Rapid response teams have become necessary components of patient care within the hospital community, including for airway management. Pediatric patients with an increased risk of having a difficult airway emergency can often be predicted on the basis of clinical scenarios and medical history. This predictability has led to the creation of airway consultation services designed to develop airway management plans for patients experiencing respiratory distress and who are at risk for having a difficult airway requiring advanced airway management. In addition, evolving technology has facilitated airway management outside of the operating suite. Training and continuing education on the use of these tools for airway management is imperative for clinicians responding to airway emergencies. We describe the comprehensive multidisciplinary, multicomponent Pediatric Difficult Airway Program we created that addresses each component identified above: the Pediatric Difficult Airway Response Team (PDART), the Pediatric Difficult Airway Consult Service, and the pediatric educational airway program. Approximately 41% of our PDART emergency calls occurred in the evening hours, requiring a specialized team ready to respond throughout the day and night. A multitude of devices were used during the calls, obviating the need for formal education and hands-on experience with these devices. Lastly, we observed that the majority of PDART calls occurred in patients who either were previously designated as having a difficult airway and/or had anatomic variations that suggest challenges during airway management. By instituting the Pediatric Difficult Airway Consult Service, we have decreased emergent Difficult Airway Response Team calls with the ultimate goal of first-attempt intubation success.
made, making it imperative to have for the establishment of rapid response systems. Although general rapid response teams are beneficial to patient outcomes, more specialized teams for specific patient populations may be necessary. Emergency airway management in adults can require specialized manpower and equipment. Furthermore, children needing emergency airway management pose additional considerations compared with adults. In an emergency situation in which a child requires airway management, highly trained and experienced personnel should be available.

Pediatric airway anatomy and respiratory physiology create unique conditions that must be addressed during pediatric airway management. When the airway is difficult (defined by the American Society of Anesthesiology Difficult Airway Task Force), a specialized skill set to manage the airway is required to reduce patient morbidity and mortality. Difficult mask ventilation occurs in ~0.02% of pediatric difficult airway cases, and difficult intubation rates range from 0.25% to 1.32% of cases. Despite the low incidence reported, perioperative airway management complications are more frequent in children than adults and remain a major cause for cardiopulmonary arrest in children, as reported by the American Society of Anesthesiology closed claims analysis and perioperative cardiac arrest registry. In addition, children with difficult airways have a higher mortality when >2 direct laryngoscopy attempts are made, making it imperative to have access early on during airway management.

Our objective was to develop a pediatric difficult airway program (PDAP) to improve the safe management of airway emergencies for the children in our institution. This program consisted of 3 components: a pediatric difficult airway response team (PDART), a pediatric difficult airway consult service (PDACS), and a multidisciplinary pediatric airway educational program. We provide a detailed description of the evidence used to develop our program beginning in 2012. In contrast to previously published articles focused only on emergency response or consultation services for airway management, we describe our implementation and execution of a multifactorial difficult airway program that we have optimized for children at our institution. Our goal was to adapt the adult difficult airway response team (DART) to optimize strategies to better manage pediatric airway emergencies and expand the program to include an airway management consult service that develops plans before respiratory compromise in at-risk children as well as an educational program for continuing education.

PDART
In 2008, our institution created the DART, consisting of a multidisciplinary team including anesthesiologists, otolaryngologist-head and neck surgeons (OHNSs), and trauma surgeons to manage all adult and pediatric patients with difficult airways. For children at our institution, the PICU team typically manages the airway initially, whereby the PICU fellow often performs the initial laryngoscopy. If difficulty occurs during ventilation and/or when securing the airway (defined as ≥2 laryngoscopy attempts), the DART is activated. If the child was already designated as having a difficult airway, the DART is called immediately should respiratory distress occur. DART carts, stocked with emergency airway supplies, were dispersed throughout the hospital floors to provide readily available equipment during an emergency. In May 2012, our medical center opened a new children’s hospital building, increasing separation between the adult and pediatric services. This created an opportunity to revise the DART structure and organize a pediatric DART for the Children’s Center. The DART is activated when personnel call the universal Lifeline phone number, relaying the location and emergency response team they need (in this case, the DART). The first task we initiated was to update the Lifeline questionnaire script to require callers to also provide the patient’s age (or close approximation). The PDART responds to a child of any age residing in the Children’s Center and any patient under the age of 15 years throughout the hospital. In addition to the pediatric anesthesiologist response during the day, a pediatric respiratory therapist and pharmacist were included in the PDART calls.

