Research Article

Variation in Out-of-Hospital Cardiac Arrest Management

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Objective. To evaluate variation in airway management strategies in one suburban emergency medical services system treating patients experiencing out-of-hospital cardiac arrest (OHCA). *Method.* Retrospective chart review of all adult OHCA resuscitation during a 13-month period, specifically comparing airway management decisions. *Results.* Paramedics demonstrated considerable variation in their approaches to airway management. Approximately half of all OHCA patients received more than one airway management attempt (38/77 [49%]), and one-quarter underwent three or more attempts (25/77 [25%]). One-third of patients arrived at the emergency department with a different airway device than initially selected (25/77 [32%]). *Conclusion.* This study confirmed our hypothesis that paramedics' selection of ventilation strategies in cardiac arrest varies considerably. This observation raises concern because airway management diverts time and energy from interventions known to improve outcomes in OHCA management, such as cardiopulmonary resuscitation and defibrillation. More research is needed to identify more focused airway management strategies for prehospital care providers.

1. Introduction

Annually, more than 395,000 Americans experience out-of-hospital cardiac arrest (OHCA) [1], a condition associated with low survival rates and poor neurologic outcomes. In response, the American Heart Association's Advanced Cardiovascular Life Support (ACLS) interventions and similar programs have been designed to provide a standardized approach to the management of cardiac arrest. Despite the increased emphasis on the precise timing of measures to improve circulation—such as chest compression, defibrillation, and drug administration—the optimal method to manage airway and breathing is left to provider preference.

Paramedics responding to OHCA patients generally have three options for providing ventilation: through a bag-valve-mask device, an endotracheal tube, or a supraglottic airway device (such as a King airway or laryngeal mask airway). Studies to date, including a 2008 Cochrane systematic review, have not been sufficient to determine which approach is superior [2]. As a consequence, paramedics have limited guidance on the optimal sequence of airway selection.

Several studies have observed considerable variation in paramedic airway selection on a national or population level [3]. The intent of our study was to characterize the variability in paramedic approach to airway management within a single emergency medical services (EMS) system for OHCA.

2. Methods

This observational study involved consecutive adults who underwent an out-of-hospital airway management procedure during cardiac arrest and were then transported by Alachua County Fire Rescue (ACFR) to UF Health Shands Hospital between July 1, 2011, and August 31, 2012. The study was approved by the Institutional Review Board at the University of Florida.

UF Health Shands Hospital, one of three 911 receiving facilities in Gainesville Florida, is the only Level I trauma center in the county, with an annual adult census of approximately 65,000 visits. ACFR is a fire-service-based EMS agency with paramedics, with an average age of 35 years and an average length of service of 5 to 10 years. ACFR provides EMS transport and first responder services in Alachua County and staffs 12 full-time advanced life support (ALS) ambulances covering 969.12 square miles and serving a general population of 259, 694 according to the United States Census Bureau estimate in July 2015. ACFR responds to calls at skilled nursing facilities, in public places, at private

residences, and in hospitals to evaluate and treat patients of all ages from birth to more than 100 years of age. The service responds to approximately 37,000 calls per year and transports more than 24,000 of those patients to an emergency department. During the period of time of the study, 172 out-of-hospital cardiac arrests occurred within Alachua County.

The study cohort consisted of consecutive adult patients (age 18 or higher) who were transported by ACFR to UF Health Shands Hospital and received airway assistance of some type (bag-valve-mask ventilation, supraglottic device placement, or endotracheal intubation) during cardiac arrest, regardless of success. Exclusion criteria included pediatric patients, death on scene, or unrecognized misplacement of an endotracheal tube. Further, all OCHA cardiac arrests not transported to UF Health Shands Hospital were excluded from the study due to lack of consistent follow-up.

