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A Comparison Of The Universal TOR Guideline To The Absence Of Prehospital ROSC And Duration Of Resuscitation In Predicting Futility From Out-of-Hospital Cardiac Arrest

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Abstract

Introduction—The Universal Termination of Resuscitation (TOR) Guideline accurately identifies potential out-of-hospital cardiac arrest (OHCA) survivors. However, implementation is inconsistent with some emergency medical service (EMS) agencies using absence of return of spontaneous circulation (ROSC) as sole criterion for termination.

Objective—To compare the performance of the Universal TOR Guideline with the single criterion of no prehospital ROSC. Second, to determine factors associated with survival for patients transported without a ROSC. Lastly, to compare the impact of time to ROSC as a marker of futility to the Universal TOR Guideline.

Design—Retrospective, observational cohort study

Participants—Non-traumatic, adult (≥ 18 years) OHCA patients of presumed cardiac etiology treated by EMS providers

Setting—ROC-PRIMED and ROC-Epistry post ROC-PRIMED databases between 2007 and 2011.

Outcomes—Primary outcome was survival to hospital discharge and the secondary outcome was functional survival. We used multivariable regression to evaluate factors associated with survival in patients transported without a ROSC.

Results—36,543 treated OHCA occurred of which 9,467 (26%) were transported to hospital without a ROSC. Patients transported without a ROSC who met the Universal TOR Guideline for transport had a survival of 3.0% (95% CI 2.5%–3.4%) compared to 0.7% (95% CI 0.4%–0.9%) in patients who met the Universal TOR Guideline for termination. The Universal TOR Guideline identified 99% of survivors requiring continued resuscitation and transportation to hospital including early identification of survivors who sustained a ROSC after extended durations of CPR.

Conclusion—Using absence of ROSC as a sole predictor of futility misses potential survivors. The Universal TOR Guideline remains a strong predictor of survival.

Keywords

Heart arrest; Cardiopulmonary resuscitation; Emergency Medical Services

Introduction

Over 400,000 out-of-hospital cardiac arrests (OHCA) occur annually in Canada and the United States^{1,2} yet less than 10% of patients survive to hospital discharge.¹ Consequently, emergency medical services (EMS) inherently transport a significant proportion of patients to hospital that ultimately do not survive.

The Termination of Resuscitation (TOR) Guideline was originally derived in 2002 to guide basic life support (BLS) prehospital providers in determination of patients in whom continued resuscitation and transport to hospital would be futile.³ Since then, the BLS TOR Guideline has been prospectively and externally validated in a number of studies using both basic and advanced life support providers and is now referred to as the Universal TOR Guideline.⁴⁻⁶ The Universal TOR Guideline states that resuscitation can be discontinued in the field by prehospital providers if the following three criteria are met: 1) the cardiac arrest was not witnessed by EMS providers; 2) the patient did not obtain a return of spontaneous circulation (ROSC) despite attempted resuscitation; and 3) no shocks were delivered (i.e. not a shockable rhythm) at any time prior to transport.⁷ Prospective validation of the Universal TOR Guideline displayed a specificity of 100% (95% CI; 99.8% to 100%) and positive predictive value of 100% (95% CI; 99.8% to 100%) for predicting futility, while reducing the transport rate to 46% of attempted resuscitations by EMS.⁴

The 2010 and 2015 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care and the National Association of EMS Physicians both support the use of validated TOR Guidelines,⁷⁻⁹ however, implementation into EMS practice has been slow and inconsistent.^{10,11} Many EMS systems continue to employ non-validated measures such as the absence of a prehospital ROSC alone or a predefined duration of CPR to stop resuscitation in the field. Reliance on these un-tested measures to predict futility risks premature termination of resuscitation in patients who could potentially survive.

We hypothesized that the Universal TOR Guideline is more accurate than use of ROSC or duration of resuscitation to predict futility from OHCA.

The objectives of this study were: 1) Compare survival rate of patients who were transported to hospital despite meeting the Universal Termination of Resuscitation guideline recommended prehospital termination of resuscitation with the single criterion of no prehospital ROSC; 2) Determine patient characteristics, prehospital and in-hospital factors associated with survival for patients who were transported without a prehospital ROSC; 3) Determine the association between the duration of cardiac arrest, ROSC, the Universal TOR guideline recommendation to transport and patient survival.

