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Prehospital Pediatric Respiratory Distress and Airway Management Interventions: An NAEMSP Position Statement and Resource Document

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Abstract

Devices and techniques such as bag-valve-mask ventilation, endotracheal intubation, supraglottic airway devices, and noninvasive ventilation offer important tools for airway management in critically ill EMS patients. Over the past decade the tools, technology, and strategies used to assess and manage pediatric respiratory and airway emergencies have evolved, and evidence regarding their use continues to grow.

NAEMSP recommends:

- Methods and tools used to properly size pediatric equipment for ages ranging from newborns to adolescents should be available to all EMS clinicians. All pediatric equipment should be routinely checked and clearly identifiable in EMS equipment supply bags and vehicles.
- EMS agencies should train and equip their clinicians with age-appropriate pulse oximetry and capnography equipment to aid in the assessment and management of pediatric respiratory distress and airway emergencies.
- EMS agencies should emphasize noninvasive positive pressure ventilation and effective bag-valve-mask ventilation strategies in children.
- Supraglottic airways can be used as primary or secondary airway management interventions for pediatric respiratory failure and cardiac arrest in the EMS setting.
- Pediatric endotracheal intubation has unclear benefit in the EMS setting. Advanced approaches to pediatric ETI including drug-assisted airway management, apneic oxygenation, and use of direct and video laryngoscopy require further research to more clearly define their risks and benefits prior to widespread implementation.
- If considering the use of pediatric endotracheal intubation, the EMS medical director must ensure the program provides pediatric-specific initial training and ongoing competency and quality management activities to ensure that EMS clinicians attain and maintain mastery of the intervention.
- Paramedic use of direct laryngoscopy paired with Magill forceps to facilitate foreign body removal in the pediatric patient should be maintained even when pediatric endotracheal intubation is not approved as a local clinical intervention.

Key words: pediatric airway emergencies; pediatric intubation; pediatric airway management; pediatric airway education; procedural competency; quality improvement

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Introduction

EMS clinicians infrequently encounter pediatric patients who require acute interventions such as use of a bag-valve mask (BVM) device, supraglottic airway (SGA) insertion, endotracheal intubation (ETI), or a surgical airway (1, 2). Our understanding of the anatomic, physiologic, and pathologic features unique to pediatric respiratory distress and airway compromise and the tools, technology, and strategies used to assess and manage pediatric respiratory and airway emergencies have evolved. Coupled with the limited clinical exposure to critically ill or injured children requiring such interventions is the variability in education, in assessment and verification of clinician competence, and in quality improvement programs guiding pediatric airway management programs. The following resource document represents evidence-based recommendations on pediatric airway monitoring, noninvasive, and invasive interventions.

PEDIATRIC EQUIPMENT

Methods and tools used to properly size pediatric equipment for ages ranging from newborns to adolescents should be available to all EMS clinicians. All pediatric equipment should be routinely checked and clearly identifiable in EMS equipment supply bags and vehicles.

Pediatric patients have physiologic and anatomic differences from their adult counterparts. These unique considerations highlight the need for specialized and dedicated pediatric equipment to be available in all EMS settings (3). Strategies to ensure availability include ensuring compliance with local, regional, state, and/or national recommended or required minimum EMS equipment lists, establishment of a local pediatric emergency care coordinator (as recommended in the joint NAEMSP position "Coordination of Pediatric Emergency Care in EMS Systems") and partnership with local hospitals, especially pediatric specialty centers (4–6). Availability of pediatric airway management equipment is a metric of a pediatric-ready EMS agency as outlined in the position statement titled "Pediatric Readiness in Emergency Medical Services Systems", supported by the American Academy of Pediatrics, American College of Emergency Physicians, Emergency Nurses Association, National Association of Emergency Medical Technicians, and National Association of EMS Physicians (7).

EMS agencies should train and equip their clinicians with age-appropriate pulse oximetry and capnography equipment to aid in the assessment and management of pediatric respiratory distress and airway emergencies.

