Predictors of sustained return of spontaneous circulation in patients with blunt traumatic out-of-hospital cardiac arrest in Taiwan

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Abstract: [Background] Patients with traumatic out-of-hospital cardiac arrest (OHCA) have very poor outcomes, with survival rate ranging from only 0% to 7.5%. The aim of this study was to evaluate the predictors of achieving sustained return of spontaneous circulation (ROSC) in adults during the early resuscitation period. [Materials and Methods] This retrospective study comprised 202 patients with traumatic OHCA in Taiwan. Demographics including pre-hospital information and in-hospital treatment events were evaluated. Variables were compared between patients who achieved sustained ROSC and those who did not to determine possible predictors of outcome. Stepwise logistic regression analysis was further used to select independent predictors. Time-related survival analysis (Kaplan-Meier) was used to analyze the likelihood of survival in patients who received different durations of in-hospital advanced life support (ALS). [Results] The head and neck (52.5%) were the most common sites of injury, and there were 29.7% patients developed cardiac arrest with hypovolemia. The two most important variables associated with achieving sustained ROSC were initial cardiac rhythm presenting as pulseless electrical activity (PEA) (before and after adjust the presence of hypovolemia: OR 6.7, 95% CI 2.0~22.3 and OR 6.7, 95% 2.0~22.4) and administration of fluid totaling > 1500ml during the first 30 min of in-hospital care (before and after adjust for the presence of hypovolemia: OR 4.7, 95% CI 2.2~10.1 and OR 4.8, 95% CI 2.2~10.3). [Discussions] Sustained ROSC was more frequently achieved in patients who had initial cardiac rhythm presenting with PEA and received > 1500 ml of fluid during the first 30 min of in-hospital care. Sustained ROSC was difficult to achieve when in-hospital ALS prolonged.

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1. Introduction

Patients with traumatic out-of-hospital cardiac arrest (OHCA) have very poor outcomes, with survival rate ranging from 0% to 7.5% [1 - 9, 10, 11]. Because of the low rate of survival associated with OHCA patients, attempts have been made to identify the patients with traumatic cardiac arrest who are more likely to survive so that unrecoverable patients can be triaged as do-not-resuscitate in the field.

Some studies have identified patients may benefit from resuscitation with external chest compression. However, in patients with hypovolaemic cardiac arrest, or cardiac tamponade, chest compressions are less effective than normal [1, 2, 12, 13]. Other predictors of an increased chance of survival include prehospital chest tube insertion, sinus rhythm, non-dilated reactive pupils and mechanism of penetrating trauma [9, 13-15, 16]. Moreover, fluids are commonly infused during cardiopulmonary resuscitation (CPR) and during the post-resuscitative period in order to increase organ perfusion and provide nutritional support. However, few studies have addressed the relationship between the amount of fluid challenge administered during initial resuscitation and the chance of achieving return of spontaneous circulation (ROSC) in patients with traumatic OHCA, especially in patients with non-hypovolemic causes. The aim of this study was to evaluate the predictors of achieving sustained ROSC in adults during the early resuscitation period.

1 Materials and methods

1.1 Study Design

This is a retrospective cohort study. We

reviewed the hospital records of 202 patients aged > 18 years with traumatic OHCA who had not presented any spontaneous circulation when arriving emergency department (ED) and been admitted to the ED at the Chang Gung Memorial Hospital-Kaohsiung, a 2500-bed medical center located in southern Taiwan, or the Changhua Christian Hospital, a 2000-bed medical center located in central Taiwan, during the period January 2007 to January 2011. Factors associated with the outcomes were analyzed. The study protocol was approved by the Institutional Review Boards of both hospitals.

1.2 Study setting

Emergency medical services (EMS) description

The organization of local public emergency medical systems and the training of EMS personnel are similar in both southern and central Taiwan. Pre-hospital basic life support (BLS) provided by EMS personnel included chest compression, use of automated external defibrillators (AED), and use of non-invasive ventilation, such as a Bag-Valve-Mask. The decision to stop resuscitation was made only by ED physicians after a detailed clinical assessment indicated that achieving successful resuscitation was not possible.