In July 2015, the Department of Anesthesiology and Critical Care Medicine made the decision to have a pediatric anesthesiology faculty remain in-house 24 hours per day, 7 days per week in an effort to optimize safety for our pediatric patients. With this addition of in-house expertise, the PDAP separated from the adult DART. (Fig 1). A pediatric anesthesiologist, in place of an adult anesthesiologist, now responds to DART calls after normal business hours for children. Pediatric OHNS faculty responds during the day; however, because of staffing constraints, senior-level OHNS residents respond at night and call in faculty should their services be required. Lastly, a specific pediatric airway bag was created, including intubating supraglottic airways, intubating stylets, pediatric cuffed and uncuffed endotracheal tubes, as well as equipment needed to perform a percutaneous needle cricothyrotomy, which is brought to every PDART call (Fig 2).

A priority of the PDART is to move stable pediatric patients to the operating suite (OR) as opposed to the adult DART priority to manage the airway at the bedside. By bringing children to the OR, we can use specialized equipment and medications to optimize spontaneous ventilation for intubation. Advanced pediatric airway equipment (including rigid and flexible fiber-optic bronchoscopes) for both OHNSs and anesthesiologists are housed only in the OR. Pediatric-specific airway carts were not dispersed throughout the Children’s Center primarily because of cost for airway carts and the frequency with which they would be used. It is the responsibility of the OHNS resident to bring the cart, only if needed, to the patient’s bedside.

MULTIDISCIPLINARY AIRWAY COURSE
In 2014, a continuing medical education–accredited multidisciplinary course was created focusing solely on
airway management of children. This is a 1-day course held semiannually for faculty, fellows, and residents in anesthesiology, pediatrics, emergency medicine, and surgery as well as OHNSs, nurse practitioners, and respiratory therapists caring for children. Didactic coursework focuses on induction of anesthesia, pediatric airway anatomy and physiology, basic and advanced airway management, supraglottic airway placement, and airway management for the critically ill child. Faculty in the Division of Pediatric Anesthesiology and Critical Care Medicine and the Department of Otolaryngology-Head and Neck Surgery teach the courses. In addition, hands-on practice stations were created for using the most common devices employed during PDART responses, such as video laryngoscopy and supraglottic airway placement on pediatric mannequins. The course participants also practice performing cricothyrotomy in pig tracheas.

The course concludes with several pediatric airway simulation scenarios modeled from true PDART calls, which tie together the skills learned throughout the day.

**PDACS**

Although rare, the difficult airway scenario in children is often predictable. Risk factors that are commonly associated with difficult airway management include physical attributes, genetic syndromes, and/or clinical scenarios (such as head and neck trauma). Many syndromes have physical attributes commonly associated with a difficult airway, including craniofacial abnormalities such as micrognathia, macroglossia, and midface hypoplasia. The physical attributes and historical features of children who required PDART suggest that the majority of children with difficult airways can be identified through screening during hospital admission. The idea for a difficult airway consult service has been described by Nykiel-Bailey et al at the St Louis Children’s Hospital, and on the basis of the experience of our PDART, we created the PDACS at our institution.

