IS CARDIOPULMONARY RESUSCITATION OUTCOME IN PRE-HOSPITAL EMERGENCY MEDICINE RELATED TO AIRWAY MANAGEMENT TECHNIQUE?

Ana Brundula[1], Frane Paleka[1], Josip Vrdoljak[2], Morena Milić[3,4], Ada Barić Grgurević[5] and Krunoslav Fučkar[6]

[1]Emergency Medicine Institute of Krapina-Zagorje County, Krapina, Croatia;
[2]University of Split School of Medicine, Split, Croatia;
[3]Department of Anesthesiology, Resuscitation and Intensive Care Medicine, Dubrava University Hospital, Zagreb, Croatia;
[4]University of Dubrovnik, Dubrovnik, Croatia;
[5]Srebrnjak Children's Hospital, Zagreb, Croatia;
[6]Krapinske Toplice Special Hospital for Medical Rehabilitation, Krapinske Toplice, Croatia

SUMMARY – According to current European Resuscitation Council guidelines, priorities in advanced life support in adult are chest compression with minimal interruption and early defibrillation. Endotracheal intubation is still considered the gold standard in airway management, but guidelines suggest that securing the airway be incremental, ranging from basic techniques to more complex ones. Doctors who work in pre-hospital emergency medicine teams (EMT) in Croatia usually lack sufficient education and expertise. The aim of this study was to determine whether there was a significant difference in recovery of spontaneous circulation during cardiopulmonary resuscitation (CPR) in out-of-hospital setting depending on the EMT airway management technique of choice. This retrospective analysis included data collected during a 10-year period at the Krapina-Zagorje County Emergency Medicine Institute on all patients with CPR performed by EMTs 20 minutes from initial emergency call. The airway management groups included oropharyngeal tube, i-gel supraglottic device, and endotracheal tube. There were 968 patients, mean age 70. In 74.61% of patients, the cause of arrest was of cardiac etiology. Our study did not find a statistically significant in difference of CPR success among the three groups analyzed according to the airway management technique of choice (p=0.74, χ2-test).

Key words: *Arrest; Cardiopulmonary resuscitation; Endotracheal intubation*

Introduction

Cardiovascular diseases are the leading cause of death in the European Union (EU). The annual incidence of out-of-hospital cardiac arrest (OHCA) in Europe is 67 to 170 *per* 100,000 inhabitants[1]. Resuscitation is attempted or continued by emergency medical service (EMS) personnel in about 50%-60% of cases[1]. Dispatch assisted cardiopulmonary resuscitation (CPR) is provided in 80% of European countries[1]. Survival following OHCA is only 10% or less[2]. According to the European Resuscitation Council (ERC) guidelines, high-quality chest compression with minimal interruption, early defibrillation, and treatment of reversible causes remain the priority in adult life support[3]. During CPR, we should start with basic airway techniques and progress stepwise according to the skills of the rescuer until effective

Correspondence to: *Ana Brundula, MD*, Emergency Medicine Institute, Krapina-Zagorje County, M. Crkvenca 1, HR-49000 Krapina, Croatia
E-mail: ana.brundula@gmail.com

