

The Multidisciplinary Approach to Pediatric Aerodigestive Disorders

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Multidisciplinary programs for the care of children with upper and lower respiratory and gastrointestinal tract disorders have emerged across the United States and become known as aerodigestive centers. This model is designed to improve clinical outcomes and healthcare value through a coordinated approach by a team that appreciates the inter-relatedness of these disorders. The primary elements include: (1)

Interdisciplinary medical and surgical team, (2) Care coordination, (3) Team meeting, and (4) Combined endoscopic procedures. This article will describe the origin and current trends in the multidisciplinary approach to pediatric aerodigestive disorders.

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Advances in the care of critically ill children and neonates have created a growing population of children with complex chronic multi-system diseases.¹ Their care is costly and complex, characterized by multiple procedures, heavy reliance on technology and multi-specialist care, and frequent hospitalizations. Parents and primary care providers experience frustration with lack of coordinated care plans and poor access to information. The imperative to improve the care of at-risk populations within a model that provides consistent, efficacious, cost-effective, outcomes-driven, patient-centered, family-focused care is widely recognized. This goal is exemplified by the triple aim proposed by the Institute for Healthcare Improvement: (1) improving the experience of care, (2) improving the health of populations, and (3) reducing the per capita costs of healthcare.² Achieving these aims requires tightly integrated multidisciplinary care teams. Research evaluating the efficacy of this approach in reducing costs and improving outcomes in children has recently emerged. One study of the impact of a comprehensive primary care clinic for children with special healthcare needs demonstrated decreased non-ICU length of stay, but no improvement in cost of care (the cost shifted from

inpatient to outpatient).³ Another study reported a reduction in hospitalization rates and total costs billed to Medicaid for medically complex patients in the year following enrollment compared to the prior year.⁴ Others have demonstrated improved parent satisfaction and decreased caregiver strain with this model.^{5,6} The only study available specifically investigating the impact of an interdisciplinary approach to pediatric aerodigestive care estimated a reduction in anesthetic episodes with an estimated reduction in associated cost as well as the parental burden of multiple trips to the medical center.⁷

There is no better example of this need for integrated care than the “aerodigestive” patient. This term has no single accepted definition, but is taken to mean a child with complex congenital or acquired conditions affecting breathing, swallowing, and growth to various degrees. This includes structural or functional airway disease, chronic parenchymal lung disease, lung injury from aspiration or infection, chronic respiratory failure, chest wall disorders, central or obstructive sleep apnea, gastroesophageal reflux, eosinophilic esophagitis, esophageal dysmotility or stricture, swallowing incoordination, oral aversions, and behavioral feeding problems (Table 1). An example of such a child is a 16-month-old former 27-week premature infant with chronic lung disease, moderate tracheobronchomalacia, deep interarytenoid notch, tracheostomy for subglottic stenosis, mild oral aversions who takes some oral feeds and some via gastrostomy, has premature spillage and laryngeal penetration when drinking liquids, a prior fundoplication and small paraesophageal hernia, and develops tachypnea and

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TABLE 1. Common aerodigestive presenting conditions

Airway	Choanal atresia Laryngomalacia Glossoptosis Vocal cord paralysis Laryngotracheoesophageal cleft Stenosis: glottic, subglottic, tracheal, complicated Tracheobronchomalacia Tracheoesophageal fistula Tracheostomy dependence
Pulmonary	Chronic lung disease of prematurity Diffuse lung diseases Asthma Bronchiectasis: aspiration, ciliary dyskinesia, immunodeficiency, post-obstructive Chronic respiratory failure
Gastroenterology	Gastroesophageal reflux Eosinophilic esophagitis Esophageal dysmotility Esophageal structure Failure to thrive
Feeding and swallowing	Swallowing incoordination Oral aversions Behavioral feeding problems
Sleep	Obstructive sleep apnea Central sleep apnea Hypoventilation
Genetic	Trisomy 21 CHARGE ^a association Pierre Robin sequence 22q11 deletion VATER/VACTERL ^b Craniofacial syndromes Opitz syndrome Cornelia de Lange syndrome Crit du Chat
Neurologic	Static encephalopathy Chiari malformation Seizure disorder Hypotonia

Most aerodigestive patients will present with a combination of multiple of the above conditions.

^aColoboma, Heart defect, Atresia choanae, Retarded growth and development, Genitourinary abnormality, and Ear and hearing abnormality.