Methods

Study Design and Setting

This was a retrospective observational cohort study of the Resuscitation Outcomes Consortium (ROC) Prehospital Resuscitation using an IMpedence valve and Early vs.

Delayed analysis (ROC PRIMED) and the ROC Epistry-Cardiac Arrest databases, whose methods have been described in detail in previous studies.^{12–14} Briefly, the two databases consist of data collected from 10 participating regions, including 7 sites in the U.S. (Birmingham, AL; Dallas/Fort Worth TX; Milwaukee, WI; Pittsburgh, PA; Portland, OR; San Diego, CA; and Seattle/King County, WA) and 3 sites in Canada (Toronto, ON; Ottawa, ON; British Columbia). The EMS agencies involved in each ROC site vary and have been described previously.^{15,16} Institutional Review Boards (Research Ethics Boards in Canada) at all 10 ROC sites granted ethics approval for retrospective analyses from the ROC database and waived the requirement for informed consent.

Study Population

We focused our analysis on consecutive adult (> 18 years) OHCA patients in whom the cause of cardiac arrest was not of obvious non-cardiac cause, and therefore presumed to be of cardiac etiology that were treated and/or transported by EMS. Arrests of known non-cardiac etiology (i.e. trauma, submersion, drug overdose, asphyxia etc) were excluded. Cases were identified from the ROC PRIMED database between June 1, 2007 and November 6, 2009 and the ROC Epistry database from November 7, 2009 to December 31, 2011

We also defined a subset of subjects with OHCA during the ROC PRIMED trial that had functional outcome data at hospital discharge.

Outcome Measures and Study Definitions

The primary outcome was survival to hospital discharge. The secondary outcome was functional survival at hospital discharge as determined by Modified Rankin Scale (mRS) or Cerebral Performance Category (CPC) score.¹⁷ We defined good functional survival as mRS 3 or CPC score of 1 or 2.^{17,18}

We defined ROSC in this study as the presence of a pulse as detected by EMS. The Universal TOR Guideline was defined in concordance with previous published literature.^{4,7} Patients who met the following three criteria: 1) cardiac arrest was not witnessed by EMS; and 2) no ROSC at any time despite attempted resuscitation; and 3) no shocks were delivered (no shockable rhythm) at any time, met the Universal TOR Guideline for prehospital termination of resuscitation. Otherwise, if patients did not meet all three criteria they met the Universal TOR Guideline for transport to hospital.

Analysis

We calculated descriptive statistics on the study population, stratified by whether the patient met the Universal TOR Guideline criteria for termination of resuscitation in the field and whether they were transported to the ED. Continuous variables were summarized using means and standard deviations, while categorical measures were measured using counts and percentages. Differences between transported/not transported groups were noted as possible selection bias from participating agencies and were adjusted for in our logistic regression analysis. After applying the Universal TOR Guideline for termination or transport to the entire study cohort (patients transported without a ROSC), we calculated the test performance characteristics of the Universal TOR Guideline to predict patient survival to

hospital discharge and functional outcome. We then compared the performance of the Universal TOR Guideline to the single criterion of no prehospital ROSC using a Chi-square test, with a two-tailed P value of 0.05 (95% confidence interval) to represent statistical significance.

Multivariable logistic regression was used to determine the predictors of survival to hospital discharge and good functional outcome in patients who were transported to hospital without a prehospital ROSC. In order to avoid inherent biases generated from using stepwise variable reduction we included predetermined variables of interest: age (continuous), EMS response time (continuous), gender (male/female), location (public/private), witness status (not witnessed, bystander, EMS), bystander CPR (yes/no), ROC site as well as a shockable rhythm at any time (yes/no), the other component of the Universal TOR Guideline.