Pulse Oximetry

Pulse oximetry is an important tool in the evaluation of respiratory distress and failure in children and adult patients. However, pulse oximetry may be inaccurate when an adult-sized probe is used on a child, which can potentially increase decision errors in the recognition and management of respiratory distress and failure.

Capnography and Capnometry

The use of end-tidal carbon dioxide ($EtCO_2$) monitoring, including capnography and capnometry, has become commonplace in many EMS systems. It is useful to help EMS clinicians identify patients with impending respiratory failure, as correlation has been shown between exhaled $EtCO_2$ and venous PCO_2 in children with moderate-to-severe respiratory distress (8). When used in conjunction with pulse oximetry, capnography identifies hypercapneic respiratory failure and apnea, as well as the improvement or worsening of hypercapnia on a breath-to-breath basis (9).

While waveform capnography has become more ubiquitous in the prehospital setting and certainly in the inter-facility transfer of critically ill pediatric and neonatal patients, there is disagreement over the use and interpretation of waveform capnography in the neonatal period (10). There is evidence to suggest that continuous end-tidal CO_2 monitoring in hospitalized ventilated neonates has been shown to reduce the degree of hypercapnea compared to neonates monitored by more traditional methods such as blood gas sampling (11). However, in the neonatal population, capnography is limited to conventional forms of ventilation and may not be accurate in certain modes of ventilation such as high frequency ventilation. Additional challenges in the use of continuous capnography in the transport setting are the weight and size of the EtCO2 detector with traditional means of capnograpy, which may increase the risk for extubation. Further, the dead space of the required adapters may cause physiologic detriment to extremely low birth weight infants. Newer generation of capnographers may eliminate this issue. Transcutaneous CO_2 monitoring may offer another opportunity for monitoring, however this equipment is not ubiquitous in the prehospital setting and is limited mainly to highly skilled neonatal transfer teams. As neonatal monitoring equipment continues to evolve, and given the physiologic benefit of continuous end-tidal CO_2 monitoring, medical directors should consider its use where feasible.

Though capnography was initially only paired with invasive airways such as endotracheal tubes, SGAs, or tracheostomies, a 2016 study by Freeman et al. found that capnography can be used in pediatric patients receiving BVM ventilation in the in-hospital setting, broadening its applicability to noninvasive ventilation strategies (12). Capnography provides the best currently available method to detect manual ventilations when ventilating patients using bag-valve-masks, supraglottic airways, or endotracheal tubes.

NONINVASIVE INTERVENTIONS

EMS agencies should emphasize noninvasive positive pressure ventilation and effective bag-valve-mask ventilation strategies in children.

Supplemental Oxygen

While commonly deployed by clinicians at many levels of training, 'blow-by' oxygen has a markedly limited role only in infants and young children who may not tolerate other interventions and who require only slight increases in FiO_2 compared to room air (13). There is limited utility even with this age group and there is no role for blow-by oxygen in older children. The choice of oxygen delivery via nasal cannula or facemasks should be based upon the severity of illness, measurement of pulse oximetry (when available), and mental status of the patient, with consideration for ease of administration in an age-appropriate manner.

Non-Invasive Positive Pressure Ventilation (NIPPV) in the Prehospital Setting

Noninvasive methods of ventilation cover a spectrum of interventions such as those commonly available in ground ambulances (use of bag valve mask to augment respirations or in response to apnea), to a wider variety of options more commonly seen in the critical care interfacility settings and hospitals such as heated humidified high-flow nasal cannula (HFNC), continuous positive airway pressure (CPAP), and bi-phasic positive airway pressure (BiPAP). NIPPV has an evolving evidence base in pediatric critical care, demonstrating reduction in respiratory severity scores as well as reducing the need for endotracheal intubation by 28% for children with asthma, bronchiolitis, and other lower airway diseases (14–16).