Inclusion and exclusion criteria

All traumatic OHCA patients presenting to the two EDs during the study period were included in this study. Patients who were pronounced dead without performing any resuscitation were excluded (n=4). As a result, a total of 202 patients were included in this study. All patients underwent resuscitation according to the advanced cardiac life support (ACLS) and the advanced trauma life support (ATLS) protocols. None of the patients had spontaneous circulation upon arrival at the ED and none of them had "do-not-resuscitate" orders before suffering trauma. Moreover, therapeutic hypothermia is not routine for patients with traumatic OHCA in the two hospitals.

Data collected

The protocols in this study adhered to the recommendations of the Utstein Consensus Conference [17]. Pre-hospital information including the mode of transportation, whether pre-hospital BLS had been administered, the location at which cardiac arrest took place, the period from the scene to the hospital, and whether AED were used, was obtained from public EMS records and witness statements [18-20]. Demographic data gathered from ED patient charts included initial vital signs, age, gender, body temperature (measured by an infrared ear thermometer), main site of injury, presence of hypovolemia, initial cardiac rhythm on presentation to the ED, the duration of in-hospital advanced life support (ALS), medications, and total amount of fluid (including crystalloid fluid, colloid fluid, and blood products) administered during in-hospital ALS, which was defined as the time patients arrived at the ED until they achieved sustained ROSC. The main sites of injury were divided into four groups according to the clinical assessments: (1) head and neck injury (intracranial hemorrhage, subarachnoid hemorrhage, epidural hemorrhage, subdural hemorrhage, skull bone fracture, and cervical spine injury); (2) thoracic injury (hemothorax and/or pneumothorax); (3) abdominal injury (spleen, liver, or pancreas, or other intra abdominal organ injury); and (4) multiple trauma (two or more injuries). Only patients suffered from blunt injury were included in this study. Each patient has been surveyed by the ED treating physicians (emergency medicine specialists) for their main sites of injury and the presence of hypovolemia. These surveys included physical findings, images, laboratory examinations and the treatment strategies. For example, patients were suspected to have hypovolemia if they presented with open wound with active/massive bleeding, massive hemothorax with chest tube placement, massive intra-abdominal fluid collection (confirmed by abdominal sonography or computed tomography scan), obvious drop of the hemoglobin and patients who requited a massive blood transfusion. Initial cardiac rhythm on presentation to the ED was obtained from electrocardiograms (ECG) that had been recorded immediately on arrival. Rhythms included ventricular fibrillation (VF), pulseless electrical activity (PEA), and asystole. VF included pulseless ventricular tachycardia.

Outcomes of interest

In this study, sustained ROSC was deemed to have occurred when chest compressions were not required for 20 consecutive minutes and signs of circulation persisted [21]. The following factors that may have influenced achievement of sustained ROSC were analyzed: pre/in-hospital information, demographic data, possible etiology, duration of in-hospital ALS, and types of medication and amount of fluid administered during in-hospital ALS. Patients who achieved sustained ROSC were admitted to the surgical intensive care unit (SICU). Factors that were predictive of outcome in these patients were analyzed. Time-related survival analysis was used to analyze the relationship between different in-hospital ALS durations (<10, 11~20, and >20 minutes) and the likelihood of achieving sustained ROSC in the ED. Survivors were followed up and evaluated their neurological outcomes with Cerebral Performance Category (CPC) scale [17]. In this study, in-hospital ALS was defined as resuscitation attempts performed in the ED. All treatments and decisions regarding the termination of resuscitation efforts were made at the discretion of the treating physician.

