Pilot Study of the Effect of a Protocol of 30 Minutes of Scene Care in Out-of-Hospital Cardiac Arrest in Rhode Island

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ABSTRACT

BACKGROUND: Improved outcomes in out-of-hospital cardiac arrest (OHCA) have been demonstrated with increased focus on high-quality CPR. In 2017, the RI Department of Health mandated 30 minutes of on-scene CPR for atraumatic cardiac arrest victims. The effects of this intervention are unknown.

METHODS: An EMR query was performed to identify OHCA cases presenting to a Lifespan hospital during the months of March 2016 (pre-intervention) and March 2017 (post-intervention) with an estimated severity index of 1 or cardiac arrest.

PRIMARY RESULTS: 63 cases of OHCA were identified. ROSC at ED presentation increased in the post-intervention period, though it was not statistically significant (12% vs 22%, CI = -0.01,0.25 vs. 0.09,0.35). Endotracheal intubation and ACLS medication use increased as well.

CONCLUSIONS: This pilot study of a protocol emphasizing on-scene CPR in urban Rhode Island resulted in changes in pre-hospital OHCA management and there was a trend toward increased ROSC in the post-intervention period.

KEYWORDS: Cardiac Arrest, Emergency Medical Services, ROSC

INTRODUCTION

Over the past 10 years, studies focusing on the provision of pit-crew style "high-quality CPR" have suggested that there are significant benefits from "high-quality CPR," compared with traditional CPR among patients with out-of-hospital cardiac arrest (OHCA). These benefits include increased survival to admission and hospital discharge, as well as improved neurologic function at discharge.[1,2] Focus on the provision of "high-quality CPR" is predicated on the idea that initial on-scene resuscitation eliminates potential degradation in CPR quality due to patient moving, transport, packaging, and other factors. These studies have mostly been conducted in high-functioning emergency medical service (EMS) systems with aggressive medical control and leadership, central organization and a high proportion of paramedic-level EMS personnel. Rhode Island EMS providers are predominantly "EMT-Cardiac" level, which is a designation unique to Rhode Island and typically permits all BLS-level interventions, as well as ACLS medications and airway techniques, see **Table 1** for EMS scope of practice in OHCA. Additionally, prior studies have been confounded by increased rates of cardiac catheterization, new advanced airway equipment, hospital triage, and other changes.

Table 1. Comparison of Rhode Island EMS scope of practice in OHCA.

Intervention	EMT Basic	AEMT - Cardiac	Paramedic
Airway	Bag Valve Mask	Bag Valve Mask	Bag Valve Mask
	Supraglottic Airway	Supraglottic Airway	Supraglottic Airway
		Endotracheal Intubation	Endotracheal Intubation
Vascular Access	None	Intraosseous	Intraosseous
		Intravenous	Intravenous
Medications	No ACLS	Basic ACLS:	Basic ACLS plus:
		Epinephrine	Magnesium
		Lidocaine	Vasopressors
		Amiodarone	Procainamide, etc
Electrical Therapy	Automated External Defibrillation	Manual Defibrillation	Manual Defibrillation

Seeking to improve outcomes from OHCA, in March of 2017, the Rhode Island Department of Health instituted new protocols requiring EMS providers to stay on the scene of an atraumatic cardiac arrest for 30 minutes, or until return of spontaneous circulation (ROSC) was achieved.[3] Traditionally, EMS providers have been taught to transport OHCA patients to hospitals quickly, so mandating them to remain on scene for up to 30 minutes is controversial. According to the American Heart Association (AHA), approximately 355,000 people each year suffer an OHCA event (110 events per 100,000 population). Studies vary, but the overall survival rate for OHCA is anywhere from 6-12%[4,5] nationally. Extrapolating these statistics to Rhode Island's population of 1 million, an estimated 1,100 Rhode Islanders are having OHCA each year, or 3 people every day.