There is growing support for the feasibility of NIPPV use by EMS clinicians in the pediatric critical care setting (17, 18). A 2014 study of 793 children under the age of 2 years that evaluated the feasibility and utility of HFNC during inter-facility transport demonstrated a 14% reduction in the need for invasive ventilation performed by the retrieval team. No patient treated with HFNC as primary therapy required rescue intubation during transport (19). As of 2018, HFNC is now in the National EMS Scope of Practice Model for paramedics (20). Barriers to the adoption of these tools for most EMS agencies are the availability of pediatric-specific equipment, the size of equipment, cost, and resources for training.

A 2010 mixed study of children >12 years old and adults found that the application of CPAP during prehospital management of acute respiratory distress resulted in a reduction in both intubation rates (7.9% vs. 0.0%) and mean ICU stay (8.0 days vs. 4.3 days) (21). There is also evidence that CPAP can be safely deployed by BLS clinicians, though this literature is limited to adult patients (22).

EMS agencies should consider the use of noninvasive ventilation strategies in children to reduce the need for invasive measures, and to do so within the educational and operational confines specific to their systems.

Bag-Valve-Mask Ventilation

BVM devices designed to provide assisted manual ventilation are ubiquitous in the EMS setting and are within the scope of practice for all types of EMS clinicians in the United States. Few opportunities exist for performing BVM, and thus it is a challenge to maintain mastery of the skill. It is important to select the appropriately sized bag valve mask in order to deliver sufficient tidal volumes to the patient. Troubleshooting lack of chest rise when ventilating children with BVM devices should include repositioning of the airway including use of a towel roll under the shoulders or neck in younger children to achieve sniffing position, using patient-size appropriate equipment, appropriate face-mask ventilation technique, and consideration of other causes of airway obstruction (23). Of importance is the recognition that of the two most commonly taught methods of face mask ventilation, the C-E and thenar-eminence methods, there is evidence to suggest that a two-person technique is more likely to generate adequate tidal volume and ventilation (24, 25).

INVASIVE INTERVENTIONS

Supraglottic airways can be used as primary or secondary airway management interventions for pediatric respiratory failure and cardiac arrest in the EMS setting.

Supraglottic Airway Devices (SGAs)

Historically SGAs have been used as rescue devices in failed airway algorithms in both in-hospital and out-of-hospital settings (26, 27). SGAs have since been shown to also be useful as primary devices to secure airways, as conduit devices to facilitate placement of endotracheal tubes (e.g., intubating LMA), and as temporizing bridge therapy to more advanced interventions (e.g., fiberoptic intubation).

The literature surrounding the use of SGAs in children is evolving. In a 2012 study comparing ETI to the use of SGAs in simulated pediatric airways, the latter were found to provide earlier, more consistent, and adequate ventilation (28). As evidenced by recent adult and pediatric manikin studies, skill retention has been shown to be higher in the use of SGAs than with ETI, even in the setting of novice providers (29, 30).

Studies evaluating the use of SGAs in cardiac arrest resuscitation in children are limited, though in adult patients with cardiac arrest the use of SGAs has been associated with better chest compression fraction and fewer interruptions in high-quality CPR (31). This finding is yet to be demonstrated in children with cardiac arrest; however, multiple endotracheal attempts are frequent, which distracts clinicians from delivering high quality CPR (32, 33). Two propensity-adjusted reviews of pediatric out-of-hospital cardiac arrest (OHCA) from the All-Japan Utstein and CARES registries showed no association between the use of SGA and increased favorable neurological outcome versus BVM. In contrast, two non-propensity-matched observational studies showed SGA use to be associated with greater survival to discharge and return of circulation when compared to BVM. In 2019 the International Liaison Committee on Resuscitation made a Class 2a, Level of Evidence C-LD recommendation that BVM is reasonable compared with advanced airway interventions in the management of pediatric OHCA (34–36).

Pediatric endotracheal intubation has unclear benefit in the EMS setting. Advanced approaches to pediatric ETI including drug-assisted airway management, apneic oxygenation, and use of direct and video laryngoscopy require further research to more clearly define their risks and benefits prior to widespread implementation.

