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Original Article

Out-of-hospital cardiac arrests: The effectiveness of prehospital epinephrine use and ventilation management on the short-term survival of patients

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Abstract

Aim: The purpose of this study was to determine the effects of using a bag-valve-mask (BVM) or endotracheal intubation (EI), and administering epinephrine during the transfer of Out-of-hospital Cardiac Arrests (OHCA) cases, and to show the effects of BVM or EI, and epinephrine use on discharge from the hospital and patient survival.

Material and Methods: Totally 109 OHCA patients were included in the study. Group 1 included patients in whom return of spontaneous circulation was achieved after Cardiopulmonary resuscitation (CPR) and who were then discharged from the hospital within 30 days. Group 2 included patients who died after emergency CPR or hospitalization. A Student's t-test was used for normally distributed continuous values, and a Chi-square ($\chi 2$) test was used for numerical data.

Results: Sixteen (14.7%) of the OHCA cases survived and were discharged within 30 days, and 93 (85.3%) died. The outcomes were similar between those who received endotracheal intubation (EI) and BVM during hospital transfer ($p = 0.569$). Epinephrine was administered to 15 (19.2%) patients in group 2 and 5 (45.4%) patients in group 1 during the transfer period, but this difference was not significant ($p = 0.167$). Logistic regression modelling did not find an association between type of airway management, epinephrine use and 30-day discharge survival.

Conclusion: The results of this study show that epinephrine had no effect on patient survival or hospital discharge in OHCA patients. Additionally, the effects of EI and BVM on 30-day survival and hospital discharge were similar.

Keywords: Out-of-hospital cardiac arrests (OHCA); epinephrine; bag-valve-mask (BVM); cardiopulmonary resuscitation (CPR)

INTRODUCTION

Although the most common cause of cardiac arrest is coronary artery disease, many other diseases can also lead to cardiac arrests (CA). In addition, cardiac arrest is still a leading cause of mortality around the world. Therefore, cardiovascular diseases are an important public health problem (1).

Ventricular fibrillation (VF) and ventricular tachycardia (VT) were the most frequent cause of out-of-hospital cardiopulmonary arrest (OHCA). Monitoring of in-hospital cardiac arrest (IHCA) has shown that 80% of the first rhythm is asystole and pulseless electrical activity in the patients (2). Early defibrillation is the most effective treatment for VF and VT, but for each minute of resuscitation, survival is reduced by 10% (3). Cardiac arrest prognosis is poor despite widespread cardiopulmonary resuscitation (CPR) education and improvements in the technique.

Airway management strategy, including endotracheal intubation and adrenaline use are substantial in OHCA patients (3,4). With the evaluation of the patient, airway management and ventilation can prevent the secondary damage of the brain and other vital organs in OHCA. ETT intubation is considered to be an advantageous airway, although more skills are required and relatively difficult to place (3,5,6). It has been shown that epinephrine use increase coronary and cerebral perfusion pressure during CPR (4,7).

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Approximately two-thirds of patients who receive early CPR die before being discharged from the hospital, and permanent brain damage is seen in more than one fourth of survivors (4). Since the survival rate after sudden cardiac arrest is still low, it is necessary to find ways to improve CPR results. Accurate and early intervention in OHCA cases can lead to a significant increase in the survival rate after discharge and improve the quality of life in surviving patients.

Previously, a number of studies have reported interest in establishing optimal airway management and epinephrine administration strategies for OHCA (3,4). However, a few studies on how to improve CPR results in Turkey exist (8).

The purpose of this study was to determine the effects of using a bag-valve-mask (BVM) or endotracheal intubation (EI), and administering epinephrine during the transfer of OHCA cases, and to show the effects of BVM or EI, and epinephrine use on discharge from the hospital and patient survival.

MATERIAL and METHODS

Study design

OHCA patients who were brought to Harran University ED were included. The patient files were scanned retrospectively. Before initiation of the study, the study protocol was conducted in accordance with the 1989 Declaration of Helsinki and was approved by the Ethics Committee of our Hospital. (Date: 26/03/2015, approval number:74059997.050.01.04/047).

Emergency ambulance services in Turkey

In Turkey, the OHCA patients are transported by "112 Emergency ambulance services " to the emergency department. 112 Emergency ambulance services in Turkey are assigned by the chief physician to keep watch at the command and control center in cases where the service capacity, the number of stations and the number of hospitals are exceeded for the continuous maintenance and administration for 24 hours. The 112 Emergency ambulance registration form, which is an example in every case reached during the ambulance service (Form 1), is arranged in three copies. This form gives information about the socio demography, the anamnesis and clinical features of the patients with cardiac arrest. All the 112 Emergency ambulance services workers regularly receive BLS and ACLS training per 6 months according to the guidelines for ACLS.