The PDACS was first instituted in 2016 in the PICU and has since expanded to cover all units in the hospital, including the emergency department (ED) and NICU. The primary providers may request a consult if an admitted patient has a history or risk factors associated with a difficult airway; however, not all pediatric clinicians focus on airway pathology. To automate the identification of children at risk for having a difficult airway, we created a 2-item screening questionnaire administered by the triage nurse when a child is being admitted to the Children’s Center. These questions inquire (1) whether there is a history of a difficult airway and (2) whether the child has any head or neck abnormality that may change airway anatomy. If either of these 2 questions is answered affirmatively, an automatic consultation to the PDACS is made. Consults are either indicated as urgent, in which an anesthesiologist completes the consult within 1 to 2 hours, or routine, whereby the consult is completed within 24 hours.

It is the responsibility of the pediatric anesthesiologist to evaluate the patient, conduct a physical evaluation and chart review, and create plans for ventilation, intubation, and sedation (if necessary and/or requested). Each consult is documented by using a preformed PDART consultation note (Fig 3), in which the provider describes airway history, successful and unsuccessful attempted techniques for ventilation, and intubation described in the past. On the basis of the patient’s pathophysiology and airway management history, first-, second-, and third-line recommendations are outlined for both ventilation and intubation management. Recommendations for where intubation should occur, such as the OR if advanced techniques and equipment are needed and the child is hemodynamically stable for transfer, as well as for sedation, extubation, and whether OHNSs should be present during airway management are also described. The child receives a difficult airway designation in the medical record, an identifying bracelet, as well as a card on

![PDART Components](https://www.aappublications.org/news)

**FIGURE 1** Components of the PDART. Activation of the PDART is via a group page from the Lifeline service. If the patient is a child (age <15 years), a pediatric OHNS will also respond during the daytime.
the hospital room door labeled DART. If worsening respiratory distress does occur, execution of the prepared airway management plan is performed, reducing the need for an emergency response. If the child is unlikely to be designated as having a difficult airway, the consultation will denote that, and identifiers are not placed.

**RESULTS**

Before the implementation of the PDAP in July 2015, there were 51 pediatric difficult airway emergencies from July 2008 to June 2015 (Table 1). The techniques most commonly attempted to secure the airway include direct laryngoscopy (41.3%), OHNS laryngoscopy (18.8%), flexible fiber-optic scope (16.3%), and video laryngoscopy (13.7%). The 3 most common successful techniques at securing the airway were direct laryngoscopy (51.4%), OHNS laryngoscopy (25.5%), and flexible fiber-optic scope (15.6%). In addition, 47% of the calls were initiated during the day (7 AM–7 PM), 43% of the calls took place at night (7 PM–7 AM), and 9.8% of the calls did not have a time recorded in our database. Most of the pediatric airway emergency calls originated from the NICU or PICU (60.8%), whereas the ED and OR had 23.5% and 11.8% of the emergencies, respectively.

Since the implementation of the PDART, there has been activation of the PDART for 19 pediatric airway emergencies. The techniques used to secure the airway during these calls include direct laryngoscopy, video laryngoscopy, and surgical tracheostomy performed by OHNSs. There are fewer airways secured by OHNSs as well as fewer PDART emergency calls on average (~11 per year pre-PDART compared with 7 per year post-PDART initiation).

From January 2018 to December 2018, we received both physician-initiated and automatic nurse-initiated difficult airway consultation requests with means of 8.1 (SD 3.9) and 14.3 (SD 5.4) requests per month, respectively.