Endotracheal Intubation (ETI)

Pediatric ETI is a high-risk, low-frequency event in the EMS setting and its inclusion in the scope of practice for EMS clinicians is an area of significant debate driven by mixed outcome results in the published literature. In the United States, though the *National EMS Scope of Practice Model* retains ETI for patients of all ages for paramedics, New Mexico and California have removed pediatric endotracheal intubation from paramedic scope of practice in their states except for critical care and flight paramedics meeting specific requirements (20).

Difficulty in achieving initial psychomotor competence, variable first pass-success, rapid atrophy of skills over time, high complication rates, and infrequent skill performance are some of the important issues to consider in developing and maintaining a pediatric ETI program within an EMS agency (37–43).

To date, there are no widely accepted pediatric ETI programs that describe the educational, operational, and quality components necessary to ensure safe and successful performance of ETI in the EMS setting. Great variability exists in the modes of teaching pediatric ETI, ranging from didactic lectures, operating room experience, low- and high-fidelity manikins, and in-field care opportunities (44).

Achieving and maintaining competency in ETI for both adult and pediatric patients requires a vigorous initial training curriculum coupled with ongoing experience with live intubations (45, 46). While this seems like a common-sense approach to learning the mechanics of intubation without the pressure of urgent circumstances, the opportunity to train on live patients is limited by the availability of opportunities to do so, especially in institutions where multiple trainees (e.g., medical students, residents, certified nurse anesthetists, fellows) are competing for time for live-subject experience (47). These issues are addressed in greater detail in the NAEMSP position statements titled Pediatric Respiratory Distress and Airway Management Training and Education, and EMS Quality Management in Pediatric Respiratory and Airway Emergencies (48, 49).

Frequency of Pediatric Intubation. Prehospital pediatric ETI attempts are infrequent (14, 30, 50, 51). A 2016 study in King County (Seattle, WA) found no more than one pediatric intubation was performed per paramedic every 2.6 years. In the Gausche et al. randomized controlled trial of airway management in Los Angeles, CA, based on the rate of pediatric patients requiring airway interventions and the number of paramedics practicing during the study period, a paramedic would have performed an invasive airway intervention on a pediatric patient only once every 8.8 years (52).

Initial Competency in Pediatric Endotracheal Intubation. In our review of more than 120 articles for this compendium, no uniform definition of competency in pediatric ETI in the prehospital setting has been identified. A 2004 study by Wang et al. evaluated the experience of 891 paramedic students from 60 nation-wide paramedic-training programs for their exposure to adult and pediatric intubations. Nearly 70 percent of participants had only 10 pediatric ETI encounters, 21% had 20, and 9% had greater than 20 encounters. The pooled overall success rate was 87.5%, and this improved with clinical exposure, and success rate exceeded 95% with greater than 30 ETI experiences (45). There are currently no published criteria for the number of pediatric intubations required in paramedic training in the United States to ensure competence.

All EMS agencies and systems that choose to approve use of pediatric endotracheal intubation must ensure that sufficient financial and personnel resources are provided to maintain consistent, high-quality initial and ongoing education, and robust quality management practices. Please refer to the NAEMSP resource document titled Quality Management in Pediatric Respiratory and Airway Emergencies for additional guidance.

Intubation Success and Complications. Successful intubation has been defined in the literature in a number of ways, including overall success rates and first-pass success (though the definition of first pass is variable), and both are typically stratified by age. First-pass success has been reported as 58.1 to 66.7%, with overall success ranging from 60.9 to 97% (15, 52, 53). Failure rates in pediatric prehospital ETI range from 14 to 50% (29, 30, 37, 38, 41, 46, 54, 55). The rate of failed intubation in the prehospital setting is markedly higher in children compared to adults (53, 56). Unfortunately, the failure rate increases as age of the patient decreases, leaving some of our most vulnerable patients at the highest risk for failed attempts at securing a definitive airway. First-pass success rates for children less than 2 years of age have been reported as low as 50% (43, 44, 57–59).

There are a number of important peri-intubation adverse events and complications that must be considered (Table 1). The rates of overall complications range from 22.6 to 36.5%, with 'major complications' occurring in 7 to 11% of pediatric ETI attempts, and minor complications in 10 to 31% (41–45, 53). See Table 2.

