



# Analysis of traumatic cardiorespiratory arrest cases in a level 3 emergency department

© Yahya Ayhan Acar, © Sedat Bilge

University of Health Sciences Turkey, Gülhane Faculty of Medicine, Department of Emergency Medicine, Ankara, Turkey

## Date submitted:

19.12.2019

## Date accepted:

27.01.2020

## Online publication date:

15.03.2020

## Corresponding Author:

Yahya Ayhan Acar MD, University of Health Sciences Turkey, Gülhane Faculty of Medicine, Department of Emergency Medicine, Ankara, Turkey  
yahyaacar@gmail.com

## ORCID:

orcid.org/0000-0002-9572-5738

**Presented in:** This manuscript was presented as an oral presentation in the International Medical Congress of Izmir Democracy University (December 6-8, 2019, Izmir).

**Keywords:** Advanced trauma life support care, cardiopulmonary resuscitation, heart arrest, return of spontaneous circulation, trauma severity indices

## ABSTRACT

**Aim:** Our study aims to investigate the return of spontaneous circulation (ROSC) outcomes in traumatic arrest patients that were admitted to the emergency department (ED).

**Methods:** This study retrospectively investigates traumatic cardiorespiratory arrest (TCA) cases that were admitted to the level 3 ED of a university hospital between October 1, 2016 and April 30, 2019. The study includes TCA cases where cardiopulmonary resuscitation was performed in the preclinical phase, and/or after admission to the ED. Additional data were collected for statistical analysis: ROSC, age, gender, mechanism of injury, laboratory findings, injury severity scores (ISS), imaging methods, and consultation requests. The exclusion criteria were as follows: (a) non-traumatic arrest, (b) incomplete records.

**Results:** A total of 41 TCA patients were included in the study. ROSC was achieved in 16 patients (39.0%). Ten subjects (24.4%) were female and 31 (75.6%) were male, and the mean age of the sample group was  $46.56 \pm 26.49$  years. ROSC did not significantly depend on gender or age ( $p=0.612$ ,  $0.064$ , respectively). Most of the traumatic injuries were in the head-neck region, the extremities, and the thorax. ROSC did not significantly depend on the mechanism of injury ( $p=0.620$ ). ROSC was significantly correlated with ISS scores ( $p=0.006$ ).

**Conclusion:** According to our data, TCA mostly occur due to blunt trauma among the young adult male population and ISS scores seem useful in predicting ROSC. Trauma team formation should be directed to reversible causes of TCA, such as bleeding control, blood/blood product transfusions, and thoracostomy, to improve patient outcomes.

## Introduction

Traumatic cardiac arrests (TCA) make up 12-13% of all cardiac arrest cases. Four out of 100,000 people experience TCA every year (1,2). TCA also constitutes 7% of all out-of-hospital cardiac arrest cases. It is a substantial cause of death for the younger population (3). TCA is mostly caused by blunt trauma, and penetrating trauma is associated with better outcome (4,5).

Despite being common, there currently is not a standard cardiopulmonary resuscitation (CPR) guideline for TCA cases. In fact, several authors claim that CPR efforts are futile for TCA

patients whereas others debate this statement (6,7). As trauma is caused by one of the reversible causes of cardiac arrest (hypoxia, tension pneumothorax, cardiac tamponade, and hypovolemia), forming trauma teams in emergency department (EDs) that largely deal with trauma cases can effectively improve mortality (6,8). It is important to note that the survival rates of traumatic and non-TCA are similar (9). Regional data regarding mortality will prove valuable, as there are regional disparities in traumatic arrest outcomes. There is limited information regarding the effectiveness of using trauma scoring systems [e.g. injury

severity scores (ISS)] in EDs. One study estimates the rate of complete neurological recovery to be 1.6% for all traumatic arrest cases (2). Achieving return of spontaneous circulation (ROSC) or respiratory activity at any point in resuscitation is associated with better outcome (9).