1.3 Data analysis

The results of descriptive analyses of independent variables are reported as percentages, median and mean ± S.D. Factors that may be associated with sustained ROSC were analyzed by the Chi-Square test (sex, main site of injury, presence of hypovolemia, place of cardiac arrest, mode of transportation, pre-hospital BLS, AED use, the fluid in the first 30 minutes of in-hospital ALS) or the Fisher's exact test (initial cardiac rhythm, component of the fluid) or Mann Whitney U test (the period from scene to hospital, epinephrine injection times, in-hospital ALS duration) or the student t-test (age, body temperature). Stepwise logistic regression analysis was used to select independent predictors of sustained ROSC and without sustained ROSC. The default entry criterion for the explanatory variables was a P value of 0.05. The default removal criterion was P = 0.10. Survival analysis was done to compare the different survival rates between different groups according to the duration of in-hospital ALS (<10, 11~20, and >20 minutes), initial cardiac rhythm (asystole, VT/VF, and PEA), and volume of fluid administrated during the first 30 minutes of in-hospital care (<1500 and >1500 ml; it was determined by the median value of all patients).

2 Results

2.1 Patient Characteristics

Patient characteristics and pre/in-hospital information of the 202 adults who presented to the ED with traumatic OHCA are presented in Table 1. Only 8 eventually survived to discharge from hospital. The mortality rate among those in whom sustained ROSC had been achieved was 83.3% (40 of 48 patients) and the overall mortality rate was 96.0% (194 of 202 patients). In the first 30 min of in-hospital care, the median volume of fluid administrated to patients was 1500 ml. A total of 99 (49.0%) patients received more than 1500 ml of resuscitative fluid (Table1).

2.2 Factors related to sustained ROSC

Sustained ROSC was achieved in 48 (23.8%) patients after initial resuscitation. The factors associated with achievement of sustained ROSC are presented in Table 2. The results of the logistic regression model are presented in Table 3. The most important factors associated with achievement of sustained ROSC were initial cardiac rhythms presenting as PEA, followed by administration of more than 1500 ml of resuscitative fluid during the first 30 minutes of in-hospital care. Moreover, after adjusting for the presence of hypovolemia, the volume of resuscitative fluid remained a significant predictor of achieving sustained ROSC.

2.3 The likelihood of achieving sustained ROSC and survival rate according to the duration of in-hospital ALS

The Kaplan-Meier survival curves adjusted for different in-hospital ALS durations are shown in figure 1 The log-rank test revealed a significant difference in survival ($p<0.001$) among sustained ROSC patients with different durations of in-hospital ALS. We noted that the survival rate was markedly higher among patients who had received in-hospital ALS for < 10 min (n=23) than among patients who had received CPR for 10-20 min (n=13) or > 20 min (n=11). The characteristics between patients who were "without any ROSC", "sustained ROSC" and "survival" are shown in Table 4. Patient presenting initial cardiac rhythms with PEA and receiving fluid more than 1500ml during the first 30 minutes of in-hospital care seemed to have higher change to survive.

2.4 Neurological outcomes of patients who survived to discharge

Among the 8 patients survived to discharge, Most of them achieved ROSC in the first 10 min of in-hospital ALS and all received emergency operations. Moreover, all of them received fluid challenge not less than 1500 ml in the first 30 minutes of in-hospital care. All survivors showed deterioration in at least one CPC scale category (when discharge) and three of them died within 3 months after discharge.

Table 1. Demographics, etiologies, and resuscitation efforts in adult patients with traumatic OHCA

	Adult Patients with Traumatic OHCA (n=202)	
	No.	%
Pre-hospital information		
Gender		
Male	152	75.2
Female	50	24.8
Age (Mean±SD) (y/o)	47.2±18.6	
Body temperature (Mean±SD) (℃)	34.1±1.6	
Main site of injury		
Head and neck	106	52.5
Thoracic	13	6.4