Within the EMS literature, critical care transport teams have demonstrated a unique aptitude for developing pediatric ETI programs with a higher degree of success than ground agencies. This is likely a function of having a smaller cohort of EMS clinicians to train and ensure the maintenance of competency, a higher rate of exposure to children requiring the intervention, ongoing mandatory training, and comprehensive continuous quality improvement programs. First-pass success rates for such agencies range from 60 to 78.6%, with overall success rates of 95.1 to 95.7% for non-physician staffed services (60–62).

TABLE 1. Types of peri-intubation complications reported in EMS literature.

Source	Complications
Losek et al. (43)	Incorrect endotracheal tube size Tube displacement Esophageal intubation
Aijian et al. (37)	Major: Unrecognized esophageal intubation Tube dislodgement Minor: Incorrect tube seize Trauma to teeth, lips or vocal cords Right mainstem intubation Vomiting
Brownstein et al. (50)	Major: Aspiration Pneumothorax Esophageal Intubation Minor: Right mainstem intubation Oral/dental trauma
Gausche et al. (52)	Right Mainstem Intubation Tube dislodgement (recognized or not) Esophageal intubation Gastric distension Vomiting Aspiration Oral/airway trauma
Ehrlich et al. (51)	Esophageal intubation Right mainstem intubation Aspiration Barotrauma Incorrect tube size Tube Dislodgement
Prekker et al. (42)	Recognized complications Bradycardia requiring intervention Esophageal intubation Tube dislodgement Peri-intubation cardiac arrest Unrecognized complications Unrecognized tube dislodgement Unrecognized right mainstem intubation Respiratory tract injury Aspiration pneumonia

The Difficult Airway. Every pediatric intubation should be considered 'high risk'; however, in comparison to adult ETI, there are few clinical prediction rules to guide EMS clinicians in their approach to pediatric airway management. A study of more than 1,500 ETIs in the pediatric ICU setting failed to identify patient characteristics with high sensitivity and specificity to aid in the prediction of difficult airways in children (63).

Table 2. Frequency of adverse events associated with prehospital pediatric endotracheal intubation by ground paramedics.

Adverse event	% Reported in literature
Incorrect tube size	6–52%
Tube dislodgement	1.5–14%
Esophageal intubation	1–9.5%
Right mainstem intubation	16.3–18%
Peri-intubation cardiac arrest	2%
Tracheal injury	0.3%

Indications for Intubation in the Literature. Current literature reports the most frequent indications for pediatric prehospital intubation as the following: cardiac arrest (44.2 to 100%), trauma (19.0 to 66.2%), status epilepticus/neurologic (8 to 19%), and respiratory distress (3.4 to 13%) (26, 38, 39, 41, 61). While these have been the most common pathologies leading to attempts at pediatric prehospital ETI, evidence supporting intubation for these clinical indications is currently lacking.

Pediatric Cardiac Arrest. There is evidence that ETI may not improve survival or neurologic outcome in pediatric out of hospital cardiac arrest (OHCA). Evidence from the pediatric 2017 Cardiac Arrest Registry to Enhance Survival (CARES) study of prehospital ground agencies with BVM, ETI, and SGA availability concluded that ETI was associated with lower survival as compared to SGA (OR 0.32) and BVM (0.39)(34). Ohashi-Fukuda and colleagues had similar findings supporting the use of BVM over ETI in pediatric cardiac arrest patients, noting no improvement across any subgroups of pediatric patients, including those with non-cardiac causes of OHCA (64). A 2015 seven-year Resuscitation Outcomes Consortium (ROC) study of 2,244 out-of-hospital non-traumatic pediatric cardiac arrests found that shorter scene times, vascular access attempts, and intravenous fluid were associated with improved survival, but not advanced airways (65).