^bVertebral anomalies, Anal atresia, Cardiac defect, TracheoEsophageal fistula, Renal anomalies, Limb anomalies.

hypoxemia with illness who presents for evaluation regarding tracheostomy decannulation. The evaluation and management of such a child requires a coordinated approach by a team that appreciates the inter-relatedness of these problems. Because evaluation often requires multiple tests and consultations, pre-planning and coordination are required to minimize the time required to complete the

evaluation, reduce the number of trips to the medical center, eliminate redundant consultations, and minimize anesthetic episodes associated with common diagnostic procedures.

Recognition of this has resulted in the rapid development of many aerodigestive clinics across the United States. A systematic search of the internet revealed 50 programs in 31 states that advertise or self-identify as “Aerodigestive” programs (as of November 2015). Through direct discussions with leaders involved in these programs it is clear that there is variability amongst these programs. The scope, structure, and components of each program may differ and they are tailored to the needs of their local and regional population. The infrastructure, resources, and limitations of their sponsoring institutions also influence them. Some programs are heavily weighted to the evaluation and optimization of airway surgical patients to improve time to decannulation and speech/swallowing outcomes. Others focus on the evaluation and management of patients with feeding disorders in the context of multiple medical comorbidities. Most programs are an uneven blend of patients with medical and surgical issues and many patients have elements of both. Despite this heterogeneity, there are several consistent structural elements: (1) Interdisciplinary medical and surgical team, (2) Care coordination, (3) Team meeting, and (4) Combined endoscopy.

The *team meeting* is an essential event where the patient’s historical data and prior testing are discussed in order to develop a coordinated itinerary of consultations and diagnostic testing (Table 2). This typically occurs after the caregivers provide a written or telephone-based intake history and reports of pertinent medical records are reviewed. The itinerary is developed based on input from the team and available best practice guidelines for various conditions. The team meeting is later utilized again to summarize the results of the recommended diagnostic testing and develop a unified care plan, which is provided to the patient’s caregivers and referring providers.

It is essential to have a clearly identified *care coordinator* to “quarterback” this process. Such an individual is often a nurse, nurse practitioner, or physician assistant who serves as the primary point of contact for the family

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TABLE 2. Common aerodigestive diagnostic tests

Diagnostic modality	Strengths	Weaknesses
Chest radiograph	Identification of lower respiratory tract disease Low radiation	Low sensitivity for bronchiectasis Limited ability to differentiate causes of lung disease
Chest CT	Distribution and severity of lung findings of various types Differentiation between airway and parenchymal disease	Increased radiation May require sedation for good imaging
Upper GI series	Evaluation of anatomy: peristalsis, stricture, hernia, gastric outlet obstruction, malrotation	Does not evaluate reflux
Radionuclide reflux scan	Physiologic conditions May document aspiration from reflux	Limited sensitivity
Gastric emptying scan	Evaluation for delayed gastric clearance	Unclear interpretation with liquid only meals
Radionuclide salivagram Radionuclide parotid scan	Assess for aspiration of saliva Assess function of major salivary glands	Poor sensitivity
Fiberoptic Endoscopic Evaluation of Swallowing (FEES)	Evaluate functional anatomy of swallow Evaluate airway protective reflexes Portable No radiation	Blind to moment of pharyngeal swallow and esophageal phase Not widely available
VideoFluoroscopic Swallow Study (VFSS)	Evaluates all phases of swallowing	Radiation exposure Limited evaluation of anatomy
Microlaryngoscopy and bronchoscopy	Superior optical resolution Evaluation of posterior larynx Access for instrumentation	Access to difficult and peripheral airways Limited assessment of airway dynamics Requires anesthesia
Flexible bronchoscopy with lavage	Evaluation of static and dynamic airway lesions, nasal-bronchial Access to difficult and peripheral airways Evaluation of airway inflammation and infection	Limited evaluation of posterior larynx Limited optical resolution Access for instrumentation Requires anesthesia
Esophagogastroduodenoscopy	Evaluation of esophageal mucosal disease: acid and eosinophilic Evaluation of esophageal, gastric, and duodenal anatomy Obtain intestinal secretions Evaluation for celiac disease	Requires anesthesia
Esophageal impedance	Identification and characterization of acid and not acid reflux May identify dysmotility	Lack of normative data Unclear relationship between impedance indices and extra-esophageal disease
Motility studies	Gold standard for dysmotility	Highly specialized Not widely available
Polysomnography	Characterization of sleep disordered breathing and sleep architecture Titration of respiratory support	Expensive and cumbersome Availability

and triages on-going questions and status updates to the appropriate team members. This ensures good communication between providers and maintenance of a clear consistent plan. It also alleviates the caregiver and referring physician burden of having to

contact multiple providers for results and recommendations.