Our study aims to investigate ROSC outcomes among traumatic arrest cases based on their ISS, vital findings, laboratory findings, and physicians' imaging and consultation preferences.

## Methods

This study retrospectively investigates TCA cases in the level 3 ED of University of Health Sciences Hospital between October 1, 2016 and April 30, 2019. Ethical approval for this study was obtained from University of Health Sciences Turkey, Gülhane Non-invasive Investigation Ethics Committee (2019-19/252). The study includes TCA cases where CPR was performed in the preclinical phase, and/or after admission to the ED. The data were obtained from the electronic database of the hospital and the patients' files. The following information was recorded: age, gender, mechanism of injury, laboratory finding, ISS, duration of CPR, ROSC outcome, preferred imaging methods, requests for consultation. The exclusion criteria were as follows: (a) non-

traumatic arrest, (b) incomplete records. The ethics committee waived the requirement for patient informed consent because no patient re-contact was established for the study.

## Statistical Analysis

The frequencies, percentages and normally distributed continuous variables were reported as means with standard deviation while non-normally distributed continuous variables were presented as medians with interquartile ranges (IQR). Categorical variables of the subject groups were compared using the chi-square test. Mann-Whitney U test was used for the paired comparison of the continuous data that were not normally distributed whereas Student's t-test was used for the paired comparison of the continuous data that were normally distributed. SPSS 18.0 software was preferred for statistical analysis, significance level was set as below 5% ( $p < 0.05$ ).

## Results

A total of 41 TCA patients were included in the study. ROSC was achieved in 16 patients (39.0%). The mean CPR duration was  $41.24 \pm 23.16$  minutes (minimum: 3, maximum: 125), and the median time to achieve ROSC was 10 minutes (minimum: 5, maximum: 30). ROSC did not significantly depend on the duration of CPR (Table 1). The CPR duration did not significantly depend

**Table 1. Demographics of the groups**

Parameter	ROSC	n	Mean $\pm$ SD	95% CI	p
Age	Non-sustained	25	52.68 $\pm$ 25.40	-0.93-32.29	0.064*
	Sustained	16	37.00 $\pm$ 26.05		
Gender (male/female)	Non-sustained	19/6	N/A	N/A	0.612**
	Sustained	12/4	N/A		
GCS	Non-sustained	23	4.70 $\pm$ 3.90	-3.23-2.08	0.572***
	Sustained	15	5.27 $\pm$ 4.01		
Heart rate	Non-sustained	18	95.50 $\pm$ 6.34	-21.24-4.86	0.209***
	Sustained	13	103.69 $\pm$ 26.18		
Systolic blood pressure (mmHg)	Non-sustained	18	106.11 $\pm$ 30.08	-9.62-37.85	0.234***
	Sustained	13	92.00 $\pm$ 34.28		
Diastolic blood pressure (mmHg)	Non-sustained	18	65.94 $\pm$ 22.33	-6.44-25.26	0.235***
	Sustained	13	56.54 $\pm$ 19.73		
ISS	Non-sustained	24	28.25 $\pm$ 9.60	4.49-19.99	0.003***
	Sustained	15	16.07 $\pm$ 14.14		
Duration of CPR	Non-sustained	25	45.92 $\pm$ 12.04	-1.02-32.20	0.084***
	Sustained	13	32.23 $\pm$ 35.09		
PRBC transfusion (Yes/No)	Non-sustained	9/16	N/A	N/A	0.334**
	Sustained	9/7	N/A		
Sedative administration (Yes/No)	Non-sustained	15/10	N/A	N/A	0.003**
	Sustained	16/0	N/A		

\*Student's t-test.

\*\*Chi-square test.

\*\*\*Mann-Whitney U test.