Data collection

In total, 266 OHCA patients brought to our hospital between June 2011 and June 2014 were retrospectively identified, and the patient files were examined. Of these patients, 84 had non-cardiac arrest (such as pulmonary edema due to congestive heart failure or pulmonary and metabolic disorders) and 73 were not included due to insufficient records. The remaining 109 adult OHCA cases with acute coronary syndrome or other cardiac ischemic history were included in the study. The OHCA cases were divided into two groups. Group 1 included patients in whom return of spontaneous circulation (ROSC) was achieved after CPR and who were then discharged from the hospital within 30 days. Group 2 included patients who died after emergency CPR or hospitalization. Patients who experienced cardiac arrest in the hospital, including in intensive care and other services, were not included in this study. In our hospital, patients who receive emergency CPR and achieve ROSC and patients who receive coronary angiography are initially hospitalized in the coronary intensive care unit. In this study, age, gender, cardiac arrest cause, CPR history, survival, mean platelet volume, epinephrine administration during transport, cardiac compression, and respiratory support (Endotracheal intubation (EI) as an advanced airway or BMA ventilation) during transport were examined. All the clinical and laboratory data were compared between groups 1 and 2.

Statistical analyses

The impacts of the above characteristics on patient survival were investigated. SPSS version 20 was used for data analysis. A power analysis was performed to ensure the scientific validity of the sample size used in the study. A Shapiro-Walk's test was used to confirm the normality of the distribution in each group. Since the distributions were normal, statistics for continuous variables, including the mean and standard deviation (SD), were calculated. A Student's t-test was used for normally distributed continuous values (mean ± sd), and a Chi-square ($\chi 2$) test was used for numerical (N, %, 1.0) data. Binomial logistic regression was assessed for survived and discharged within 30 days, with airway management and epinephrine use as independent variables. Values of $P < 0.05$ were considered significant.

RESULTS

Table 1 shows the clinical characteristics of the patients. Of the 109 cases, sixteen (14.7%) of the OHCA cases survived and were discharged within 30 days, and 93 (85.3%) died. Of the 109 cases, 61.5% (n = 67) were male and 38.5% (n=42) were female. The mean ages of groups 1 and 2 were 44.43±18.92 and 64.30±14.73 years, respectively. The age of patients in group 1 was significantly lower than that in group 2 ($P < 0.001$). Routine laboratory data for all cases are shown in Table 2.

Based on the use of epinephrine and airway management at the time of ED arrival (alpha =0.05 and effect size= 0.8), respectively two-tail power was 90 % and 80% in the study.

Of the patients in group 1, 11 (68.8%) underwent EI, and 5 were given BVM (31.2 %) (Figure 1). Fifty-seven (62.3%) patients in group 2 underwent EI and 36 (38.7%) were given BVM. The outcomes were similar between those who received EI and BVM during hospital transfer (p=0.569).

The time between cardiac arrest and ED arrival was 30.31± 8.65 minutes in group 1 and 41.66 ± 16.91 minutes in group 2. The 30-day discharge survival was higher in OHCA patients who arrived at the ED sooner (p=0.01).

Table 1. Baseline demografical characteristics of patients

Parameters	Survived Patients (14.7%, n=16) [n,% or Mean±SD]	Dead patients (%93; n=85.3) [n,% or Mean±SD]	P*
Gender			
(Male/Female)	11/5	56/37	0.598
Age (years)	44.43±18.92	64.30±14.73	<0.001
Endotracheal			
Intubation (yes/no)	11/5	57/36	0.625
Symptoms (yes/no)	13/3	86/7	0.163
Admission time (min)	30.31± 8.65	41.66 ± 16.91	0.01
Cardiac compression			
(yes/no)	16/0	57/26	0.015
Multiple attempts			
CPR (yes/no)	1/15	30/63	0.033
Transfer with			
112 (yes/no)	16/0	68/25	0.018
Adrenalin use (yes/no)	11/ 5	78/15	0.167

* Admission time- the time until the patient is brought to the emergency department, CPR- cardiopulmonary resuscitation, Cardiac compression- giving the pressure with hand to the patient's chest to provide basic life support, Symptoms- Chest pain, palpitations, vomiting etc , Student t test or Chi-square test 112- patient transport service to hospital as a official in Turkey

