



Aligning airway management strategy with resuscitation priorities for out-of-hospital cardiac arrest

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Out-of-hospital cardiac arrest (OHCA) is a common and deadly event, occurring more than 350,000 times per year in the United States, with less than 10% of patients surviving to hospital discharge (1). The optimal airway management strategy for these patients remains unknown. Endotracheal intubation (ETI), supraglottic airway (SGA) placement, and bag mask ventilation (BMV) are common initial approaches, and are all mentioned as options in the most recent Advanced Cardiovascular Life Support (ACLS) guidelines (2).

Previous data regarding airway management for OHCA have been solely from observational studies (3-5). These studies were limited by issues such as variable paramedic experience, unexamined situational factors, resuscitation time bias, and disproportionate use of certain devices as rescue rather than initial techniques (6). Fortunately, a number of recent randomized controlled trials examining airway strategies for OHCA have given us new insights into optimal care for these critical patients.

In a recent study published in *JAMA*, Wang *et al.* compared OHCA airway management with laryngeal tube (LT) or ETI (7). The laryngeal tube is a supraglottic device with two cuffs: a proximal cuff which sits in the upper pharynx, and a distal cuff at the esophageal inlet (8). It is the most commonly used supraglottic device for airway management of OHCA in the United States (9). In Wang's multicenter, cluster-crossover randomized

trial involving 3,004 patients, 27 EMS agencies were randomized to a strategy of initial airway management with either LT or ETI. If the initial attempt was unsuccessful, the EMS personnel were allowed to use any available rescue technique. The primary outcome, 72-hour survival, favored the LT-based strategy over ETI, 18% *vs.* 15%, with a number needed to treat of 34. Secondary outcomes of successful return of spontaneous circulation (ROSC), survival to hospital discharge, and favorable neurologic outcome also all favored the LT strategy. These improved outcomes were likely related to a higher first-attempt success rate (90.3% *vs.* 51.6%), and lower incidence of airway management requiring three or more airway device insertion attempts (4.5% *vs.* 18.9%) in the LT group compared to the ETI group.

Furthermore, the typically cited advantages of endotracheal tubes (ETTs) did not seem to confer a benefit in this population. ETTs provide greater airway isolation and are often chosen over SGAs to protect from pulmonary aspiration of gastric contents. However, there was no difference in pneumonia or pneumonitis between the two groups. It is possible that the higher incidence of multiple intubation attempts in the ETI group led to more cases of gastric insufflation and aspiration during airway management, neutralizing any subsequent benefit from the device once in situ. ETTs are also believed to be superior devices for positive pressure ventilation, but the incidence

of inadequate ventilation with either device was too small to be considered clinically relevant (1.8% with LT *vs.* 0.6% with ETI). Finally, laryngeal tubes are not considered definitive airways, and are uncommonly employed for prolonged mechanical ventilation in the intensive care unit. Indeed, 64% of LTs were replaced with ETTs on arrival to the hospital. However, 33% of ETTs placed by paramedics were also exchanged for new ETTs on hospital arrival. This may have been to confirm correct placement, or due to cuff malfunction, improper size, or copious secretions or emesis in the initial ETT. For a great number of OHCA patients, the EMS-placed airway device, regardless of type, is replaced upon hospital arrival.

The Wang paper joins two other recent RCTs in providing evidence for airway management during OHCA. Benger *et al.* found that among 9,296 OHCA patients treated by paramedics who were randomized to SGA (i-gel; Intersurgical, Berkshire, UK) or ETI as the initial airway strategy, there was no difference in neurologic outcome at 30 days (10). Similar to the Wang study, the authors found higher rates of successful airway placement in two or less attempts with the SGA, and no difference in rates of aspiration. Also in both studies, patients randomized to ETI were more likely to be rescued by SGA placement after initial device failure than vice versa. Jabre *et al.* found that when EMS teams consisting of three members, including a physician, were randomized to an initial airway strategy of bag mask ventilation (BMV) *vs.* ETI, there was no difference in neurologic outcomes, survival to hospital admission, or 28-day survival (11).

The findings of Wang's study may be best viewed as supporting a strategy that results in earlier oxygen delivery, rather than identifying an inherent benefit of an appropriately placed LT over an ETT. To further explore this question, it would be worthwhile to conduct a secondary analysis of the data collected by this study to compare the outcomes of patients intubated successfully with ETT on the first attempt with those who had first attempt success with LT placement. Multiple studies of critically ill adults have found airway complications, including death, associated with 3 or more direct laryngoscopy (DL) attempts or failure to change airway plans despite difficulty with the first technique attempted (12-15). This may be due to hypoxemia, aspiration, bleeding, or swelling from airway trauma, the likelihoods of which all increase with multiple attempts. These studies took place in hospitals with physicians who frequently perform ETI, including anesthesiologists, intensivists, and emergency physicians.

In contrast, the majority of paramedics in the United States perform two or fewer ETIs per year, with many performing zero (16).