The following out-of-hospital variables were recorded by on-scene EMS providers in EMS Pro (©2004, ZOLL Data Systems) as part of routine field reports: age, gender, time between EMS arrival and first airway attempt, return of spontaneous circulation (ROSC), initial electrical rhythm on cardiac monitor, timing of airway management attempts, device selected, and success or failure of each attempt. All attempts were categorized by type of intervention (bag-valve-mask, endotracheal intubation, and supraglottic device placement) and sequence of attempts, regardless of success or failure. Each chart was reviewed retrospectively and data points were collected and stored without personal identifiers in RedCAP (Research Electronic Data Capture), a secure, web-based application used at the University of Florida and designed to support traditional case report form data capture and surveys for research studies.

3. Results

During the study period, there were 172 total out-of-hospital cardiac arrests, 77 of whom received supportive airway management procedures and were transported to UF Health Shands Hospital. Of these, 30 (39%) subsequently achieved return of spontaneous circulation (ROSC), including two-thirds (12/18 [67%]) of patients with a shockable rhythm (ventricular tachycardia or ventricular fibrillation) versus 31% (18/59) of those in asystole or pulseless electrical activity (PEA) arrest. Variation in rates of ROSC and survival to hospital discharge between airway techniques was not powered to achieve statistical significance.

Paramedics demonstrated considerable variation in their approaches to airway management. Approximately half of all OHCA patients received more than one airway management attempt (38/77 [49%]), and one-quarter underwent three or more attempts (25/77 [25%]). One-third of patients arrived at the emergency department with a different airway device than initially selected (25/77 [32%]).

The paramedics' airway management attempts are summarized in Figure 1. As a first approach, providers selected bag-valve-mask (BVM) in 11 patients (14%), the King airway in 14 (18%), and endotracheal intubation in 52 (68%). For all patients receiving BVM as the initial approach, this

management technique continued throughout transport. Among the 14 patients in the King airway group, 2 subsequently underwent endotracheal intubation, 1 received BVM ventilation, and 1 underwent an additional King airway attempt before ultimately receiving BVM.

The greatest variation occurred among the 52 patients receiving endotracheal intubation as an initial approach. One-third (18/52 [35%]) had no further attempts. Another 24 (46%) underwent an additional endotracheal intubation attempt, 8 of which were successful, while 11 had a follow-up King airway placement, 3 received BVM, and 1 received a King airway followed by BVM. Among those in whom endotracheal intubation was not repeated after a failed endotracheal intubation attempt, 1 paramedic selected BVM, 6 selected the King airway, 2 performed two King airway attempts, and 1 attempted King airway placement followed by BVM.

4. Discussion

OHCA remains a leading cause of death in the United States, with a mortality rate of approximately 92% [4]. Although many aspects of medical care in cardiac arrest have become standardized, one important area of management—the method of delivering oxygen and ventilation—is often left to provider preference. This variation might reflect a lack of scientific consensus regarding which method confers the greatest benefit to survival and favorable neurologic outcome.

Previous studies evaluating large data registries have noted wide variation in paramedic selection of ventilation strategies in cardiac arrest on a population or national level [3, 5, 6]. Our study revealed significant variation within a single ground-based EMS agency, among paramedics operating under identical medical care protocols. In particular, paramedics who selected endotracheal intubation as their initial approach had very high rates of variance, with two-thirds of patients receiving at least one additional attempt at ventilation strategy. The selection of endotracheal intubation as the first choice might reflect the practice patterns of emergency physicians in the hospital, who use endotracheal intubation almost exclusively. However, our study suggests that this approach might be less suitable in out-of-hospital resuscitation and could, in fact, delay care. A related concern is whether numerous airway selections distract paramedics' focus away from delivering continuous compression. Future studies may evaluate the role of protocols in improving compression fraction and outcomes.