Lastly, we examined the association between duration of CPR and patient survival. Kaplan-Meier curves were used to calculate the proportion of patients who obtained a ROSC over the duration of CPR. The outcomes for the Kaplan-Meier curves were reported stratified by survival and functional outcome at hospital discharge. Further, the time until ROSC (95% CI) for the 75th, 90th and 99th percentile of patients that survived to hospital discharge, and who had a good functional outcome were reported. We then applied the other two components of the Universal TOR Guideline at each time point to examine the accuracy in recommending termination of resuscitation. All statistical analyses were performed with commercially available statistical packages (SAS, version 9.3, Cary, NC; R, version 2.14.1, R Foundation for Statistical Computing, Vienna, Austria; STATA, version 12.0, College Station, TX).

Results

During the study period there were a total of 36,543 adult OHCA of presumed cardiac etiology treated by EMS; of these 21,387 (59%) patients were transported to the hospital and 15,156 (41%) had resuscitation terminated in the field. Of the transported patients, 9,467 (44%) did not obtain a prehospital ROSC and comprised the study population. Of these patients transported without a ROSC 4,142 (44%) met the Universal TOR Guideline for field termination, while 5,325 (56%) met the Universal TOR Guideline for transport to hospital with continued resuscitation (Figure 1). Table 1 reports the descriptive statistics on the study population, stratified by whether the patient met the Universal TOR Guideline criteria for termination of resuscitation in the field and whether they were transported to the ED.

In the entire study cohort (patients transported without a prehospital ROSC), survival to hospital discharge for patients that met the Universal TOR Guideline for termination was 0.7% (95% CI 0.4%–0.9%). In the cohort of patients without a ROSC who had either a shock delivered or an EMS witnessed arrest the survival rate was 3.0% (95% CI 2.5%–3.4%), P value <0.001. (Table 2)

In the subset of cases with functional outcome data (11,991), 5,329 (44%) patients were transported without a prehospital ROSC. Of these patients and the Universal TOR Guideline recommended continued resuscitation and transport in 3,009 (57%) and recommended field

termination of resuscitation in 2,230 (43%). The proportion of patients with a good functional outcome at hospital discharge was significantly higher in those transported to hospital without a prehospital ROSC who met the Universal TOR Guideline for transport; 1.7% (95% CI 1.2%–2.2%), compared to those who met the Universal TOR Guideline for field termination; 0.3% (95% CI 0.1%–0.6%), P value <0.001. (Table 2)

The clinical characteristics of survivors versus non-survivors in patients transported to hospital without a ROSC are shown in Table 3. After adjusting for known predictors of survival, cardiac arrests that were witnessed by EMS, or had a shock delivered at any time had the largest association with patient survival (Table 4). Cardiac arrests that occurred in a public location were also associated with patient survival while older age was associated with worse survival to hospital discharge. The multivariable regression analysis for functional outcome again confirmed the two missing components of the Universal TOR Guideline, witnessed by EMS and having a shock delivered at any time had the largest effect on functional outcome. Cardiac arrests that occurred in a public location were also associated with good functional outcome, while older age was associated with poor outcome (Table 4).

Figure 2 shows the relationship between the duration of CPR prior to ROSC and modified Rankin score for all patients transported to the ED. Ninety percent of patients that survived to hospital discharge obtained a ROSC by 20.0 minutes (95% CI 19.0, 20.8) of resuscitation, and 99% by 37.0 minutes (95% CI 35.1, 40.4). Application of the Universal TOR Guideline early in the resuscitation would have identified these patients as potential survivors and recommended transport for 99.3% and 100% of the patients at each one of these time points respectively. These results were consistent with results in patients with good functional outcome. Ninety percent of patients who survived to discharge with good functional outcome had obtained ROSC after 19.5 minutes (95% CI 18.4, 20.4) of resuscitation, and 99% by 37.0 minutes (95% CI 35.2, 40.9). Again, application of the Universal TOR Guideline early in the resuscitation would have identified these potential survivors and recommended transport in 99.6% and 100% respectively of all survivors with good functional outcome.

Discussion

There have been significant changes to the treatment of OHCA since the original derivation of the Universal TOR Guideline. Despite advancements in care, the Universal TOR Guideline remains an accurate tool to identify patients who would benefit from continued resuscitation and transport and to identify patients in whom resuscitation should be confidently terminated with current resuscitation strategies and CPR guidelines.¹⁹ Any increase in the rate of survival from OHCA over time²⁰ appears to be robustly captured by the Universal TOR Guideline criteria. Although previous research has shown that the rate of initial ventricular fibrillation/ventricular tachycardia (VF/VT) rhythms are diminishing²¹ the increase in survival may be captured by the Universal TOR Guideline as an increased number of patients with initial non-shockable rhythms who are converted to VF/VT and have a shock delivered, or an increased number of patients who obtain a prehospital ROSC.