Based on prior research demonstrating improved outcomes after the implementation of protocols centered on high-quality CPR, we hypothesized that an increased rate of ROSC at presentation to the ER would be seen after similar protocols were established in Rhode Island. We expected high compliance with mandatory 30-minute on-scene CPR, as well as increased use of medications and advanced airway techniques.

STUDY DESIGN AND METHODS

This study was conducted at Lifespan affiliate hospitals in Rhode Island: Rhode Island Hospital (a tertiary-level, academic hospital), The Miriam Hospital, and Newport Hospital. New CPR protocols were instituted in March of 2017. To evaluate these protocols, OHCA patients were identified via electronic medical record query. Period 1 was chosen as March 2016, approximately 1 year prior to the institution of new CPR protocols. Period 2 was chosen as March 2017, the first month after institution of new CPR protocols. The same month pre- and post-intervention was chosen to help limit the seasonal variability of ER presentations. The study protocol was approved by the institutional review board.

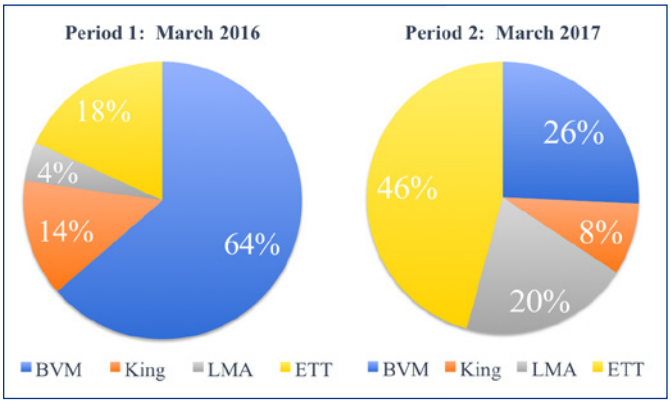
Inclusion criteria for brief chart review included: estimated severity index[6] of 1, or chief complaints of "ventricular fibrillation", "VF", "cardiac arrest", "CPR", and "code blue." Exclusion criteria included age <18, pregnant patients, prisoners, and transfers. Patients who had OHCA while en route to the hospital were also excluded, as were post-arrest transfers from other facilities. The initial EMR query identified 214 patients. These charts were reviewed by one of the authors (JT). Based on the EMS report, and ED physician and nursing notes, those records deemed to be due to non-cardiac causes were then excluded, such as stroke, trauma, primary respiratory arrest, and overdose. When unclear, the patients were assumed to be cardiac in etiology. Post-mortem reports, inpatient notes, discharge summaries and other inpatient data were not reviewed. After exclusion of non-OHCA patients, the total number of patients in period 1 was 25 and period 2 was 38.

These OHCA charts (n=63) were then reviewed further and data was abstracted, including EMS run sheet narratives and timestamps, EMS provider level (EMT-B, "cardiac" or paramedic), EMS agency distance from hospital (median EMS station distance to hospital), patient demographics and comorbidities, use of automated CPR devices, airway management methods, duration of CPR, patient cardiopulmonary status at presentation to the ER, return of spontaneous circulation (ROSC), patient disposition (to ICU, catheterization lab, morgue, etc.), and ER length of stay. The primary outcome for the study was ROSC at presentation to the ER, i.e., if the patient had a pulse upon arrival to the ER after receiving treatment by EMS providers. Whether the patient received less than 30 minutes by EMS, or greater than or equal to 30 minutes of CPR was coded in a binary fashion. Data were analyzed by the new CPR protocol periods (period 1 = pre, period 2 = post). Data are reported descriptively as counts or percentages with the appropriate 95% confidence intervals (CI) calculated.

RESULTS

63 total patients had a complete chart review performed (**Figure 1**). Average age was 64 years, and 58% of the patients were male. 15 patients received bystander CPR. CPR devices were commonplace, having been used in nearly half of resuscitations with data available. Initial shockable rhythms occurred in 18 of 58 cases with complete data. EMS was dispatched to a patient's home in 68% of cases. 81% of patient EMR charts had EMS charts scanned-in and available for review.