CI: Confidence interval, CPR: Cardiopulmonary resuscitation, GCS: Glasgow Coma Scale, ISS: Injury severity score, N/A: Non-applicable, PRBC: Packed red blood cell, ROSC: Return of spontaneous circulation, SD: Standard deviation

on the mechanism of injury (blunt or penetrating,  $p=0.599$ , Mann-Whitney U test). Ten patients (24.4%) were female and 31 (75.6%) were male, and the mean age of the sample group was  $46.56 \pm 26.49$  years. ROSC did not significantly depend on gender or age ( $p=0.612$ ,  $0.064$ ; respectively) (Table 1).

Among the 41 patients, 38 (92.7%) were brought to the ED through emergency ambulance services (112 in Turkey). The median length of stay in the ED was 60 minutes (IQR: 45-143). The mean Glasgow Coma Scale (GCS) score at the time of admission was  $4.92 \pm 3.90$ . This value was not significantly

different for the two subject groups (Table 1). It was observed that among the laboratory findings, only the hemoglobin, pH,  $\text{HCO}_3$ , and lactate levels were significantly different between the two subject groups (Table 2).

The injury mechanisms among the patients were as follows: motor vehicle collision, 43.9% ( $n=18$ ); penetrating injury, 14.6% ( $n=6$ ); falls, 22% ( $n=9$ ); other, 19.5% ( $n=8$ ). ROSC did not significantly depend on the mechanism of injury (Table 3).

The anatomical locations of the sustained injuries were as follows: head-neck region, 32 (78.1%); extremities, 25 (60.9%);

**Table 2. Laboratory parameters in relation to return of spontaneous circulation outcomes**

Parameter	ROSC	n	Mean $\pm$ SD	95% CI	p
White blood cell count ( $10^9$ cells/mL)	Non-sustained	25	$10.19 \pm 3.79$	-6.62-0.81	0.122*
	Sustained	12	$13.09 \pm 7.71$		
Hemoglobin (g/dL)	Non-sustained	25	$12.42 \pm 2.53$	0.03-0.02	0.046*
	Sustained	12	$10.39 \pm 3.59$		
Hematocrit (%)	Non-sustained	25	$37.62 \pm 6.86$	-0.76-10.61	0.087*
	Sustained	12	$32.70 \pm 10.68$		
Platelets ( $10^9$ cells/mL)	Non-sustained	25	$171.48 \pm 74.74$	-52.56-56.52	0.942*
	Sustained	12	$169.50 \pm 90.53$		
Glucose (mg/dL)	Non-sustained	22	$154.68 \pm 90.51$	-88.92-31.35	0.338*
	Sustained	15	$183.47 \pm 85.29$		
Urea (mg/dL)	Non-sustained	22	$37.50 \pm 25.78$	-19.24-16.51	0.878*
	Sustained	15	$38.87 \pm 27.04$		
Creatinine (mg/dL)	Non-sustained	22	$1.20 \pm 0.48$	-0.50-0.21	0.405*
	Sustained	15	$1.35 \pm 0.58$		
Sodium (mmol/L)	Non-sustained	22	$141.86 \pm 3.62$	-4.64-1.65	0.342*
	Sustained	14	$143.36 \pm 5.71$		
Potassium (mmol/L)	Non-sustained	20	$5.06 \pm 1.66$	-1.12-0.78	0.723*
	Sustained	14	$5.23 \pm 0.62$		
pH	Non-sustained	19	$7.16 \pm 0.15$	0.02-0.28	0.024*
	Sustained	12	$7.01 \pm 0.21$		
PaO <sub>2</sub> (%)	Non-sustained	19	$38.67 \pm 22.60$	-43.07-7.89	0.169*
	Sustained	12	$56.26 \pm 46.63$		
pCO <sub>2</sub> (%)	Non-sustained	19	$54.14 \pm 15.27$	-22.44-11.86	0.533*
	Sustained	12	$59.43 \pm 31.33$		
Lactate (mmol/L)	Non-sustained	19	$7.54 \pm 3.60$	-6.96-0.15	0.06*
	Sustained	12	$10.94 \pm 6.11$		
HCO <sub>3</sub> (mmol/L)	Non-sustained	19	$18.39 \pm 4.17$	1.01-8.13	0.014*
	Sustained	12	$13.83 \pm 5.49$		
INR	Non-sustained	18	$2.55 \pm 5.66$	-3.73-3.77	0.188**
	Sustained	11	$2.53 \pm 2.66$		
Prothrombin time (seconds)	Non-sustained	18	$14.13 \pm 3.71$	-25.51-0.98	0.146**
	Sustained	11	$27.37 \pm 25.21$		

\*Student's t-test.