ventilation is achieved[3]. The ERC guidelines suggest that tracheal intubation be only used in settings where the success rates are high, i.e., only rescuers with a high tracheal intubation success rate should use tracheal intubation[3]. The expert consensus is that a high success rate is over 95% within two attempts at intubation[3]. Pre-hospital care is provided by EMS and there are variations in the way it is organized greatly between the 27 EU countries. In Croatia, we distinguish two types of medical teams in pre-hospital emergency settings: T1 team (MD, nurse/medical technician and licensed driver) and T2 team (two medical technicians/nurses). Most of physicians are young, lacking experience and without specialist training. The best initial approach to advanced airway management during OHCA is yet unknown[4]. Despite the fact that endotracheal intubation (ETI) is the gold standard in airway management, when it is performed by pre-hospital MD without training and experience, it can be associated with complications, e.g., interruptions in chest compression, unrecognized esophageal intubation, compromised oxygenation, and trauma. The traditional role of tracheal intubation has been challenged by the introduction of supraglottic airway devices (SGAs)[4]. SGAs are an alternative to intubation. They are faster and easier to insert and may reduce the complications associated with tracheal intubation[5]. The risk of regurgitation is higher during OHCA and SGAs may dislodge more frequently than tracheal tubes[6]. A randomized clinical trial in OHCA patients published in 2018 concluded that favorable neurological status at discharge, survival to hospital discharge, and return of spontaneous circulation (ROSC) on arrival to the emergency department (ED) were in favor of laryngeal tube insertion over ETI[7]. Moreover, a randomized controlled trial (RCT) by carried out by Benger *et al.* in a similar setting showed no significant favorable functional outcome at 30 days when comparing SGA and ETI[8]. It is clear that discussion is still going on about the effects of airway intervention techniques used during CPR in pre-hospital settings. The aim of this study was to establish whether there was a significant difference in the results of out-of-hospital resuscitation or ROSC depending on the airway management technique used, i.e., endotracheal tube (ET), i-gel supraglottic device (SGA) and oropharyngeal tube.

Patients and Methods

We retrospectively analyzed data on patients from the e-Emergency program having undergone pre-hospital cardiopulmonary resuscitation. The research was conducted in Croatia at the Emergency Medicine Institute of the Krapina-Zagorje County and included a ten-year period from June 1, 2012 to May 31, 2022. The study did not include patients with incomplete medical documentation in the e-Emergency database and those who did not have the Utstein form filled out.

Considering the specific working conditions in pre-hospital emergency medical service, as well as the inability to obtain complete past medical history, standardized programs/databases were created, such as e-Emergency database.

A single patient form is based on SAMPLE (S – signs/symptoms, A – allergies, M – medications, P – past medical history, L – last oral intake, E – events leading up to present illness) and ABCDE (A- airway, B-breathing, C-circulation, D-disability, E-exposure) assessment, vital parameters, Glasgow Coma Scale (GCS), rTS (revised Trauma Score), electrocardiogram (ECG) and immediate emergency medical measures. Therefore the main data source was the Utstein form, an internationally accepted form of reporting the CPR outcome, which is an integral part of e-Emergency database. The inclusion criterion was that CPR was performed by EMS (out-of-hospital emergency medical services) teams within 20 minutes of the call.

The following parameters were analyzed: sex, age, cause of arrest, time from the onset of arrest to team arrival, implementation of Basic Life Support (BLS) until arrival of the team, initial ECG rhythm, method of maintaining the airway, occurrence of ROSC and sustained ROSC until arrival at the hospital depending on the method of maintaining the airway. Techniques for maintaining the airway that were analyzed were oropharyngeal tube, i-gel supraglottic device and endotracheal tube.

Statistical analysis and data visualization was performed with MedCalc, version 19.1.2. (MedCalc Software, Ostend, Belgium) statistical software. Categorical variables were presented as whole numbers and percentages. The χ^2-test was used to test differences among the groups. Data distribution normality was assessed with Kolmogorov-Smirnov test. Statistical significance was set at $p < 0.05$.

The study was approved by the Ethics Committee of the Krapina-Zagorje County Emergency Medicine Institute, in accordance with the World Medical Association outlined in the Declaration of Helsinki (ethical principles for medical research involving human subjects). OHCA is unpredictable. Within seconds of cardiac arrest, a person becomes unconscious and thus incapacitated. In this situation, it is impractical to consult another person without placing the potential participant at risk of harm from delaying treatment. Therefore, it was not possible to seek consent before enrolment and intervention.