The Aerodigestive *interdisciplinary team* may have broad or variable representation, which could include otolaryngology, gastroenterology, pulmonology, sleep

medicine, pediatrics, nursing, speech and language pathology (SLP), occupational therapy (OT), nutrition, genetics, neurology, pediatric surgery, thoracic surgery, physical medicine and rehabilitation, social work, and psychology. Team make-up varies between programs based

on resource availability and the needs of the population served. Specialists central to all programs however, include otolaryngology, pulmonology, gastroenterology, and feeding and swallowing therapists (SLP and/or OT).

The role of the otolaryngologist centers primarily on evaluation of airway surgical issues and aspiration.

Common presenting issues include airway stenosis (which may be multi-level and complex), obstructive sleep apnea, and abnormalities that predispose to aspiration. Liberation from tracheostomy dependence is a frequent parent goal. When necessary, successful airway reconstruction requires (1) sufficient pre-operative evaluation of all airway lesions and non-airway diagnoses, (2) appropriate patient selection, (3) appropriate technique, staging, and timing, (4) and effective patient optimization.^{8,9}

An understanding of surgical approaches for airway reconstruction in the context of static and dynamic lesions is essential and must include an appreciation of their interrelatedness with other comorbidities. It is in this context that an interdisciplinary team approach improves outcomes and reduces costs.^{9,10} One comorbidity that is almost universally considered in aerodigestive patients is chronic pulmonary aspiration. For this reason, swallowing evaluation by videofluoroscopic swallow study (VFSS) and/or fiberoptic endoscopic evaluation of swallowing (FEES) are routinely utilized. In many centers FEES examinations are performed jointly by an otolaryngologist and a SLP in order to comprehensively evaluate upper airway dynamics, the functional anatomy of swallowing, and the oral preparation, timing, and effectiveness of swallowing. Voice assessments may also be made. In this setting, aspiration risk is assessed and

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feeding recommendations can be provided to parents. Videofluoroscopic swallow studies offer additional information from directly observed pharyngeal swallow and the esophageal phase, which are usually complementary. Occupational therapists and SLPs are crucial

members of the team, who provide specific recommendations for safe oral consistencies, appropriate feeding devices and technique, response to feeding cues, encouraging an interest in feeding and developing or maintaining oral skills.

The role of the pulmonologist in an aerodigestive program is to provide complementary anatomic airway

evaluation, optimize care for respiratory comorbidities prior to airway reconstruction, and assist with post-operative management. Pulmonologists are most effective as an integral

part of the surgical team, providing input on surgical approach, staging and timing. Pulmonologists may evaluate for and manage lung injury due to aspiration, active infectious or inflammatory lung disease, impaired airway clearance, interstitial lung disease, asthma, sleep apnea, dynamic airway lesions, and respiratory muscle weakness. In a study of post-repair tracheoesophageal fistula patients evaluated in an aerodigestive program, 100% were identified as having tracheomalacia and 68% had inflammatory lung disease with severity of tracheomalacia correlating to dysphagia.¹¹ More than two-thirds had changes to their pulmonary management (increasing and decreasing intensity).

The role of the gastroenterologist is to evaluate growth and nutrition, gastrointestinal barriers to safe and adequate feeding, and to manage esophageal disease that may complicate airway reconstruction. This may include acid or eosinophilic esophagitis, reflux aspiration, esophageal stricture or dysmotility, rumination, gastritis, and malabsorption. Determination of a causal link between esophageal disease and respiratory or airway symptoms is particularly challenging and requires

close coordination between the gastroenterologist, pulmonologist, and otolaryngologist in order to accurately assess these interactions.^{12–15}

A key component of the aerodigestive evaluation is the “triple endoscopy.” This refers to the performance of a microlaryngoscopy and bronchoscopy, flexible fiberoptic bronchoscopy with lavage, and esophago-gastroduodenoscopy under a single anesthetic. Other studies such as impedance probe insertion, echocardiography, MRI, and controlled-ventilation chest CT can also be coordinated with this anesthetic episode. Coordination can be burdensome from a scheduling perspective, but minimizes the risks and redundant costs of multiple anesthetics. Collaco et al⁷ estimated a 41% reduction in anesthetic episodes through the utilization of combined endoscopy.

In the end, the goal of the aerodigestive program is to provide consistent, efficacious, cost-effective, outcomes-driven, patient-centered, family-focused care to this complex medically fragile population. As a result of evaluation, the aerodigestive patient should have a well-defined inclusive care plan incorporating feeding, growth, breathing, sleep, respiratory infections, and airway disease that is in alignment with the family’s goals and values. Airway reconstruction patients should have their medical conditions optimally controlled and a surgical plan that maximizes the likelihood of successful decannulation and minimizes the risk of adverse sequelae.

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