\*\*Mann-Whitney U test.

CI: Confidence interval, INR: International normalized ratio, ROSC: Return of spontaneous circulation, SD: Standard deviation

abdomen, 12 (29.3%); pelvic region, 9 (22%); vertebrae, 6 (14.6%); blood vessels, 6 (14.6%). Multiple trauma was not significantly correlated with ROSC compared to other trauma (p=0.079, chi-square test). A total of 2 patients (4.9%) underwent tube thoracostomy.

The preferred imaging methods were as follows: X-ray imaging, 6; ultrasound imaging, 7; computed tomography (CT), 17; magnetic resonance imaging, 2. None of the imaging methods were significantly correlated with ROSC (p=0.643, 0.672, 0.295, N/A, respectively; chi-square test). The CT findings of 17 patients were as follows: maxillofacial fracture, 6 (35.3%); hemothorax, 5 (29.4%); pneumothorax, 2 (11.8%); fractured scapula, 3 (17.6%); rib fracture, 3 (17.6%); intra-abdominal hemorrhage, 3 (17.6%); pelvic fracture, 4 (23.5%); vertebral fracture, 7 (41.2%).

The consulted departments were as follows: neurosurgery, 18 (43.9%); anesthesia, 13 (31.7%); thoracic surgery, 11 (26.8%); general surgery, 11 (26.8%); orthopedics, 10 (24.4%); pediatric surgery, 2 (4.9%); cardiovascular surgery, 2 (4.9%);

other, 13 (31.7%). The total number of consultations was found to be correlated with ROSC outcome (p=0.014, Mann-Whitney U test).

The ISS findings were as follows: 25 and above, 22 (53.7%); 16-24, 7 (17.0%); below 16, 10 (24.3%). The ROSC outcomes of the three groups were found to be significantly different where increasing ISS score indicated a lower probability of ROSC (p=0.006) (Figure 1) (Table 4).

The blood and blood product replacement findings were as follows: packed red blood cell (PRBC) transfusion, 18 (44.9%); fresh frozen plasma (FFP) transfusion, 5 (12.2%); tranexamic acid administration 3 (7.3%). PRBC transfusion was not correlated with ROSC outcome (p=0.334) (Table 1).

**Discussion**

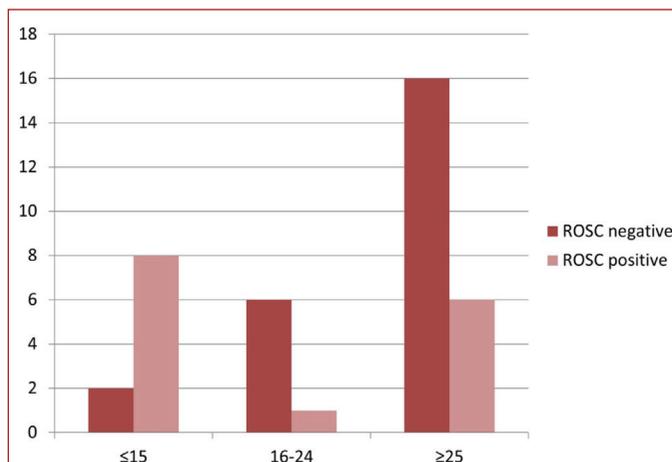
There are several regional and national studies regarding the ROSC outcomes of TCA patients. These studies found the ROSC rates of TCA patients to be between 14.0% and 49.1% (1-3,10,11). The sizeable differences between these studies can be explained by the exclusion of TCA cases that were preclinically pronounced dead, and the differences in the data of Utstein style reports. In our hospital, CPR is performed for all cardiac arrest cases in accordance with hospital policy, regardless of traumatic/non-traumatic cause. All cardiac arrest patients that received CPR in the hospital (traumatic/non-traumatic) were included in our study. We found that ROSC was achieved in 39.0% of TCA patients, which is consistent with current literature.