Results

The research included 968 patients, 631 (65.18%) male and 337 (34.81%) female patients, mean age 70, with deviation of 14.81. The youngest patient who underwent CPR was aged 4 years and the oldest was aged 88 years. The mean time to team arrival was 12 minutes and 36 seconds. In 45.5% of patients, BLS was performed until arrival of the EMS team (Table 1). In 20.93% of patients, BLS was managed by a dis-

Table 1. Performing Basic Live Support before emergency team arrival

	Basic Life Support	
Yes	441	45.5%
No	482	49.7%
Unknown	45	4.7%
Total	968	100.0%

patcher of the medical reporting unit (DMRU) until arrival of the emergency medicine team. The most frequent cause of arrest was of cardiac etiology, recorded in 74.61% of patients (Table 2). The most common

Table 2. Causes of arrest

Cause of arrest	n	
Asphyxia	36	3.7%
Cardiac etiology	723	74.6%
Unknown	175	18.2%
Trauma	28	2.9%
Poisoning	4	0.4%
Drowning	2	0.2%
Total	968	100.0%

initial heart rhythm was asystole in 67.3%, followed by pulseless electrical activity (PEA) in 19% and ventricular fibrillation (VF) in 11.9% of patients, while the arrest rhythm was ventricular tachycardia (VT) found in only 1.8% of patients (Fig. 1). The airway was
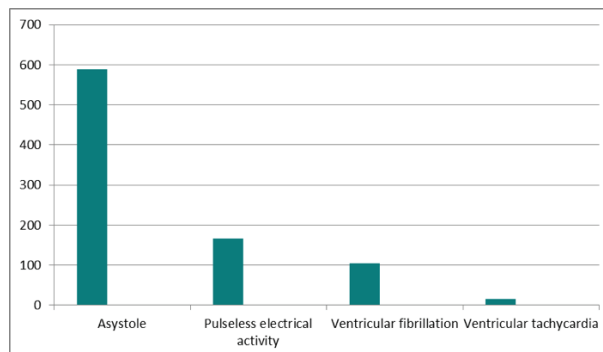

Fig. 1. Patient distribution according to initial rhythm.

secured in 29.5% of patients with an oropharyngeal tube, in 62% of patients with i-gel SGA, and in 9.5% of patients with an endotracheal tube (Table 3). The

Table 3. Methods of airway maintenance

Method of airway maintenance	n	
Endotracheal tube	92	9.5%
i-gel supraglottic airway	601	62%
Oropharyngeal tube	275	29.5%
Total	968	100.0%

methods of maintaining the airway patency were analyzed according to gender (Table 4), age (Table 5), and cause of the arrest (Table 6), yielding no statistically significant difference. ROSC was achieved in 178 (18.38%) patients and maintained in 127 (13.11%) patients until hospital admission. When analyzing ROSC occurrence and maintaining until arrival to the hospital, there was no statistically significant gender difference (Table 7) or age group difference (Table 8). The occurrence of ROSC and maintaining were also analyzed according to the cause of arrest, i.e., cardiac causes, asphyxiation, trauma, drowning, poisoning and unknown causes, as illustrated in Table 9. When comparing ROSC and different methods of airway maintenance in patients where the initial rhythm was VF, there was no statistically significant difference (p=0.74, χ^2-test) (Table 10). Furthermore, when comparing pa-

Table 4. Airway method: comparison between genders

Airway	Male	Female	p=0.027*
Endotracheal tube	56 (8.8%)	36 (10.6%)	
i-gel	378 (60.0%)	223 (66.2%)	
Oropharyngeal tube	197 (31.2%)	78 (23.2%)	

*χ^2-test; values are expressed as number (%)

Table 5. Airway method: comparison among age groups

Age group (years)					
Airway	0-9	9-19	20-64	≥65	p<0.001*
Endotracheal tube	0 (0 %)	0 (0 %)	26 (6.4 %)	66 (11.8 %)	
i-gel	6 (100 %)	4 (100 %)	356 (88.7 %)	235 (42.2 %)	
Oropharyngeal tube	0 (0 %)	0 (0 %)	19 (4.7 %)	256 (46 %)	

*χ^2-test; values are expressed as number (%)

