Critical Airway Response Team "CART": Airway Emergencies in a Tertiary Care Pediatric Hospital

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Management of pediatric airway emergencies at tertiary care pediatric hospitals differ significantly from airway management at adult institutions. Various factors contribute to this difference including congenital, craniofacial, or airway anomalies and the higher incidence of airway foreign bodies, which are often not present in the adult population[1-3]. Similarly, various studies have shown that endotracheal intubation in pediatric patients is associated with higher levels of operator stress and carries significant potential of morbidity and mortality[4, 5].

Although exposure to advanced airway training is a requirement for a pediatric residency, there is not a high enough frequency of these occurrences to allow for a high level of proficiency, especially for complex airway situations[5, 6.] Despite this, the presence of a dedicated multidisciplinary airway team, with specialized equipment and skills developed to respond to complex pediatric airway emergencies, has not been a common practice at pediatric hospitals.

Establishing a hospital wide system where multiple members of different disciplines coordinate care to respond to an emergency following a detailed protocol is a significant undertaking for any hospital. A hospital wide initiative like this one requires consideration of important organizational, political, logistic, and administrative factors that could affect the acceptance, implementation, and ultimate effectiveness of the system[7].

We develop a multidisciplinary airway team able to rapidly provide care for critical airway throughout the hospital. The project was named "**CART: Critical Airway Response Team**". In this chapter we will describe our initial experience in the development and early implementation of a multidisciplinary rapid response airway team utilizing a self-contained transportable airway unit.

In January 2011, the full CART activation system went into effect. Prior to roll out we set strict activation guidelines in which only an attending with adequate intubating experience such as emergency department (ED), anesthesiology, otolaryngology, or pediatric/neonatal critical care could activate the CART system. A paging system was set up to reach all the members of CART. The pager message would contain three pieces of information: the word CART in capital letters, the location and call back number, and the name of the attending activating the system. Upon system activation, a self contained mobile airway cart with a video tower, rigid bronchoscopy/laryngoscopy set, flexible nasolaryngoscopy

equipment, tracheotomy kit and multiple sizes of endotracheal tubes, tracheotomy tubes, and other airways was deployed to the location [8,9]. The physician responders include pediatric anesthesiologists, pediatric otolaryngologists, pediatric surgeons, and pediatric or neonatal intensive care unit (ICU) attendings depending on the location. Professional staff assisting the CART activation included operating room staff, an intensive care nurse, and a respiratory therapist (**Table 1**). Upon system activation an operating room was also held. Once the airway had been established, a page saying "CART ACTIVATION HAS BEEN CANCELLED" was sent out to alert responders that may be on their way, and to release the operating room

Table 1. Cart Activation Response Team Equipment

Tracheotomy Equipment
Tracheotomy Set, Scalpels
Tracheotomy Tubes (with tight-to-shaft cuff)
Needle Cricothyrotomy Set
Surgical Lubricant, Prep, and Drapes; Tape, Suture
Laryngoscopy and Bronschoscopy Equipment
Flexible Laryngoscope
Operative Laryngoscopes
Intubating Laryngoscopes
Digital Video Intubation Equipment
Rigid Bronchoscopes
Telescopes, Bridges, Prisms
Rigid and Flexible Suctions
Camera and Light Cables
Defog, Tooth Guards, Ventilator Connectors, Body Adapters
Airway Supplies
Endotracheal Tubes (cuffed and uncuffed)
Laryngeal Mask Airways
Nasal Trumpets
Oral Airways
End-Tidal CO_2 Detector, Stylets, Magill Forceps
Personal Protective Gear
Masks with Faceshield
Surgical Caps and Gowns
Sterile Surgical Gloves

For auditing purposes adequacy of the CART activation was established by actual need of endotracheal intubation or tracheotomy, activation by an experienced airway attending, and adequacy of the pager message. We also analyzed situations when a CART activation should have taken place, but the system was not activated. We describe these "missed activations" as a situation other than in the operating room in which the two major airway services such as anesthesia and otolaryngology were present for an intubation using specialized airway equipment, and CART activation did not take place [8,9].

As otolaryngologists, we are well aware of the differences in anatomy between the pediatric and adult airway. It is also important to consider that pediatric pulmonary physiology also affects airway management. Infants have higher oxygen consumption rates than adults as well as a higher ratio of minute ventilation to functional residual capacity. This can result in steep declines in arterial oxygen partial pressures if the airway becomes occluded [10]. This combination of anatomic and physiologic factors can make pediatric airway management especially challenging.

Although there is no consensus on what constitutes a critical airway, it is widely accepted to be persistent respiratory distress with disruption of airflow, which results in an inability to mask or intubate the patient. Our case series demonstrates that in the pediatric tertiary care institution, there is a high likelihood of patients with critical airways having congenital and airway anomalies requiring a special airway equipment and training. Early recognition of an "at risk" situation is extremely important in these patients since they require an extra level of airway expertise to be safely managed.

The concept of rapid and early rescue has been applied in other fields of medicine including trauma, cardiology, medical emergency teams (MET) and pediatric rapid response systems [11-13]. It seems logical to apply these concepts to emergency airway management, especially in pediatric hospitals. A rapid response critical airway system allows highly trained individuals to deliver complex airway intervention anywhere in the hospital. The goal is to provide the same equipment and expertise of the personnel involved in critical airway cases in the operating room wherever and whenever it is required.

Our system was implemented in two stages based on actual airway emergencies, however, simulation has also been recently used to evaluate the efficacy of a critical airway rapid response system. Johnson *et al* showed improvement in response time with the novel airway system and better survival rate utilizing the new system[14]. Staging the development of our rapid response system allowed us to identify the personnel and resources needed prior to the full implementation of the CART. Two of the major patterns we recognized were the high utilization of the operating room and the need to develop a concise and efficient paging message that goes to all members of CART.

In conclusion, the CART system allows rapid mobilization of expert, airway-specific personnel and equipment. This allows facile assembly of an operative airway unit that can be deployed throughout the hospital. Further, additional studies can help determine the frequency of training of the hospital personnel necessary for efficient implementation and expansion of the system.

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