The CPR duration findings in our study are compliant with those of Elkbuli et al. (12), who indicate that the duration of CPR was 1-120 minutes for TCA cases. There are several reasons that cause CPR durations to significantly vary, especially in the context of TCA. Unlike medical arrests, TCA cases may require additional interventions, such as thoracostomy, blood product transfusion, and consultation to specialists, all of which will increase the duration of CPR. Furthermore, it is possible that the patient will be pronounced dead shortly after admission due to irreparable trauma. Also, CPR procedures may vary due to local law or institutional standards. Some researchers suggest the development of a specific CPR protocol for TCA cases will

**Table 3. Return of spontaneous circulation rates in relation to mechanism of injury**

	ROSC non-sustained n	ROSC sustained n	Total	p*
Motor vehicle collisions	13 (52.0%)	5 (31.3%)	18	0.620
Penetrating injuries	3 (12.0%)	3 (18.8%)	6	
Falls	5 (20.0%)	4 (25.0%)	9	
Others	4 (16.0%)	4 (25.0%)	8	
Total	25 (100%)	16 (100%)	41	

\*Chi-square test.  
ROSC: Return of spontaneous circulation



**Figure 1.** Distribution of return of spontaneous circulation in relation to injury severity score

ROSC: Return of spontaneous circulation

**Table 4. Return of spontaneous circulation rates in relation to injury severity score**

ISS groups	ROSC non-sustained n	ROSC sustained n	Total	p*
≤15	2 (8.3%)	8 (53.3%)	10	0.006
16-24	6 (25.0%)	1 (6.7%)	7	
≥25	16 (66.7%)	6 (40.0%)	22	
Total	24 (100%)	15 (100%)	39	

\*Chi-square test.  
ISS: Injury severity score, ROSC: Return of spontaneous circulation

be effective in addressing the CPR duration. Smith et al. (6) indicated that neither external chest compressions (ECC) nor the administration of epinephrine were found to be effective in TCA cases; however, they needed to be resumed due to the absence of an alternative. The standard CPR protocol was administered to all our TCA subjects as well, including ECC and epinephrine applications.

TCA is mostly observed in the younger population. Different studies report the mean age of patients to be between 33.0 and 48.9 (13-15) years. Consistently, we have found the mean age of our subjects to be  $46.56 \pm 26.49$ .

TCA is more common among males, studies report, between 59% and 92%, all TCA patients are men (1-3,14,15). Pekdemir et al. (16) have found that in Turkey, males make up 59% of all trauma cases, and 67.9% of the trauma cases that require hospitalization. Moore et al. (11) found that males made up 87.3% of all TCA cases; however, gender or age was not found to be correlated with ROSC outcomes. Our findings are consistent with the literature. It can be concluded that men are more commonly subject to severe trauma, but gender does not influence overall ROSC outcomes of TCA.

Irfan et al. (1) found that 91% of trauma cases are transported with ground ambulances. This is consistent with our findings, where 97.2% of the patients were transported to the hospital with emergency ambulance services. In contrast, Pekdemir et al. (16) reported that in 1997, only 9.2% of trauma cases were transported to the hospital with an ambulance. The mode of transport was not found to be correlated with mortality. Another study that was conducted in the same hospital in 2017 found that this number had increased to 80.9%, indicating an increased use of emergency medical services over the years, allowing most cases to be treated on site (17). This supports the notion that well-trained paramedics can be an important part of trauma management systems.