Abdomen	15	7.4
Multiple	68	33.7
Presence of hypovolemia		
Yes	60	29.7
No	142	70.3
Place of cardiac arrest		
Home	34	16.8
Outside home	168	83.2
Mode of transportation		
EMT	190	94.1
Non-EMT	12	5.9
The period from scene to hospital (median±IQR) (min)	21±9	
Perform pre-hospital BLS		
Yes	156	77.2
No	46	22.8
AED use		
Yes	45	22.3
No	157	77.7
In-hospital information		
Initial cardiac rhythm		
Asystole	184	91.1
VF*	3	1.5
PEA	15	7.4
Epinephrine injection (median±IQR) (times)	9.4±6	
In-hospital ALS duration (median±IQR) (min)	30±28.8	
Total fluid in the first 30 minutes of in-hospital care(ml)		
<1500	103	51.0
>1500	99	49.0
Component of the fluid		
Crystalloid only	106	52.5
Crystalloid and colloid	59	29.2
Crystalloid and blood	19	9.4
Crystalloid, colloid and blood	18	8.9
Sustained ROSC**		
Yes	48	23.8
No	154	76.2
Survival to discharge		
Yes	8	4.0
No	194	96.0

* VF includes patients with pulse less VT.

**Sustained ROSC: ROSC≧20 min.

Table 2. Predictors of sustained ROSC in adult patients with traumatic OHCA

	Adult Patients with Traumatic OHCA (n=202)		
	Sustained ROSC*		p-value
	Success(n=48)	Failure (n=154)	
Gender			0.74
Male	37	115	
Female	11	39	
Age (Mean±SD) (y/o)	47.6±19.1	47.1±18.5	0.86
Body temperature(Mean±SD) (℃)	34.5±1.4	34.0±1.6	0.07
Main site of injury			0.20
Head and neck	29	77	

Thoracic	2	13	
Abdomen	5	8	
Multiple	12	56	
Presence of hypovolemia			0.41
Yes	12	48	
No	36	106	
Place of cardiac arrest			0.97
Home	8	26	
Outside home	40	128	
Mode of transportation			0.54
EMT	46	144	
Non-EMT	2	10	
The period from scene to hospital (median) (min)	21	22	0.69
Perform pre-hospital BLS			0.67
Yes	36	120	
No	12	34	
AED use			0.50
Yes	9	36	
No	39	118	
Initial cardiac rhythm***			<0.001
Asystole	37	147	
VF**	1	2	
PEA	10	5	
Epinephrine injection*** (median) (times)	3	10	<0.001
In-hospital ALS duration*** (median) (min)	11	35	<0.001
Fluid in the first 30 minutes of in-hospital care***(ml)			<0.001
<1500	11	92	
>1500	37	62	
Component of the fluid			0.479
Crystalloid only	30	76	
Crystalloid and colloid	11	48	
Crystalloid and blood	3	16	
Crystalloid, colloid and blood	4	14	

*Sustained ROSC: ROSC≧20 min.
**VF includes patients with pulse less VT.
***Factors associated with achievement of sustained ROSC

Table 3. Results of the logistic regression model with sustained ROSC as target variable before and after adjusted for the presence of hypovolemia

	Before adjust the presence of hypovolemia		After adjust the presence of hypovolemia	
	OR	95% Confidence Limits	OR	95% Confidence Limits
Rhythm				
Asystole	1		1	-
VF*	2.7	0.2~36.7	3.2	0.2~43.2
PEA	6.7	2.0~22.3	6.7	2.0~22.4
Fluid in the first 30 minutes of in-hospital care				
<1500ml	1		1	-
>1500ml	4.7	2.2~10.1	4.8	2.2~10.3