Using prehospital ROSC as the sole criterion for termination is unwise given that we have identified in this study, a significant number of survivors who would have been terminated if providers had employed only ROSC as the sole criteria for termination. Not surprisingly, the characteristics most strongly associated with survival and functional outcome in patients who did not achieve a prehospital ROSC were the other two components of the Universal TOR Guideline, specifically EMS-witnessed cardiac arrests or received a shock prior to transport. This adds further evidence for the need to rely on predictive factors beyond the absence of ROSC to accurately predict patient outcome from OHCA.

It is common practice in some services to terminate resuscitation efforts if there is an absence of ROSC after 20 minutes of resuscitation. This study suggests this approach is also unwise given that 175 patients (10.0% of all survivors) obtained a ROSC only after this time point, including 125 (9% of patients) with good neurological status. Application of the Universal TOR Guideline would have identified all of those patients who survived, early in the resuscitation as potential survivors and worthy of transport. Instead, each of these patients endured long durations of CPR (> 20 minutes) in the field prior to transport.

Ensuring that all potential survivors are transported with ongoing resuscitation often results in reduced specificity, over-inclusion, and an increase in the overall number of patients that are transported to hospital. Although utilization of the absence of prehospital ROSC alone to terminate resuscitation would have resulted in 44% fewer transports compared to the Universal TOR Guideline, the single criterion approach would have missed 186 survivors identified by the 3-criteria Universal TOR Guideline. It is important that while trying to reduce unnecessary transports to hospital that it does not come at the expense of missing potential survivors. As resuscitation care evolves for OHCA's it is important to continue to evaluate the performance of the Universal TOR Guideline.

In order to appropriately apply the Universal TOR Guideline patients with a confirmed non-obvious cause presumed cardiac arrest should receive four 2-minute intervals of CPR before considering the application of the Universal TOR Guideline.²² Correct application of the Universal TOR Guideline following this standard protocol results in the identification of 99% of patients who survive to hospital discharge. This should provide the impetus for prehospital providers to transport patients to hospital once they meet the Universal TOR Guideline for transport. Correctly applying the rule will avoid inappropriate termination of resuscitation on scene by using the absence of ROSC as a reason to stop resuscitative efforts or using the duration of CPR as a measure of futility.

There is considerable variation between EMS services both in transport practices, and in the criteria used as evidence for futility. As such, it is important that EMS services institutionalize guidelines for the termination of resuscitation in the prehospital setting based on validated criteria. This will ensure that resuscitation is not stopped prematurely in those patients in whom resuscitation is not futile, while at the same time foregoing transportation to hospital in those with no chance of survival.

Limitations

Although the data is gathered from a large, prospectively collected, multicenter database, the study is a retrospective analysis and is therefore dependent on the quality of data collected and susceptible to measurement bias as with other observational research. Second, as not all patients were transported to hospital and the transportation practice varied considerably between sites, this study cannot be used as a strict validation of the Universal TOR Guideline, but as a comparison between methods of determining futility. Lastly, the Universal TOR Guideline has only been validated for use in the adult population and for those arresting from a presumed cardiac etiology. Without validation, these guidelines cannot be extrapolated for use in pediatric OHCA or in cardiac arrests where the etiology is thought to be obvious and non-cardiac in origin (i.e. trauma, submersion, drug overdose, asphyxia etc.).

Conclusion

Using the presence or absence of prehospital ROSC to identify potential survivors from OHCA is unfounded based on the evidence. The validated Universal TOR Guideline, comprised of three components suggests transport of a potentially viable patient if at any time during the resuscitation when any of the following are observed 1) the rhythm is shockable, or 2) the arrest is witnessed by EMS, or 3) a ROSC occurs. Prehospital providers should focus on guideline compliant high-quality resuscitation on scene and the implementation of validated Universal TOR criteria to ensure that potential survivors receive full resuscitation and transport.