It is crucial to determine the level of consciousness in TCA patients. Studies have found the mean GCS scores to be between 3 and 5.6 for TCA patients (1,5,15). Similarly, our subjects' mean GCS score was  $4.92 \pm 3.90$ . Bleeding is the most common preventable cause of trauma-related deaths (11). There are several indicators that can be used to evaluate blood circulation, such as heart rate, blood pressure and hemoglobin levels. The mean systolic blood pressure (SBP) of TCA cases at the time of admission was reported to be between 49.6 and 80.1 (5,15). We did not find that SBP at the time of admission was an indicator of ROSC outcome. Huber-Wagner et al. (5) have found the mean hemoglobin value to be 8.2 mg/dL for TCA patients. We found this value to be  $11.69 \pm 3.07$ , and that it was significantly different for the positive and negative ROSC outcome groups. When determining the stage of hypovolemic shock, heart rate, blood pressure and level of consciousness are not enough, and hemoglobin levels cannot not used. Thus, Mutschler et al. (18)

indicate that hemoglobin levels at the time admission can be misleading as an indicator, and also that only 10.3% of trauma patients can be adequately classified according to the Advanced Trauma Life Support (ATLS) guideline, which indicates that a relevant update is necessary. A recent update included blood base deficit, a blood gas parameter, as an indicator in shock staging. Consistently, we found that blood gas parameters were significantly different for patients with different ROSC outcomes.

Blunt trauma is a more common cause of TCA, rates are reported to be between 85.2 and 96.53%, and the most common cause of blunt trauma is motor vehicle accidents (1,5,13,14,16). It is important to differentiate blunt and penetrating trauma, as resuscitative thoracotomy is significant in the management of penetrating TCA, despite having limited use in blunt trauma cases (9). It should be noted that the mechanism of the trauma is not found to be directly correlated with mortality. We have similarly found that blunt traumas, and specifically motor vehicle accidents are the major cause of TCA, and that the mechanism of trauma does not significantly affect ROSC outcomes.

According to the studies of Huber-Wagner et al. (5) and Avcı et al. (15), traumas mostly affect the head-neck region and the thorax among TCA patients. Similarly, Irfan et al. (1) found that 66.0% of TCA patients had sustained head trauma, and Barnard et al. (13) found that 86.8% of patients had traumatic brain injury and severe hemorrhage. We have correspondingly found that most traumatic injuries were in the head-neck region, the extremities, and the thorax. In primary and secondary examinations, it is important to thoroughly assess head-neck and thorax regions. It is worth noting that thorax traumas are among the reversible reasons of cardiac arrest.

Current ATLS guidelines suggest that the radiological exams should only be done after the primary examination, when the patient's condition has improved, and bedside if possible. As mentioned before, the reversible causes of cardiac arrest, including hypoxia, tension pneumothorax (TPX), cardiac tamponade and hypovolemia, need to be rapidly diagnosed and treated (6). As radiological imaging will be helpful in the detection of these causes, it will be beneficial to carry out focused assessment with sonography in trauma (FAST) and bedside ultrasound examinations in early stages, provided that they do not get in the way of the resuscitation process. In our study, most subjects were examined with CT. The reason for lower rates of FAST and ultrasonography may be that not all physicians in the ED have adequate experience with FAST, or the poor condition of certain patients may have prevented them from being transported to the radiology department for further examinations. We were unable to find any studies that specifically researched imaging methods in the context of TCA.

There are several scoring systems that are used to determine the severity and mortality of trauma cases, ISS is one of the most

common scoring systems. ISS is the best system at predicting mortality, and an ISS score below 25 is an indicator of good outcome for TCA (9,19). Huber-Wagner et al. (5) found that the mean ISS score was 41.0 for TCA patients, and Barnard et al. (13) found it to be 29 (minimum-maximum: 21-75). Georgescu et al. (14) indicate that the ISS results of TCA patients were between 30 and 75 and were correlated with the ages of the patients. We have similarly found that ISS scores could have predictive value regarding ROSC outcomes.