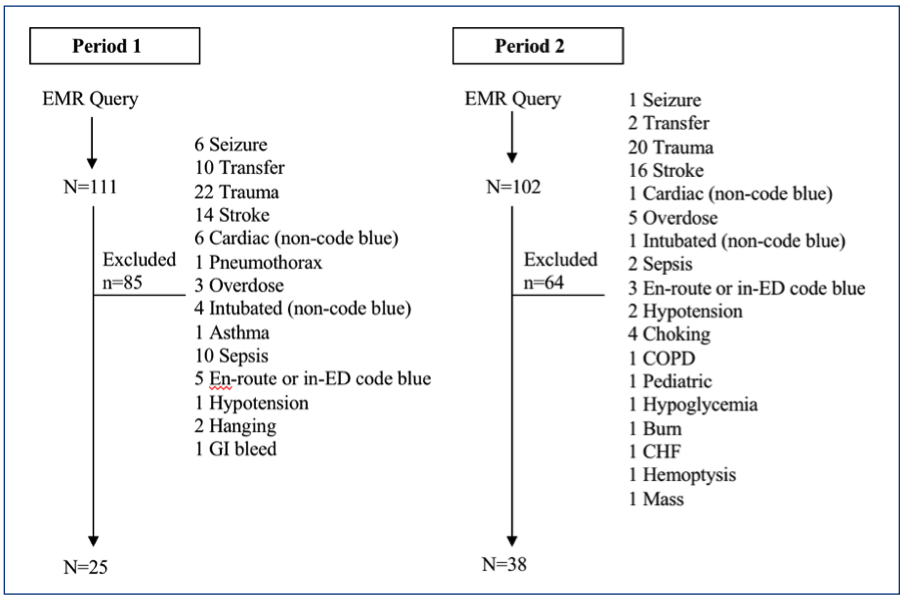
Figure 1. Comparison of prehospital airway use between the two study periods. Bag Valve Mask (BVM), King LT (King), Laryngeal Mask Airway (LMA), Endotracheal Tube (ETT).



11 of these patients had ROSC at presentation to the ER. 3 of these patients were in period 1, while 8 of them were in period 2, though this difference in ROSC was not statistically significant (12% vs 22%, CI = -0.01,0.25 vs. 0.09,0.35). In period 1, none of the patients received 30 minutes of CPR, while in period 2, 19 of 37 patients received 30 minutes of CPR.

Airway use changed dramatically between the time periods (**Figure 2**). The majority of EMS airway management consisted of bag-valve mask (BVM) use in period 1 (14 of 22) while endotracheal tubes were significantly more common in period 2 (16 of 36). EMS attempted intubation in 10 cases in period 1, and were successful in 4 cases (40% success rate; 95%CI: 21, 59), while in period 2, intubation was attempted in 23 cases and successful in 16 (70% success rate; 95%CI: 55, 85). Medication use was also altered; the median milligrams (mg) of epinephrine in period 1 was 2mg, while it increased to 5mg in period 2; with some patients receiving as much as 12mg of epinephrine.

Figure 2. Inclusions and exclusions for both study periods.



All patients who had ROSC at presentation to the ER (n=11) survived to admission to the hospital. Most commonly, patients were admitted to the MICU (n=6), followed by the CCU (n=4). Notably, there was an additional cohort of patients who did not have ROSC at presentation to the ER, but did survive to admission (n=8); 5 of these 8 patients were in period 1, and 2 of the 3 patients who had no ROSC at presentation to the ED but did survive to admission had ROSC for EMS but had lost a pulse upon presentation to the ER.

DISCUSSION

This is the first study on the new CPR protocols in Rhode Island. More broadly, prior studies on "high-quality" CPR have studied CPR bundled with other interventions, such as increased triage to PCI centers, have simultaneously implemented rigorous CPR training for first responders and EMS providers, and have been confounded by additional interventions, such as the implementation of new airway equipment. However, these studies have reported improved outcomes including better neurologic outcome at discharge and higher rates of ROSC.[1,2,7-13] These studies have also been in high-functioning EMS systems with rigorous medical control and a high proportion of paramedic-level EMS providers. It is important to note that our study is limited by lack of control for patient arrest characteristics, age and comorbidities, provider level, and other factors.