Table 2. Baseline laboratory characteristics of patients

Parameters	Survived Patients (16; 14.7%) [Mean±SD]	Dead patients (93; 85.3%) [Mean±SD]	P*
WBC, 10^3/µl	12.54 ±7.05	15.09 ±6,00	0.129
PLT, x10^9/L	188.12±48.38	263.58±89.96	0.001
APTT, seconds	34.87±11.25	39.79±21.80	0.381
Na, mmol/L	140.62±3.20	142.73±20.44	0.683
K, mmol/L	4.49±0.57	4.67±0.69	0.331
Cl, mmol/L	106.00±11.02	105.44±8.51	0.817
Glucose, mg/dL	155.93±82.81	186.72±112.97	0.300
AST, U/L	71.06±55.55	80.91±94.14	0.686
ALT, U/L	56.75 ±40.77	66.72±88.77	0.661
CKMB,	12.40±14.80	10.09±13.60	0.537
Troponin, ng/dL	1.36±0.87	1.29±2.90	0.931
Ca, mg/dL	8.96±1.14	8.61±1.15	0.266
Hs-CRP, mg/dl	6.49±6.43	6.68±7.12	0.922

* Student t test
ALT- Alanine Aminotransferase,APTT- Partial thromboplastin time, AST- Aspartate Aminotransferase, Ca- calcium,CK-MB- creatine kinase-myocardial band isoform ,hs-CRP - high sensitive C reactive protein, K-Potassium, Cl- chlor, PLT-platelet,-Na- sodium, WBC- white blood cell.

Cardiac compression was provided for all patients in group 1, but 26 (29%) patients in group 2 did not receive cardiac compression during hospital transfer (Figure 2, p = 0.015). One (6.3%) of the 16 patients in group 1 and 30 (47.6%) of 93 patients in group 2 suffered from repeated cardiac arrest.

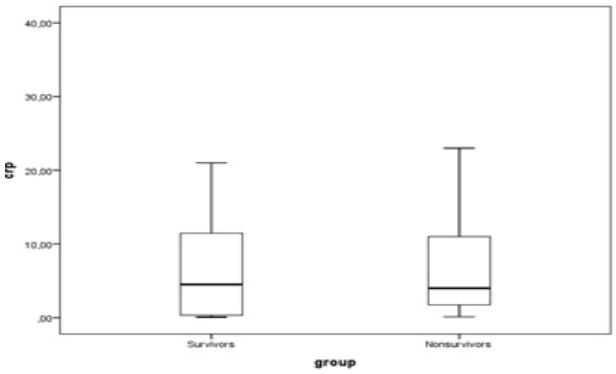

Figure 1. The effects CPR management on 30-day survival and hospital discharge

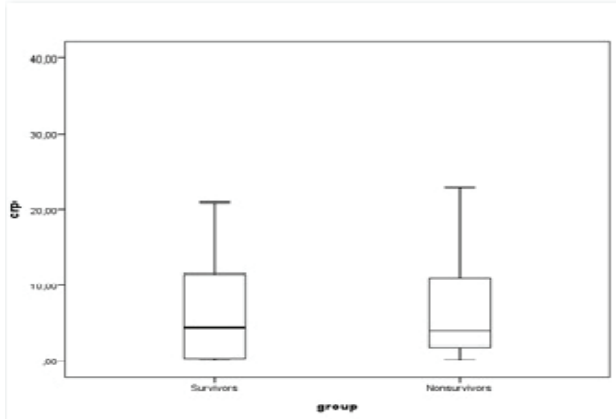

Figure 2. The effects airway management on 30-day survival and hospital discharge

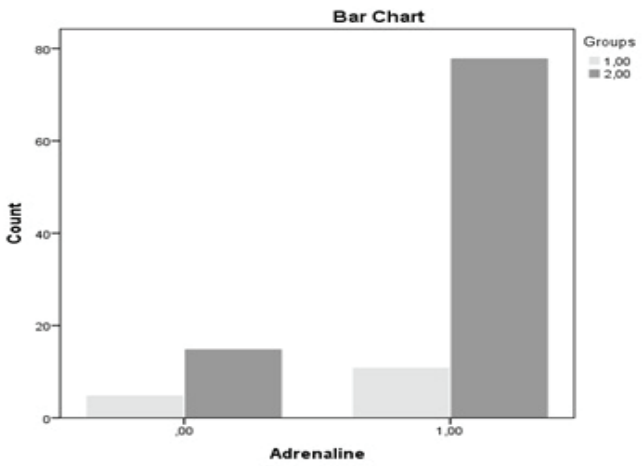

Figure 3. The effects epinephrine use on 30-day survival and hospital discharge

Survival in cases of repeated cardiac arrest was significantly lower (p = 0.033). All patients in group 1 and group 2 were transferred to the ED by ambulance. Epinephrine was administered to 15 (19.2%) patients in

group 2 and 5 (45.4%) patients in group 1 during the transfer period (Figure 3), but this difference was not significant (p=0.167). In addition, logistic regression modelling did not find an association between type of airway management, epinephrine use and 30-day discharge survival.