Barnard et al. (13) found that an approach that focuses on reversible causes of cardiac arrest can increase the survival rate to 7.5%. Treating specifically reversible causes with hemorrhage control, thoracostomy, blood transfusion, and surgery were associated with improved ROSC and survival among TCA patients (1). Evans et al. (7) suggest focusing on reversible reasons for TCA patients, instead of ECC. They recommend using direct pressure, tourniquet and pelvic bandage to control hemorrhage. Tube thoracostomy is recommended as a lifesaving treatment for TPX. Smith et al. (6) even suggest that if tube thoracostomy is an available option, the physician should avoid needle decompression. Empiric bilateral chest decompression is recommended for all other TCA cases if there are no other possible explanations (7). Resuscitative thoracotomy should be considered for all TCA cases that have sustained penetrating trauma unless there is severe head injury, multisite trauma, or no sign of cardiac activity (9). In their study, Huber-Wagner et al. (5) found that 5.7% of TCA patients had TPX, 23.2% underwent chest tube insertion, and 10.2% underwent emergency thoracotomy. Irfan et al. (1) reported the rates of need and tube thoracostomy to be 3.4% and 6.0%, respectively. We found the rate of thoracostomy to be 4.9% and concluded that the prevalence of thoracostomy would depend on several factors, such as institutional policies, training, experience of the physician and available equipment.

Smith et al. (6) recommend 0 Rh (-) PRBC infusion for traumatic arrest patients with hypovolemia, and according to the outcome, to follow this with plasma, platelet and cryoprecipitate transfusions, all of which need to be warmed prior to application. In the Huber-Wagner study, the mean amount of PRBC that was administered before admission to the ICU was  $9.2 \pm 12.1$  (5). In the Irfan study, 15% of the subjects received blood transfusions (1). In our study, 44.9% and 7.3% of the subjects had PRBC and FFP transfusions, respectively. Despite these relatively high blood product administration rates, the ROSC rates were not significantly different. We conclude that it is crucial to provide the patient with blood and blood products in the early stages of hypovolemic shock; however, this alone cannot resolve the risk of mortality, and it should be reinforced with effective hemorrhage control and early surgical intervention.

The current study has several limitations. Cardiac rhythm at the time of admission was not evaluated. Post-ROSC operation

outcomes and discharge statuses were not evaluated. Preclinical intubation, thoracostomy or other medical interventions were not recorded.

## Conclusion

Our findings indicate that most TCA cases occur among the young adult male population, and mostly due to blunt trauma from motor vehicle accidents. Injuries were most common in the head-neck region, the extremities, and the thorax, and ISS scores were useful in predicting ROSC outcomes in these patients. Our results suggest that TCA cases differ from non-traumatic arrest cases especially in reversible causes. Reinforcement of trauma team efforts to improve lifesaving attempts, such as bleeding control, blood/blood product transfusions, and thoracostomy, can improve patient outcomes.

## Ethics

**Ethics Committee Approval:** Ethical approval for this study was obtained from University of Health Sciences Turkey, Gülhane Non-invasive Investigation Ethics Committee (2019-19/252).

**Informed Consent:** The ethics committee waived the requirement for patient informed consent because no patient re-contact was established for the study.

**Peer-review:** Externally peer-reviewed.

## Authorship Contributions

Concept: Y.A.A., S.B., Design: Y.A.A., S.B., Data Collection or Processing: Y.A.A., S.B., Analysis or Interpretation: Y.A.A., S.B., Literature Search: Y.A.A., S.B., Writing: Y.A.A., S.B.

