *and/or* FEES (nine responses, 32.14%). Four authors (14.28 %) reported using FEES alone. The decision to perform a postoperative swallowing study was guided by the preoperative findings. Patients with silent aspiration would benefit the most from postoperative VFSS or FEES, whereas clinical evaluation might be sufficient for patients with clinically overt aspiration.

There is variability in the available hospital resources, access to speech/language pathologists/occupational therapists, and increased awareness of the risks of radiation exposure in the pediatric population, which can affect diagnostic strategies. Other follow-up modalities suggested by the authors included the thickener-weaning protocol, MLB, a salivagram for saliva aspiration, and dye testing in the presence of a tracheostomy.

Section 5: Intractable aspiration

The group was asked to define “intractable aspiration” as there is no clear definition in the literature. Many respondents deemed this to be controversial. The most comprehensive definition obtained by the authors was persistent aspiration despite maximal rehabilitative, medical, and surgical interventions (excluding laryngotracheal separation and diversion procedures). Intractable aspiration can lead to clinically important sequelae such as progressive pulmonary deterioration.

The authors scored the definitions on a 5-point Likert scale (mean = 4.85, SD = 0.36). Although no consensus was reached as there were four outliers (deviation from the mean score by two or more Likert points), 23 (85.2%) respondents strongly agreed with the definition.

Aspiration is considered persistent after at least 3-months of an intensive feeding therapy trial. Patients with an underlying neurological deficit, chronic inability to handle secretions, or abnormal cough reflex are at an increased risk of intractable aspiration. Intractable aspiration can be addressed by (percentage of respondents in agreement): laryngotracheal separation (96.3%), tracheostomy (70.4%), diversion procedure (55.6%), or narrow field laryngectomy (40.7%).

6. Conclusion

The management of pediatric aspiration is best achieved through a multidisciplinary approach with a comprehensive investigation strategy and different treatment options.

7. Disclaimer

The mission of the IPOG is to develop recommendations for the management of pediatric otolaryngologic disorders to improve patient care. Recommendations are based on the collective opinions of the authors for each specific topic/publication. Any person seeking to apply or consult a report is expected to use an independent medical judgment in the context of individual patients and institutional circumstances.

8. Authors contributions

Dr. Bshair Aldriweesh is the first author and Dr. Sam J Daniel is the senior author. The remaining authors are listed in alphabetical order. All authors contributed to the drafting and critical revision of the recommendations. All authors approved the final version of this manuscript and agreed to be accountable for all aspects of this work.

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Figure legends

Figure 1. Approach to aspiration algorithm