This observational, retrospective pilot study reported outcomes from 63 patients suffering from OHCA treated by 16 different departments with predominantly EMT-Cardiac level providers. While the number of patient cases of OHCA was relatively limited in this study, and its retrospective nature gives rise to several limitations, we did observe trends in management. Over the study period, there was an increase in the number of patients receiving 30 minutes of CPR in compliance with the new RI Department of Health protocols, an increase in the use of advanced airways and increase in the amount of medications patients received.

With respect to airway management, supra-glottic devices and endotracheal tubes were more common in period 2 than period 1. This likely owes to the fact that EMS providers feel that bag valve mask ventilation of patients for 30 minutes is inferior to advanced airway devices and may be difficult with vomiting or the effort required for a good face-mask seal for the entire 30 minutes. Prior literature has suggested that patients with advanced airways, conversely, have worse outcomes. For example, in one retrospective cardiac arrest database, among 10,691 OHCA patients, survival was highest among patients treated with BVM compared with other devices (OR1.31).[7] While this may indicate that patients who were more likely to have a good outcome did not require placement of an advanced airway, such as those who woke up immediately after defibrillation and therefore did not require additional airway management, it is also possible that increased focus on patient airways may have taken focus and time away from CPR. Studies have shown that pre-hospital providers sometimes pause compressions for intubation; one study found a median pause of 109 seconds.[8] Research has found pauses in CPR to be deleterious – one recent study of 319 defibrillator OHCA cases, showed that increasing peri-shock pause was associated with decreased survival.[9] Though more patient intubations were attempted during period 2 than period 1, we cannot comment on success rates of intubation given the small n, though success rates of pre-hospital intubation have been cited as anywhere between 60 and 93%.[10]

During pre-hospital codes, patients received a variety of medications, including epinephrine, naloxone, sodium bicarbonate, and glucose. One patient received as much as 12mg of epinephrine, which is of questionable utility. Prior studies have shown that epinephrine use during cardiac arrest is associated with increased rates of ROSC, though may ultimately worsen outcomes.[9-12] In these studies, patients receiving over 5mg of epinephrine had the lowest odds of survival (OR 0.23), relative to patients who did not receive epinephrine. This retrospective study is also subject to similar confounding – that is, that patients receiving more epinephrine had been pulseless for a longer period of time, which is certainly associated with a worse prognosis.

LIMITATIONS

The study was limited by the fact that EMS agencies in Rhode Island began using the new CPR protocols at different time periods. This study was retrospective and may not account for confounders such as EMS training, new equipment and apparatus, although there was no system-wide institution of new protocols and procedures, as there has been in past studies. EMS chart availability was not uniform, which may also bias results. EMS providers are supposed to submit their reports for scan into the EMR, which does not reliably occur. Finally, researchers may have mis-categorized patients as victims of OHCA (or excluded them as non-OHCA patients) who were suffering from respiratory arrest, overdose or another process. While the treatment for OHCA and pulseless arrest is CPR, a primary process other than cardiogenic OHCA, such as overdose, might call for higher prioritization of other treatments, such as administration of naloxone or a secure airway. Patients suffering from respiratory arrest-induced OHCA could have worse outcomes when treated with "high-quality CPR" than patients with VF-induced OHCA, though this has not been studied.

CONCLUSIONS

Overall, we found that EMS agencies are complying with 30-minute CPR protocols. More patients had ROSC at presentation to the ER and survived to admission in period 2, post-intervention, than did in period 1, though this difference was not statistically significant. Future directions for the project include abstraction of more data, including expanding periods 1 and 2 to include >1 year of data, as well as case-matching patients to more definitively determine the effects of CPR duration on patient outcomes at presentation, as well as neurologic function at discharge.

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Disclaimer

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