Table 6. Airway method: comparison among causes of arrest

		Cause of arrest					
Airway	Cardiac	Asphyxia	Trauma	Unknown	Poisoning	Drowning	p<0.001*
Endotracheal tube	69 (9.5%)	3 (8.3%)	6 (21.4%)	11 (6.2%)	2 (50%)	1 (50%)	
i-gel	456 (63%)	12 (33.3%)	2 (7.1%)	130 (74.2%)	0 (0%)	1 (50%)	
Oropharyngeal tube	198 (27.5%)	21 (58.3%)	20 (71.5%)	34 (19.4%)	2 (50%)	0 (50%)	

*$\chi 2$-test; values are expressed as number (%)

Table 7. Return of spontaneous circulation (ROSC) outcomes: comparison between genders

ROSC	Gender (male)	Gender (female)	p<0.001*
Ever	127 (20.1%)	80 (23.7%)	
Maintained	97 (15.3%)	59 (17.3%)	
Never	407 (64.5%)	257 (59%)	

*$\chi 2$-test; values are expressed as number (%)

Table 8. Return of spontaneous circulation (ROSC) outcomes: comparison among age groups

Age group (years)					
ROSC	0-9	9-19	20-64	≥65	p<0.001*
Ever	4 (50%)	0 (0%)	133 (25.6%)	70 (11.8%)	
Maintained	2 (25%)	0 (0%)	117 (22.6%)	37 (6.2%)	
Never	2 (25%)	4 (100%)	268 (51.8%)	487 (82%)	

*$\chi 2$-test; values are expressed as number (%)

Table 9. Return of spontaneous circulation (ROSC) outcomes: comparison among causes of arrest

		Cause of arrest					
ROSC	Cardiac	Asphyxia	Trauma	Unknown	Poisoning	Drowning	p<0.001*
Ever	173 (24%)	12 (33.3%)	7 (25%)	13 (7.6%)	2 (50%)	0 (0%)	
Maintained	141 (19.5%)	5 (14%)	4 (14.2%)	4 (2.2%)	2 (5 %)	0 (0%)	
Never	409 (56.5%)	19 (52.7%)	17 (60.8%)	158 (90.2%)	0 (0%)	2 (100%)	

*χ^2-test; values are expressed as number (%)

Table 10. Return of spontaneous circulation (ROSC) according to the method of maintaining airway when ventricular fibrillation is initial rhythm

	ROSC		
Method of airway maintenance	Maintained to hospital admission	Ever achieved	
Endotracheal tube	3	3	6 (6.1%)
i-gel supraglottic airway	24	39	63 (64.3%)
Oropharyngeal tube	13	16	29 (29.6%)
	40 (40.8%)	58 (59.2%)	98

Table 11. Return of spontaneous circulation (ROSC) according to the method of maintaining airway when asystole is initial rhythm

	ROSC		
Method of airway maintenance	Maintained to hospital admission	Ever achieved	
Endotracheal tube	9	11	20 (13.2%)
I-gel supraglottic airway	35	55	90 (59.2%)
Oropharyngeal tube	24	18	42 (27.6%)
	68 (44.7%)	84 (55.3%)	152

Table 12. Return of spontaneous circulation (ROSC) according to the method of maintaining airway when pulseless electrical activity is initial rhythm

	ROSC		
Method of airway maintenance	Maintained to hospital admission	Ever achieved	
Endotracheal tube	6	8	14 (25.5%)
i-gel supraglottic airway	9	19	28 (50.9%)
Oropharyngeal tube	4	9	13 (23.6%)
	19 (34.5%)	36 (65.5%)	55

tients with asystole as the initial rhythm, there was no significant difference in ROSC (p=0.14, χ^2-test) (Table 11). In patients with PEA, there was no significant difference in ROSC until hospital admission and ROSC maintenance either (p=0.74, χ^2-test) (Table 12). The group of patients whose initial ECG rhythm was VT was small (n=15), thus we did not perform statistical test for this patient group.

Discussion

The research compared three airway management techniques in cardiopulmonary resuscitation applied in out-of-hospital conditions. Among the main findings of this study, the first is that pre-hospital EMS personnel in Krapina-Zagorje County, Croatia, most often chooses SGAs in OHCA (62%). Second, patients with ROSC suffered OHCA with initial shockable rhythm (VF).