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Reference List

1. Nichol G, Thomas E, Callaway CW, et al. Regional variation in out-of-hospital cardiac arrest incidence and outcome. *JAMA*. 2008; 300(12):1423–1431. [PubMed: 18812533]
2. Go AS, Mozaffarian D, Roger VL, et al. Heart disease and stroke statistics--2013 update: a report from the American Heart Association. *Circulation*. 2013; 127(1):e6–e245. [PubMed: 23239837]
3. Verbeek PR, Vermeulen MJ, Ali FH, Messenger DW, Summers J, Morrison LJ. Derivation of a termination-of-resuscitation guideline for emergency medical technicians using automated external

- defibrillators. *Academic emergency medicine : official journal of the Society for Academic Emergency Medicine*. 2002; 9(7):671–678. [PubMed: 12093706]
4. Morrison LJ, Verbeek PR, Zhan C, Kiss A, Allan KS. Validation of a universal prehospital termination of resuscitation clinical prediction rule for advanced and basic life support providers. *Resuscitation*. 2009; 80(3):324–328. [PubMed: 19150167]
 5. Sasson C, Hegg AJ, Macy M, et al. Prehospital termination of resuscitation in cases of refractory out-of-hospital cardiac arrest. *JAMA*. 2008; 300(12):1432–1438. [PubMed: 18812534]
 6. Morrison LJ, Visentin LM, Kiss A, et al. Validation of a rule for termination of resuscitation in out-of-hospital cardiac arrest. *New England Journal of Medicine*. 2006; 355(5):478–487. [PubMed: 16885551]
 7. Morrison LJ, Kierzek G, Diekema DS, et al. Part 3: ethics: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2010; 122(18 Suppl 3):S665–675. [PubMed: 20956219]
 8. Millin MG, Khandker SR, Malki A. Termination of resuscitation of nontraumatic cardiopulmonary arrest: resource document for the National Association of EMS Physicians position statement. *Prehospital Emergency Care*. 2011; 15(4):547–554. [PubMed: 21843074]
 9. Mancini ME, Diekema DS, Hoadley TA, et al. Part 3: Ethical Issues: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2015; 132(18 Suppl 2):S383–396. [PubMed: 26472991]
 10. Sasson C, Forman J, Krass D, et al. A qualitative study to understand barriers to implementation of national guidelines for prehospital termination of unsuccessful resuscitation efforts. *Prehospital Emergency Care*. 2010; 14(2):250–258. [PubMed: 20144019]
 11. Sasson C, Forman J, Krass D, Macy M, Kellermann AL, McNally BF. A qualitative study to identify barriers to local implementation of prehospital termination of resuscitation protocols. *Circulation. Cardiovascular Quality & Outcomes*. 2009; 2(4):361–368. [PubMed: 20031862]
 12. Morrison LJ, Nichol G, Rea TD, et al. Rationale, development and implementation of the Resuscitation Outcomes Consortium Epistery-Cardiac Arrest. *Resuscitation*. 2008; 78(2):161–169. [PubMed: 18479802]
 13. Aufderheide TP, Kudenchuk PJ, Hedges JR, et al. Resuscitation Outcomes Consortium (ROC) PRIMED cardiac arrest trial methods part 1: rationale and methodology for the impedance threshold device (ITD) protocol. *Resuscitation*. 2008; 2:179–185.
 14. Stiell IG, Callaway C, Davis D, et al. Resuscitation Outcomes Consortium (ROC) PRIMED cardiac arrest trial methods part 2: rationale and methodology for “Analyze Later vs. Analyze Early” protocol. *Resuscitation*. 2008; 2:186–195.
 15. Davis DP, Garberson LA, Andrusiek DL, et al. A descriptive analysis of Emergency Medical Service Systems participating in the Resuscitation Outcomes Consortium (ROC) network. *Prehospital Emergency Care*. 2007; 11(4):369–382. [PubMed: 17907019]
 16. Glover BM, Brown SP, Morrison L, et al. Wide variability in drug use in out-of-hospital cardiac arrest: a report from the resuscitation outcomes consortium. *Resuscitation*. 2012; 83(11):1324–1330. [PubMed: 22858552]
 17. Rittenberger JC, Raina K, Holm MB, Kim YJ, Callaway CW. Association between Cerebral Performance Category, Modified Rankin Scale, and discharge disposition after cardiac arrest. *Resuscitation*. 2011; 82(8):1036–1040. [PubMed: 21524837]
 18. Jennett B, Bond M. Assessment of outcome after severe brain damage. *Lancet*. 1975; 1(7905):480–484. [PubMed: 46957]
 19. Travers AHC, Rea TDC, Bobrow BJ, et al. Part 4: CPR Overview: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2010; 122(18 Supplement 3):S676–S684. [PubMed: 20956220]
 20. Steinmetz J, Barnung S, Nielsen SL, Risom M, Rasmussen LS. Improved survival after an out-of-hospital cardiac arrest using new guidelines. *Acta Anaesthesiologica Scandinavica*. 2008; 52(7):908–913. [PubMed: 18477076]
 21. Cobb LA, Fahrenbruch CE, Olsufka M, Copass MK. Changing incidence of out-of-hospital ventricular fibrillation, 1980–2000. *JAMA*. 2002; 288(23):3008–3013. [PubMed: 12479765]