*VF includes patients with pulse less VT

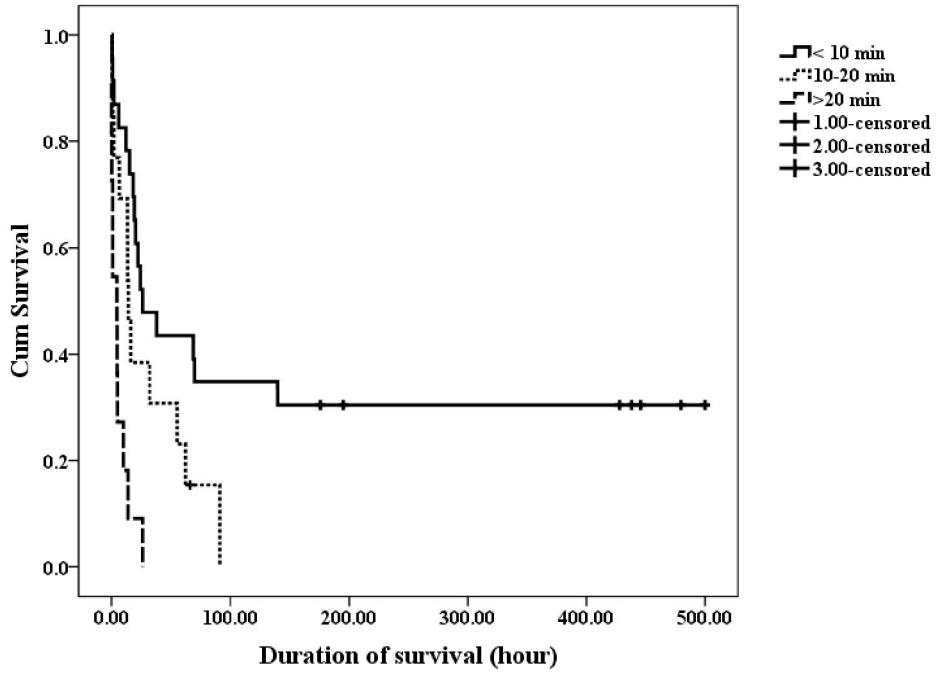

Figure 1. The log-rank test revealed a significant difference in survival between the sustained ROSC patients with different in-hospital ALS durations. The survival rate was still markedly higher among patients who had received in-hospital ALS for < 10 min (n=23) than among patients who had received ALS for 10-20 min (n=13) or > 20 min (n=11) ($p<0.05$).

Table 4. Characteristics between patients who were "without any ROSC", "sustained ROSC" and "survival"

	Adult Patients with Traumatic OHCA (n=202)						
	Without any ROSC (n=154)		Sustained ROSC without survival (n=40)		Survival (n=8)		P value
	No.	%	No.	%	No.	%	
Age > 65 (y)	34	22.1	7	17.5	3	37.5	0.450
Male	115	74.7	31	77.5	6	75.0	0.934
Presence of hypovolemia	48	31.20	11	27.50	1	12.50	0.500
Initial cardiac rhythms							<0.001
Asystole	147	95.5	33	82.5	4	50.0	
VT/Vf	2	1.3	1	2.5	0	0.0	
PEA	5	3.2	6	15.0	4	50.0	
Fluid >1500ml in the first 30 minutes of in-hospital care	62	40.3	29	72.5	8	100.0	<0.001
Losing a pulse en route	25	16.2	9	22.5	2	25	0.564

3 Discussions

We found that initial cardiac rhythm was a significant predictor of achieving sustained ROSC in the ED. Asystole was the predominant arrest rhythm and that patients with initial cardiac rhythms presenting as PEA were more likely to achieve sustained ROSC than patients with an asystolic cardiac rhythm. According to our result, patients with initial cardiac rhythm of VF did not indicate statistic difference to achieve sustained ROSC because of the small number of patients with VF.

Fluids are commonly infused during CPR and are well known to increase circulating volume during resuscitation and improve cardiac output and blood