As our study encompassed all age groups including children, it is important to emphasize that the main cause of arrest in children is of respiratory etiology. Having that in mind, in CPR in children, airway management and ventilation are primary, whereas CPR in adults considers chest compressions with minimal interruptions and early defibrillation a priority. There are variations in national practices in the world regarding the use of different airway devices in pre-hospital settings. The choice of technique and the potential of success depend on the setting and training and skill level of EMS personnel. In our research, there was no significant difference in the outcome of resuscitation among patients resuscitated by using different airway management methods. Although ETI has been considered a definitive airway technique since no regurgitation and aspiration occur once placed, it requires extensive technical skills and continuous training. SGAs are simple to insert and require minimal training, so it is appropriate airway management in OHCA for youngest physicians in pre-hospital settings. For survival, "the links in the chain of survival" are crucial, which include early emergency activation, early CPR, early defibrillation, and timely and appropriate advanced care. We remind that dispatcher-initiated telephone cardiopulmonary resuscitation (TCPR) is independently associated with improved survival and improved functional outcome after OHCA[9]. Although evidence supports the association between bystander automated external defibrillator (AED) use and improved clinical outcomes, in our study AED was used only once[10]. Unfortunately, the research did not show data on patient discharge from the hospital with ROSC after CPR because in Croatia, the Utstein form that is routinely filled out after every pre-hospital CPR is not completed after hospital admission.

Conclusion

No significant difference in the incidence of ROSC was proven to depend on the airway management technique, irrespective of the initial ECG rhythm in cardiac arrest. Emergency medicine is a specialty in which time is critical. We recommend ERC guidelines and stepwise approach in CPR airway management in pre-hospital settings according to EMS team expertise.

Acknowledgment

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Sažetak

UTJEČE LI TEHNIKA ZBRINJAVANJA DIŠNOGA PUTA U UVJETIMA IZVANBOLNIČKE HITNE MEDICINE NA ISHOD KARDIOPULMONALNE REANIMACIJE?

A. Brundula, F. Paleka, J. Vrdoljak , M. Milić, A. Barić Grgurević i *K. Fučkar*

Prema aktualnim smjernicama Europskog reanimacijskog vijeća prioriteti u naprednim mjerama održavanja života u odraslih su kompresija prsnoga koša s minimalnim prekidima i rana defibrilacija. Iako je endotrahealna intubacija zlatni standard zbrinjavanja dišnoga puta, smjernice upućuju na zbrinjavanje dišnoga puta postupno, od bazičnih tehnika zbrinjavanja dišnoga puta prema složenijim, sukladno iskustvu liječnika i učinkovitosti ventilacije. U Hrvatskoj timovi izvanbolničke hitne medicine (IBHM) najčešće uključuju mlade liječnike bez dovoljno izobrazbe i iskustva u naprednim tehnikama zbrinjavanja dišnoga puta. Cilj istraživanja bio je utvrditi postoji li razlika u oporavku spontane cirkulacije pri kardiopulmonalnoj reanimaciji (KPR) u uvjetima IBHM ovisno o izboru tehnike zbrinjavanja dišnoga puta. Retrospektivno smo analizirali podatke iz programa e-Hitna kroz desetogodišnje razdoblje u Zavodu za hitnu medicinu Krapinsko-zagorske županije. U analizu su uključeni svi bolesnici kod kojih su KPR proveli timovi IBHM unutar 20 minuta od poziva. Tehnike zbrinjavanja dišnoga puta koje su se analizirale bile su: orofaringealni tubus, i-gel maska, endotrahealni tubus. Istraživanjem je obuhvaćeno 968 ispitanika srednje dobi od 70 godina. U 74,61% ispitanika uzrok aresta bio je kardijalne etiologije. U provedenom istraživanju nije pronađena statistički značajna razlika u uspješnosti oživljavanja između tri skupine ovisno o tehnici zbrinjavanja dišnoga puta (p=0,74, χ²-test).

Ključne riječi: *Arest; Kardiopulmonalno oživljavanje; Endotrahealna intubacija*