22. Morrison LJ, Eby D, Veigas PV, et al. Implementation trial of the basic life support termination of resuscitation rule: reducing the transport of futile out-of-hospital cardiac arrests. *Resuscitation*. 2014; 85(4):486–491. [PubMed: 24361458]

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Figure 1.
Consort Diagram for Study Population

Figure 2.

Comparison of the time of return of spontaneous circulation and patient outcome at hospital discharge

mRS= Modified Rankin Scale; CPR= Cardiopulmonary Resuscitation; ROSC= Return of Spontaneous Circulation

Table 1

Descriptive statistics of patients based on Universal TOR Guideline (N=36,543)

	Universal TOR = terminate and were transported	Universal TOR = terminate and were terminated	Universal TOR = transport and were transported	Universal TOR = transport and were terminated
N	4,142	11,116	17,245	4,040
Age (years)	64.5 (17.3)	68.7 (16.9)	65.9 (15.9)	68.4 (15.6)
Male Gender	2,576 (62.2%)	6,632 (59.7%)	11,219 (65.1%)	2,872 (71.1%)
Bystander CPR	1,556 (39.1%)	4,278 (40.2%)	6,667 (39.7%)	1,489 (38.2%)
Bystander Witnessed	1,661 (40.1%)	2,646 (23.8%)	8,592 (49.8%)	1,669 (41.3%)
EMS Response Time (mins)	5.7 (2.8)	5.9 (3.3)	5.9 (4.0)	6.0 (2.9)
Initial Rhythm				
VF/VT	0 (0.0%)	0 (0.0%)	7,188 (42.1%)	1,504 (37.4%)
Pulseless Electrical Activity	1,128 (27.3%)	1,510 (13.8%)	4,393 (25.7%)	864 (21.5%)
Asystole	2,466 (59.8%)	7,900 (72.2%)	4,095 (24.0%)	1,286 (31.9%)
AED – Non-Shockable	503 (12.2%)	1,473 (13.5%)	1,174 (6.9%)	332 (8.2%)
Cannot Determine	30 (0.7%)	66 (0.6%)	231 (1.4%)	40 (1.0%)
Public Location	612 (14.8%)	581 (5.2%)	3,522 (20.4%)	482 (11.9%)
Universal TOR Criteria				
Shock Delivered	0 (0.0%)	0 (0.0%)	10,263 (59.5%)	3,417 (84.6%)
Witnessed by EMS	0 (0.0%)	0 (0.0%)	3,602 (20.9%)	618 (15.3%)
Prehospital ROSC	0 (0.0%)	0 (0.0%)	11,920 (69.1%)	476 (11.8%)

Table 2

Patient outcomes for patients transported without a prehospital return of spontaneous circulation

All Patients Transported Without a Prehospital ROSC	Met TOR for termination (no shock AND not EMS witnessed)	Met TOR for transport (shock delivered OR EMS witnessed)	P value
Survival to Hospital Discharge	n = 4,142	n = 5,325	
Percent (%), (95% CI)	0.7 (0.4 to 0.9)	3.0 (2.5 to 3.4)	<0.001
Functional Survival	n = 2,230	n = 3,009	
Percent (%), (95% CI)	0.3 (0.1, 0.6)	1.7 (1.2, 2.2)	<0.001