pressure after an initial successful ROSC. The evidence supporting the use of intravenous fluid during CPR in primary cardiac arrest is limited. Ascertaining the true effects of fluids during CPR is hampered by the fact that most studies do not have a control group that did not receive fluid. Bender et al. found no significant difference in the rate of ROSC and survival to hospital admission between patients who received a hypertonic saline/starch solution during OHCA and patients who received starch alone (ROSC, 66.7% versus 51.5%, p = 0.21; admission, 57.6% versus 39.4%, p = 0.14, n = 66) [22, 23]. Two studies had analyzed the relationships between survival and the amount of blood transfusion in patient with traumatic cardiac arrest. One study had large patient number (n=757) and reported that patients who underwent massive blood transfusion of more than 10 units of packed red blood cells had a lower chance of survival [13]. Another study (n=184) mentioned that the amount of blood transfusion did not associated with the survival [14]. However, to our knowledge, blood transfusion is not the only one kind of fluid administrated during early resuscitation and hemorrhage related hypovolemic shock was not the majority in our results. In this study, we found that patients who received > 1500 ml of fluid during the first 30 min had a significantly greater chance of achieving sustained ROSC. In addition, the components of the fluid and the amount in each categories of fluid (crystalloid, colloid and blood) did not serve as predictors of achieving sustained ROSC in our study; we suspected that there were some reasons that might influence the results, including (1) all patients had received crystalloid initially and control group was lacking; (2) patients who did not maintain their ROSC over 15 min have very low change to receive blood transfusion because of preparing for blood products still need time.

In fact, we did not arbitrarily selected 1500 ml as a volume target to aim for achieving ROSC based on post hoc analysis of the results, this being the median of the volume of fluids given to our cohort of patients. An ideal amount of fluid in the early resuscitation period finally need to be determined depend on the clinical differences of patients and their treating physicians. Moreover, after adjusting for the presence of hypovolemia, we found that the administration of high volumes of fluid during initial resuscitation is beneficial not only for patients with hypovolemia but also for patients with neurological injuries and those with asphyxia.

Although initial cardiac rhythm presenting as PEA/VF was associated with achievement of sustained ROSC, initial cardiac rhythm was not significantly associated with prolonged survival. Therefore, we suspect that high volumes of resuscitative fluid as well as electrical activity in the heart can reestablish circulation during in-hospital ALS; however, prolonged CPR as well as the patients' underlying pathologies was the major factors that led to death during the post-resuscitative period. Seven of the patients who survived received CPR for less than 10 min, and only one patient received CPR for 11 min. Therefore, we suggest that survival to discharge is unlikely for traumatic OHCA patients who require prolonged CPR.

Limitations

In this study, however, only 8 patients survived to discharge from hospital. Therefore, the factors associated with good neurologic outcomes were difficult to analyze [24]. All traumatic OHCA patients received resuscitation in the ED but most of them died. The patients who achieved a return of spontaneous circulation after primary resuscitation received further treatment or critical care in the ICU. The retrospective nature of this study and small patient number were also limitations. Our regional data cannot well reflect the whole facts throughout the world but pointed the importance of fluids in early resuscitation. Finally, the amount of fluid administered might have been influenced by the treating physicians, and patients who had undergone longer durations of CPR might have received more fluid. The 1500 ml was initially determined by the median value of all patients and fluid left in the IV bottle after stopping resuscitation is difficult to evaluate. Moreover, there was no control group in this study. Therefore, this study was limited to detecting associations and could not establish causality. The associations between ROSC and the categories of fluid administrated during CPR should be further analyzed in the future.

Conclusions

Initial cardiac rhythm is an important predictor of achieving sustained ROSC. In addition, administration of high volumes of resuscitative fluid during the first 30 min of in-hospital ALS might increase the likelihood of achieving sustained ROSC. Our findings suggest that there is an inverse relationship between duration of in-hospital ALS and survival.

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References

1. Soar J, Deakin CD, Nolan JP, et al. European Resuscitation Council guidelines for resuscitation 2005. Section Cardiac arrest in special circumstances. Resuscitation 2005;67:S135-70.
2. Stockinger ZT, McSwain Jr NE. Additional evidence in support of withholding or terminating cardiopulmonary resuscitation for trauma patients in the field. J Am Coll Surg 2004; 198:227-31.
3. Powell DW, Moore EE, Cothren CC, et al. Is