There are multiple challenges unique to airway management for OHCA, all of which may contribute to a lower chance of success. The patient is unable to cooperate with an airway assessment, is not fasted, may be more likely to have difficult-airway factors, may have additional injuries complicating airway management (burns, cervical spine or facial trauma), and may have secretions or emesis in the airway. The out-of-hospital environment results in sub-optimal monitoring, patient positioning, and access to advanced airway equipment. Due to the limited size of EMS teams, a hands-free dedicated leader who maintains an objective view of the complete situation is often impossible. Additional support staff is missing, as is the option to call for an airway expert. Finally, the urgency of the situation, complexity of additional aspects of care, and infrequency of airway management scenarios may increase the stress and difficulty for EMS providers. Given these conditions, it is not surprising that first attempt and overall intubation success rates are significantly lower for prehospital paramedics than in-hospital physicians (14).

Advanced airway management for OHCA is challenging, yet it is only one of many critical aspects of resuscitation. In addition to providing ventilation, paramedics must perform chest compressions, obtain vascular access, administer medications, defibrillate, and transport the patient to a hospital, often with teams of only two or three providers. The goal of CPR is to maintain the energy states of the heart and brain through restoration of blood flow and oxygen delivery. Blood flow is the major limiting factor, and thus minimizing interruptions of compressions is paramount. In light of this, ACLS guidelines recommend the choice of airway device be determined by the skill and experience of the provider, with the goal to minimize any interruptions in compressions (2). ETI, the most technically challenging airway option, is a more cognitively demanding task than the other aspects of ACLS. Therefore, when ETI is chosen as the initial airway strategy, the provider is at risk for fixation bias to the detriment of other more critical aspects of care, such as ensuring high-quality, uninterrupted compressions (17). A 2009 study showed that ETI resulted in an average interruption of 45 seconds on the first attempt, and the combined duration of interruptions from multiple attempts often extended for several minutes (18). Therefore, it is possible, if not likely, that the decreased survival in the ETI group of Wang's study was related

to interruptions or delays in other aspects of care. Unfortunately, interruption data was not collected, and we are unable to test this hypothesis with the given cohort.

There is a growing recognition among airway experts that as the number of available airway management techniques and devices grows, so too does the complexity of decision-making. Despite this, the primary goal of any airway management episode remains oxygen delivery. This will always be more important than the use of one “best” technique, or even the successful placement of an ETT (19-21). This movement started 25 years ago, with the introduction of the American Society of Anesthesiologists difficult airway algorithm (22). Most simply, these recommendations can be summarized as: “Patients do not die from failure to intubate. They die from failure to oxygenate and ventilate.” The reduction in airway-related deaths following implementation of these guidelines remains one of the great patient-safety success stories of the last few decades (23).

Despite many new airway devices becoming available, difficult airway algorithms have changed little in the interim years, with one exception. The introduction of the SGA as a simple and reliable means for establishing oxygenation and ventilation has led to its inclusion as a step in nearly all airway algorithms. Otherwise, the focus of these algorithms remains avoidance of delays and task fixation by limiting procedural attempts, prompt recognition of failure, and rapid transition to alternative oxygenation methods (20,21,24). One of the simplest and most widely applicable difficult airway algorithms is the “Vortex” approach to emergency airway management described by Chrimes (20). This strategy recommends a “best effort” attempt at ETI, SGA placement, or BMV. If the first attempt is unsuccessful, the provider rapidly transitions to a different technique. Once adequate oxygenation is achieved with one technique, the patient enters the “green zone”, where they are no longer at risk of imminent desaturation. This allows the provider to regroup and develop a strategy in light of the current situation.

Based on the above studies, circumstances unique to OHCA, and the principles of difficult airway management, we propose a strategy for OHCA airway management that seeks to maintain an objective overview of the priorities of resuscitation and avoid complications associated with multiple attempts. To reduce delays which may come with complex decision-making in an urgent situation, we recommend individual providers or EMS agencies choose a single primary device for first attempts. This may be ETI

via one technique, a single SGA device, or BMV, depending on the training and skill sets of individual providers and airway equipment available to different EMS services (25). If ETI or SGA placement is chosen, positioning and technique should be optimized to provide the best chance for success on the first attempt, while minimizing interruptions in chest compressions (14). If the first attempt (defined by the laryngoscope or airway device entering the mouth) is unsuccessful at establishing ventilation, we recommend immediately transitioning to a single alternative technique, especially if the first attempt was ETI. Once adequate ventilation is achieved with any technique, airway management is considered “accomplished”, and focus should remain on other resuscitation tasks. If ventilation becomes impaired again, the strategy is repeated. Otherwise, ventilation should be maintained with the current technique until arrival at the hospital, where circumstances and available resources improve the chances of successful ETT placement.

Other difficult airway algorithms may allow for more than one attempt before switching techniques. However, we believe that this may be inadvisable prior to hospital arrival, given the other patient care tasks that must be performed by EMS, and the inherent difficulties of airway management in this environment. By limiting the choice of techniques and number of attempts, this strategy will allow the provider to avoid the distraction inherent in attempting to achieve the “ideal” airway management outcome, while maintaining a focus on the overall picture and goals of resuscitation (25).

It is unlikely that the ideal airway device or technique will ever be determined for OHCA. Rather, the best strategy is one that will allow the goal of oxygenation to be achieved quickly, reliably, and without unnecessary complications or distractions. By identifying the sources of risk inherent to airway management, and the biases that prevent optimal care, we hope to prevent the goal of “perfect airway management” from becoming the enemy of effective resuscitation.

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Footnote

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