Most recently, a systemic review and meta-analysis comparing ETI or SGA to BVM for pediatric cardiac arrest was published (66). These investigators found that BVM had better survival to hospital discharge with good neurologic outcome compared to ETI and SGAs, and there were limited data favoring SGAs over ETI. However, the evidence was low to very low and these authors highlighted a need for a well-designed randomized trial (35). The 2019 American Heart Association update on Pediatric Advanced Life Support (PALS) reaffirmed the 2010 recommendation that "in the prehospital setting it is reasonable to ventilate and oxygenate infants and children with BVM, especially if transport time is short" and also stated that in OHCA, "transport time, provider skill level and experience, and equipment availability should be considered in the selection of the most appropriate airway intervention (67)."

Pediatric Trauma. A 2018 observational study of 106 pediatric head-injured children in Australia by Heschel et al. found that Drug Assisted Airway Management (DAAM) was successful in 99% of patients, 93% on first pass, and that 67% of these patients had a favorable neurologic outcome, as compared with 54% in the non-intubated patient cohort. It should be noted however, that these patients underwent ETI by highly trained Intensive Care paramedics, part of a critical care transfer rescue team (64).

Importantly, a larger body of literature has demonstrated worse outcomes for injured children who undergo prehospital ETI (68, 69). In 2004 Ehrlich evaluated 105 rural pediatric trauma patients who underwent ETI in the field, transferring hospital, or the receiving trauma center. The authors found that patients who underwent ETI in the field had the lowest first pass success rate (67% versus 95% trauma center) and highest failure rate (50% versus if the first pass was unsuccessful 0% in either hospital). Additionally the authors found children who underwent prehospital intubation had the highest complication rates (66% versus 29% in the referring hospital and 4% in the trauma center) (51). In an 8-year review of the National Pediatric Trauma Registry, the authors concluded that field intubation was a strong, independent negative predictor of survival or good neurologic outcome, even when adjusted for severity of injury and degree of head injury (70).

Pediatric Status Epilepticus. Pediatric patients in status epilepticus represent nearly 20% of all prehospital intubations (43, 45). Prehospital intubation complications and failure rates are higher in young children and infants compared to school-aged children, adolescents, and adults. (71, 72). Seizures, and the therapeutic use of benzodiazepines can result in alterations of both consciousness and apnea (73). Studies of pediatric patients intubated by ground-based EMS clinicians reveal that for those patients intubated in the field and extubated in the emergency department (ED), 45–58% of the cases were patients with a diagnosis of seizure (42, 44). The use of ETI in the prehospital seizure patient has been demonstrated to be predictive of worse outcomes. Gausche et al. examined pediatric seizure as a subgroup and found a trend toward decreased survival

(81% vs. 95%) and poor neurological outcome (81% vs. 92%) when such patients received ETI as opposed to BVM (52). The authors concluded that with such a high inherent survival rate that the risk of ETI was not warranted. Several additional studies, including the 2012 RAMPART study demonstrated that performance of ETI at any point in the management of the seizing patient (prehospital or in the ED) is associated with an increased rate of mortality (7% vs. 0.4%)(74, 75).

Prehospital Drug Assisted Airway Management. Evidence in the ED setting has shown that ETI facilitated by use of sedative and paralytic medications, historically known as Rapid Sequence Intubation, but recently re-defined under the catchall of Drug Assisted Airway Management (DAAM), has been associated with a high first pass success rate in pediatric patients, with few deleterious adverse events, and has been historically supported by the American College of Emergency Physicians (75, 76). In the EMS setting the use of deep sedation or sedation followed by paralysis to facilitate performance of ETI has been described with variable success (77). In a 9-year observational study of Australian Intensive Care Paramedics evaluating the efficacy of prehospital DAAM in pediatric patients with traumatic brain injuries, DAAM was associated with a high first pass success rate (93%), decreased hospital length of stay, and favorable outcomes (66). In the 2013 Tollefson study, all children underwent drug-assisted intubation by flight paramedic and nurses, with a first pass success rate of 78% but overall success rate of 95%(61). In the limited literature describing DAAM in ground EMS transport there does appear to be an increase in success rates when medications are used (59, 60). In the most comprehensive review, a 2019 study by Jarvis et al. found that DAAM had higher levels of success compared to no medications in the ETI and SGA groups in both the pediatric and adult cohorts (53).