emergency department resuscitative thoracotomy futile care for the critically injured patient requiring prehospital cardiopulmonary resuscitation? J Am Coll Surg 2004;199:211-5.
4. Martin SK, Shatney CH, Sherck JP, et al. Blunt trauma patients with prehospital pulseless electrical activity (PEA): poor ending assured. J Trauma 2002;53:876-80.
5. Rosemurgy AS, Norris PA, Olson SM, et al. Prehospital traumatic cardiac arrest: the cost of futility. J Trauma 1993;35:468-474.
6. Battistella FD, Nugent W, Owings JT, et al Field triage of the pulseless trauma patient. Arch Surg 1999;134:742-745.
7. Shimazu S, Shatney CH. Outcomes of trauma patients with no vital signs on hospital admission. J Trauma 1983;23:213-216.
8. Stockinger ZT, McSwain NE. Additional evidence in support of withholding terminating cardiopulmonary resuscitation for trauma patients in the field. J Am Coll Surg 2004;198:227-231.
9. Lockey D, Crewdson K, Davies G. Traumatic cardiac arrest: who are the survivors? Ann Emerg Med 2006;48:240-4.
10. Lai SC, Wu HP, Yang YS, et al. Initial glasgow comascale during the early post-resuscitative period predicts the neurologic functions in children with traumatic out-of-hospital cardiac arrest. J Neurosci Neuroeng 2013;2:66-71.
11. Lei WY, Chen WL, Lin FH, et al. Using proteinuria in early post-resuscitative period to predict survival duration and neurologic outcomes. J Neurosci Neuroeng 2012;1:82-89.
12. Hopson LR, Hirsh E, Delgado J, et al Guidelines for withholding or termination of resuscitation in prehospital traumatic cardiopulmonary arrest. J Am Coll Surg 2003;196:106-112.
13. Huber-Wagner S, Lefering R, Qvick M, et al. Outcome in 757 severely injured patients with traumatic cardiorespiratory arrest. Resuscitation 2007;75:276-85.
14. Pickens JJ, Copass MK, Bulger EM. Trauma Patients Receiving CPR: Predictors of Survival. J Trauma 2005;58:951-58.
15. Cera SM, Mostafa G, Sing RF, et al. Physiologic predictors of survival in post-traumatic arrest. Am Surg 2003;69:140-4.
16. Lin YR, Yang MC. Survival and neurological outcomes in children with out-of-hospital cardiac arrest. J Neurosci Neuroeng 2012;1:213-221.
17. Safar P. Resuscitation after Brain Ischemia, in Grenvik A and Safar P Eds: Brain Failure and Resuscitation. Churchill Livingstone, New York. 1981:155-184.
18. Soad M. Hegazy, Lamiaa A. El-Sayed, Tarek Y. Ahmed, et al. Avoiding Pitfalls in Trauma Triage: Effect of Nursing Staff Development. Life Sci J 2012;9(1):1006-1014.
19. Hend M. Elazazay, Amany L. Abdelazez and Omibrahem A. Elsaie. Effect of Cardiopulmonary Resuscitation Training Program on Nurses Knowledge and Practice. Life Sci J 2012;9(4): 3494-3503.
20. Mehrdad sharifi, Shahram Baraz, Falaheddin Mohammadi, et al. Patients Perception and Satisfaction of the Ambulance Service (115) at Shahrekord, Iran. Life Sci J 2012;9(4):2196-2201
21. Cummins RO, Chamberlain DA, Abramson NS, et al Recommended guidelines for uniform reporting of data from out-of-hospital cardiac arrest: The Utstein style. Ann Emerg Med 1991;20:861–874
22. Bender R, Breil M, Heister U, et al. Hypertonic saline during CPR: feasibility and safety of anewprotocol of fluid management during resuscitation. Resuscitation 2007;72:74–81.
23. Helmy Elgawaby, Mohamed Shehata, Sherif Sabri, et al. Effect of Hypertonic Saline on Adequacy of Resuscitation, Progression of Inflammation and Outcome of Critically Ill Septic Patients. Life Sci J 2011;8(4):1148-1153.
24. Mostafa Shokati A, Parkhideh Hasani, Human Manoochehri, et al. The Lived Experience of Iranian Caregivers of Comatose Patients. Life Sci J 2012;9(3):1656-1662.

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