5. Limitations

Our study had several limitations. First, this was a retrospective chart review with a sample size of fewer than 100 patients, limiting the validity of our findings. The study was performed in a single EMS agency serving a single county in Florida and was restricted to adult patients, limiting the generalizability of results. Patients were not matched to specific prehospital care providers, which prevented evaluation of variation in strategies by individual paramedics. Last, although all patients were adults in cardiac arrest, unrecorded factors could have
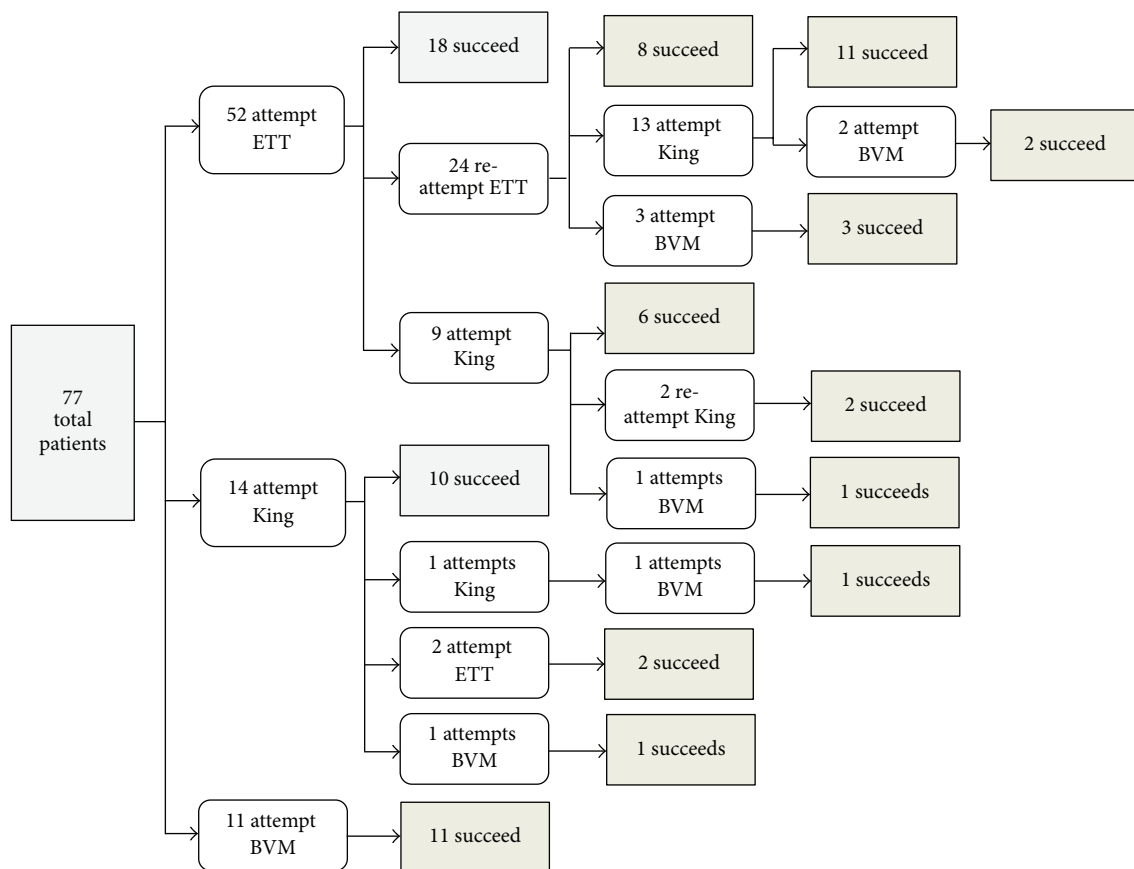
FIGURE 1: Airway management outcomes summary.

influenced providers to select a specific ventilation technique. Paramedics were not interviewed about why a specific technique was selected.

6. Conclusion

This study confirmed our hypothesis that paramedics vary considerably in their selection of ventilation strategies in cardiac arrest. Without scientific consensus, EMS medical directors are left to defer to paramedic discretion in selection of airway management. This study highlights the importance of a large, randomized trial of ventilation management techniques to reduce practice variation in OHCA.

Competing Interests

The authors declare that they have no competing interests.

Acknowledgments

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