**DISCUSSION**

Children needing emergency airway management pose several unique concerns. We created a multidisciplinary group to manage emergency pediatric difficult airways in our institution. Our results from DART calls before the implementation of the PDART show that a variety of devices and techniques were used to secure the airway during those events. Direct laryngoscopy, for example, was used in 67.5% of all DART calls before the implementation of the PDART. This implies that standard direct laryngoscopic techniques and commonly used laryngoscopy blades can be used to secure the airway in the majority of patients deemed difficult during an emergency, and emphasis on optimizing routine intubation techniques of nonanesthesia providers is required during educational coursework. Overall, other techniques that were commonly used include video laryngoscopy (15.7%) and placement of supraglottic airways (8.9%). These findings provide evidence for our multidisciplinary education initiative to teach first responders to children in respiratory distress (ie, pediatricians, intensivists, nurse practitioners, emergency physicians, and respiratory therapists) how to use these alternative methods. In addition, our data show that the most common locations for PDART calls were the NICU and PICU (58.5%) as well as the ED (21.4%). Our educational initiative primarily focuses on teaching...
basic and advanced airway techniques and the use of commonly used devices to providers in these units. Not all hospitals and facilities across the United States have pediatric anesthesiologists on staff, and education on basic airway techniques as well as supraglottic airway placement and video laryngoscopy for nonanesthesia pediatric providers may be necessary. Other findings that support the implementation of a PDART program included the timing of the events. The number of DART calls during daytime hours were approximately equal to the number of overnight calls, which is consistent with recently published data showing perioperative cardiac arrest in children occurred at all hours, with higher mortality during after-hour emergencies. These data support the need for airway emergency response personnel, including pediatric anesthesia, OHNSs, respiratory therapists, in tertiary pediatric hospitals to be available 24 hours per day.

The initiation of the PDAP has provided many benefits to our institution, and each arm of the program is currently being formally evaluated. Briefly, having experts on the PDART in-house has decreased morbidity associated with pediatric airway management, especially in children with a difficult airway. The PDACS has allowed for early identification of children at risk for difficult airway so that formal airway management plans can be placed before respiratory failure. This early recognition

FIGURE 3  An example of the PDART Consultation Note. Each topic has dropdown menus that allow for easy completion of the note. After completion, ventilation and intubation plans can be copied and pasted into the Problem List under the Overview of the Difficult Airway Problem. By doing this, all practitioners caring for the patient can easily access and follow airway management recommendations in an emergency. BVM, bag-valve mask; CP, cerebral palsy; ETT, endotracheal tube; LMA, laryngeal mask airway; s/p, status post.
and preplanning has decreased the need for emergency airway management and allowed for a more controlled approach when the need to secure the airway arose. Lastly, our multidisciplinary airway course has provided continuing hands-on training and simulation for our first responders, improving their first-attempt success at securing an airway in an otherwise routine intubation. This has also contributed to fewer PDART calls and optimized first-attempt success.

Implementation of the PDAP in our institution provided many benefits but was not without several hurdles. To have a successful PDART, it was necessary for pediatric-trained personnel to be in-house and immediately available for emergency calls around the clock. Before having the pediatric anesthesiologist in-house, children were managed by adult anesthesiologists, who may not have had the optimal skill set to care for difficult airway emergencies in young children. Institutions that care for small children but do not have a pediatric anesthesiologist or OHNS in-house around the clock should consider regular and frequent airway training courses for faculty who will be responding to pediatric airway emergencies. Having readily available intubation and ventilation equipment were already components of our operating rooms. However, institutions that do not have pediatric-specific video laryngoscopes, flexible fiber-optic scopes, and/or specialty laryngoscopes should make available these

FIGURE 4  A time line of events during the development of the PDAP. Air-Q is a type of LMA. LMA, laryngeal mask airway; RT, respiratory therapist.
devices if caring for children in their facilities. Another limitation was identifying at-risk patients when initiating the PDACS. Automatic screening during admission drastically reduced this issue, identifying many patients with potential difficult airway, allowing for the implementation of airway plans in patients who may not have been identified otherwise. Lastly, we have many resources at our disposal, including a pediatric anesthesiology coordinator or on-call attending, who can conduct the consultations, and a fully equipped simulation center with all the airway devices used and state-of-the-art simulation laboratories equipped with mannequins representing all ages. Our primary hurdle regarding the educational component was the difficulty our clinical faculty faced finding the time to participate. To avoid this issue, courses can be offered on the weekends.

CONCLUSIONS

The development and implementation of the PDART, a difficult airway consultation service, and a multidisciplinary education initiative should substantially improve pediatric airway management within the hospital setting. We described our experience developing an all-encompassing program to optimize the response to and care of children needing emergent airway management. Buy in and participation from multiple shareholders was crucial for the successful implementation of the PDAP.

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