DISCUSSION

In this study, the survival rates of patients who did or did not receive EI or BVM were similar. Patients who were brought to the ED earlier survived longer and were more often discharged within 30 days. Cardiac compression during transport also increased survival, but epinephrine administration had no effect.

The primary aim after cardiac arrest is to apply an experienced and continuous multidisciplinary plan for returning to normal function. Successful CPR is the first and most important step for returning patients to a normal life after cardiac arrest (9).

There are many studies in the literature on basic life support (BLS) and advanced cardiac life support (ACLS), including CPR (10). The latest guidelines for ACLS were published in 2015. BLS is the cornerstone of resuscitation, and witnessed arrest CPR is critically important for OHCAs. Cardiac compression and early defibrillation are the main determinants of survival (11). In the study, some OHCA patients did not receive cardiac compression immediately or at all. On average, the emergency rescue team in our country reaches the patient in 4-10 minutes in the city center, according to reports consulted for this study. In addition, patients who received CPR immediately upon ambulance arrival survived longer than patients who did not.

There are numerous reports on airway management in cardiac arrest patients. These reports, which include studies on the use of laryngeal masks, EI, and BVM ventilation, showed that these approaches have similar effects on outcomes (3,6,12). In addition, a recent cohort study was published on airway management in IHCA patients (13,14). The researchers reported that the ROSC ratio was lower in endotracheal-intubated patients. In addition, IHCA patients intubated within 15 minutes had lower survival, lower neurologic recovery, and lower rate of discharge compared to patients that were not intubated within 15 minutes (15). Airway management in OHCA patients is essential. A multicenter randomized controlled study reported that BVM and EI resulted in similar complications and survival outcomes in OHCA patients (15). Maignan et al. also compared EI and BVM outcomes in cardiac arrest patients and found that the discharge and survival results were similar for both interventions (16). In this study, we compared EI and BVM in OHCA patients. Similar to the literature, we found no differences in 30-day survival or hospital discharge between EI and BVM ventilation techniques. Thus, the results are in agreement with the literature.

Epinephrine administration during CPR reduces blood flow to all organs and increases blood flow to the heart, resulting in increased coronary perfusion pressure and a delayed heartbeat. Observational and limited clinical studies have shown positive effects of standard-dose epinephrine for survival after CPR (17). However, epinephrine also inhibits myocardial function by increasing coronary artery pressure (18). The potentially dangerous effects of epinephrine, which are mediated via α- and β-receptors, cause decreased cerebral microvascular blood flow and influence neurological outcomes. Cardiovascular instability, including increased myocardial function and tachydysrythmia risk, may cause an increase in thrombocytic activation after ROSC (19). This may result in a pulmonary or cerebral embolism. Additionally, the epinephrine administered during CPR may cause impaired lactate clearance and gastric mucosal perfusion (10,20). There is contradictory evidence about the effect of epinephrine on survival and functional recovery, particularly regarding neurological results in OHCA patients. One study from Japan reported that the ROSC rate increased with epinephrine use, but that this had no effect on survival or functional recovery (21). In the same study, a higher ROSC ratio was reported in the epinephrine group, but it was also related with lower 1-month survival and worse neurologic sequelae. Perkins et al. reported a randomized trial of epinephrine in it ROSC patients. In this study ,the use of epinephrine resulted in a significantly higher rate of 30-day survival than the use of placebo (7). In Olasveengen's study, epinephrine was associated with shorter survival time, but a shorter time to discharge and positive neurological results (22). In the study, we evaluated the survival and discharge after resuscitation in patients who received epinephrine. The results suggested that pre-hospital administration of epinephrine had no effect on survival or hospital discharge. However, this study included a limited number of cardiac arrest patients, and additional studies are needed to clarify the effect of epinephrine in cardiac arrest patients.

LIMITATIONS

This study has several limitations. The major limitation is that this was a retrospective study in a single center. Another limiting factor was the limited data available, which resulted in the excluding many subjects from the study. We were also not able to clearly determine how many patients received defibrillation. Additionally, the first rhythm of the OHCA patients brought to the ED without EMS mechanisms was not understood. From our perspective, the most important limiting factor was the contradictory information regarding the time between cardiac arrest onset and arrival at the ED by ambulance. The result was that we did not record the transport time for OHCA patients.

CONCLUSION

The results of this study show that epinephrine had no effect on patient survival or hospital discharge in OHCA patients. Additionally, the effects of EI and BVM on 30-day survival and hospital discharge were similar. The results of this study emphasize the need for additional studies to determine the effect of epinephrine in cardiac arrest patients.

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Financial Disclosure: There are no financial supports.
Ethical approval: Before initiation of the study, the study protocol was conducted in accordance with the 1989 Declaration of Helsinki and was approved by the Ethics Committee of our Hospital. (Date: 26/03/2015, approval number:74059997.050.01.04/047).

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