**Conflict of Interest:** No conflict of interest was declared by the authors.

**Financial Disclosure:** The authors declared that this study received no financial support.

## References

1. Irfan FB, Consunji R, El-Menyar A, et al. Cardiopulmonary resuscitation of out-of-hospital traumatic cardiac arrest in Qatar: A nationwide population-based study. *Int J Cardiol.* 2017;240:438-443.
2. Leis CC, Hernandez CC, Blanco MJ, Paterna PC, Hernandez Rde E, Torres EC. Traumatic cardiac arrest: should advanced life support be initiated? *J Trauma Acute Care Surg.* 2013;74:634-638.
3. Escutnaire J, Genin M, Babykina E, et al. Traumatic cardiac arrest is associated with lower survival rate vs. medical cardiac arrest - Results from the French national registry. *Resuscitation.* 2018;131:48-54.
4. Byun CS, Park IH, Oh JH, Bae KS, Lee KH, Lee E. Epidemiology of trauma patients and analysis of 268 mortality cases: trends of a single center in Korea. *Yonsei Med J.* 2015;56:220-226.

5. Huber-Wagner S, Lefering R, Qvick M, et al. Outcome in 757 severely injured patients with traumatic cardiorespiratory arrest. *Resuscitation*. 2007;75:276-285.
6. Smith JE, Rickard A, Wise D. Traumatic cardiac arrest. *J R Soc Med*. 2015;108:11-16.
7. Evans C, Quinlan DO, Engels PT, Sherbino J. Reanimating Patients After Traumatic Cardiac Arrest: A Practical Approach Informed by Best Evidence. *Emerg Med Clin North Am*. 2018;36:19-40.
8. Magnone S, Allegri A, Belotti E, et al. Impact of ATLS guidelines, trauma team introduction, and 24-hour mortality due to severe trauma in a busy, metropolitan Italian hospital: A case control study. *Ulus Travma Acil Cerrahi Derg*. 2016;22:242-246.
9. Harris T, Masud S, Lamond A, Abu-Habsa M. Traumatic cardiac arrest: a unique approach. *Eur J Emerg Med*. 2015;22:72-78.
10. Zwingmann J, Lefering R, Feucht M, Südkamp NP, Strohm PC, Hammer T. Outcome and predictors for successful resuscitation in the emergency room of adult patients in traumatic cardiorespiratory arrest. *Crit Care*. 2016;20:282.
11. Moore HB, Moore EE, Burchiel CC, et al. Establishing Benchmarks for Resuscitation of Traumatic Circulatory Arrest: Success-to-Rescue and Survival among 1,708 Patients. *J Am Coll Surg*. 2016;223:42-50.
12. Elkbuli A, Flores R, Dowd B, Hai S, Boneva D, McKenney M. Survival of trauma patients needing CPR shortly after arrival: The National Trauma Data Bank Research Data Set. *Am J Emerg Med*. 2018;36:2276-2278.
13. Barnard E, Yates D, Edwards A, Fragoso-Iniguez M, Jenks T, Smith JE. Epidemiology and aetiology of traumatic cardiac arrest in England and Wales - A retrospective database analysis. *Resuscitation*. 2017;110:90-94.
14. Georgescu V, Tudorache O, Strambu V. Traumatic cardiac arrest in the emergency department - Overview upon primary causes. *J Med Life*. 2014;7:287-290.
15. Avci S, Arslan ED, Buyukcam F. Retrospective evaluation of traumatic deaths in emergency department. *Sakarya Med J*. 2017;7:15-19.
16. Pekdemir M, Cete Y, Eray O, Attila R, Cevik A, Topuzoglu A. Determination of the epidemiological characteristics of the trauma patients. *Ulus Travma Acil Cerrahi Derg*. 2000;6:250-254.
17. Akbulut F. Analysis of traumatic cardiac arrest cases admitted to Dokuz Eylül University Hospital Emergency Department between January 2007 and June 2010. [Medical Specialist Thesis]. İzmir: Dokuz Eylül University; 2011.
18. Mutschler M, Paffrath T, Wöfl C, et al. The ATLS classification of hypovolaemic shock: a well established teaching tool on the edge? *Injury*. 2014;45(Suppl 3):35-38.
19. Lovely R, Trecartin A, Ologun G, et al. Injury Severity Score alone predicts mortality when compared to EMS scene time and transport time for motor vehicle trauma patients who arrive alive to hospital. *Traffic Inj Prev*. 2018;19(Suppl 2):167-168.