Video Laryngoscopy. The introduction of video-assisted laryngoscopy as an alternative to direct laryngoscopy has also been evaluated for its impact on the success of ETI, however the literature predominantly reflects operating room data and there is a dearth of prehospital studies in pediatric patients. Multiple pediatric simulation studies have demonstrated statistically significant improvement for inexperienced EMS clinicians in first pass success, reduction in time to intubation, and superior glottic views with video-assisted laryngoscopy (78–81). In the clinical environment, the results have been mixed. In several studies video laryngoscopy provided better glottic views but at the cost of statistically significant longer times to successful intubation (82–86). There is insufficient evidence in the literature to support or refute the use of video laryngoscopy over direct laryngoscopy for prehospital endotracheal intubation. Mastering the skill of video laryngoscopy, if not used frequently, requires not only a robust initial competency program, but also highlights the need for ongoing education to support skill retention.

Apneic Oxygenation. Apneic oxygenation, the passive provision of oxygen via nasal cannula (both low and high flow), has been demonstrated to reduce episodes of hypoxemia and prolong the safe apnea time in adult patients and has also been shown to improve first pass ETI success rates in the ED and EMS settings for adults (87, 88). The data supporting its use in pediatrics are still evolving, but suggests that it may prolong the safe apnea time (89, 90). A 2019 observational study of 149 pediatric patients undergoing ETI in the ED found that apneic oxygenation reduced the risk of peri-intubation hypoxemia by 50% (aOR 0.3, CI 0.1–0.8)(91). In contrast, a 2019 retrospective review of 305 intubations in a pediatric ED found that apneic oxygenation delivered via simple nasal cannula at age-specific flow rates was not associated with a lower risk of desaturation (92).

Paramedic use of direct laryngoscopy paired with Magill forceps to facilitate foreign body removal in the pediatric patient should be maintained even when pediatric endotracheal intubation is not approved as a local clinical intervention.

Magill Forceps for Foreign Body Removal

Acute partial or complete foreign body airway obstruction remains an evidence-based rationale for developing and maintaining skills in laryngoscopy and the use of Magill forceps by EMS clinicians. In one descriptive analysis of patients less than five years old, airway obstruction represented 3.7% of all pediatric encounters, however only 1.6% of those encounters required an intervention such as vascular access, Magill forceps use, or albuterol administration (93).

In the case of foreign body airway obstruction, Magill Forceps are the only rescue option if chest or abdominal thrusts fail. As a result, the value in obtaining and maintaining proficiency in this skillset by advanced EMS clinicians justifies provision of initial and ongoing psychomotor training (94, 95). Use of cadaveric and computer simulation models have been demonstrated as effective in establishing both initial and ongoing competency in these procedures among resident physicians and may have utility in the training of EMS clinicians (96, 97).

CONCLUSION

There is emerging literature in support of noninvasive modes of ventilation for children in the prehospital setting. Effective bag-valve mask ventilation strategies are important as the primary method of supporting ventilation in the pediatric population and all EMS clinicians should be proficient in this skill. Additionally, there is growing evidence to support the use of SGAs as a primary airway device in pediatric patients.

The current available evidence does not show benefit for pediatric prehospital ETI in the management of pediatric OHCA, trauma or seizures. Prehospital ETI may in fact, increase mortality in select populations. The literature suggests that EMS clinicians infrequently encounter pediatric patients with respiratory failure and thus makes maintenance of skills an important factor for the medical director in deciding on scope of practice for pediatric airway management. Furthermore, first pass success rates for ETI are overwhelmingly poor. Finally, achieving and maintaining competency in this high-risk low frequency intervention is challenging. Pediatric ETI should not be routinely performed unless agencies can consistently provide comprehensive educational opportunities with clinical exposure, establish and maintain competency in their clinicians, and utilize a strong continuous quality management program. A focus on noninvasive modes of ventilation and optimization of BVM efficacy should be paramount in EMS systems and drive future prehospital strategies.

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