Table 3

Clinical characteristics and in-hospital factors in patients transported who did not achieve a prehospital return of spontaneous circulation

	No Prehospital ROSC and Died	No Prehospital ROSC and Survived
N	9,281	186
Utstein variables		
Age, mean (sd)	64.3 (16.5)	58.5 (13.6)
Male gender, n (%)	6,215 (67.0%)	133 (71.5%)
Initial rhythm, n (%)		
VF/VT	2,354 (25.5%)	114 (63.3%)
Pulseless electrical activity	2,429 (26.3%)	32 (17.8%)
Asystole	3,543 (38.5%)	22 (12.2%)
AED – Non-shockable	800 (8.7%)	9 (5.0%)
Cannot determine	99 (1.1%)	3 (1.7%)
Shock delivered, n (%)	3,868 (41.7%)	128 (68.8%)
EMS witnessed, n (%)	1,713 (18.5%)	57 (30.6%)
Bystander CPR, n (%)	3,174 (35.3%)	69 (37.7%)
Public location, n (%)	1,822 (19.7%)	72 (38.9%)
EMS response time (minutes), mean (sd)	6.0 (4.6)	5.9 (2.8)
Prehospital Characteristics		
Number of shocks delivered, mean (sd)	3.6 (2.9)	4.7 (3.3)
Bystander witnessed, n (%)	3,797 (40.9%)	85 (45.7%)
Bystander AED, n (%)	289 (9.1%)	10 (14.3%)
Highest level of EMS, n (%)		
ALS	8,627 (93.0%)	163 (87.6%)
BLS+	398 (4.3%)	11 (5.9%)
BLS-D	251 (2.7%)	12 (6.5%)
BLS	5 (0.1%)	0 (0.0%)
Length of time on scene (minutes), mean (sd)	24.3 (9.9)	21.0 (8.9)
Length of transport (minutes), mean (sd)	7.9 (5.4)	8.6 (6.2)
CPR fraction	0.7 (0.2)	0.7 (0.2)
Advanced airway, n (%)	7,285 (78.6%)	113 (60.8%)
Total dose of epinephrine (mg), mean (sd)	3.6 (2.0)	3.3 (1.9)
Hospital Characteristics		
Urban center, mean (sd)	3,614 (91.5%)	148 (92.5%)
> 100 beds, n (%)	3,965 (95.4%)	161 (97.0%)
Academic center, n (%)	2,193 (51.0%)	105 (60.7%)
Catheterization laboratory, n (%)	2,715 (63.2%)	126 (72.8%)
Cardiac catheterization, n (%)	95 (1.6%)	72 (38.9%)
Coronary artery bypass graft, n (%)	1 (0.0%)	7 (4.8%)

	No Prehospital ROSC and Died	No Prehospital ROSC and Survived
ICD implantation, n (%)	2 (0.0%)	26 (14.1%)
Pacemaker implantation, n (%)	5 (0.1)	6 (4.1)
ICU length of stay (days), mean (sd)	1.6 (3.2)	11.0 (9.7)
DNR order written, n (%)	507 (41.3%)	16 (13.9%)

ROSC = Return of Spontaneous Circulation; VF = Ventricular Fibrillation; VT = Ventricular Tachycardia; AED = Automated External Defibrillator; EMS = Emergency Medical Services; CPR = Cardiopulmonary Resuscitation; ALS = Advanced Life Support; BLS – Basic Life Support; ICD = Implantable Cardioverter-Defibrillator; ICU = Intensive Care Unit; DNR = Do Not Resuscitate

Table 4

Adjusted analysis of survival to hospital discharge and functional survival in patients transported who did not achieve a prehospital return of spontaneous circulation

	Survival to Discharge (n = 9,467)		Functional Survival (n = 4,865)	
Variable	Odds Ratio	95% CI	Odds Ratio	95% CI
Age	0.98	(0.97, 0.99)	0.97	(0.96, 0.99)
Male gender	0.92	(0.65, 1.30)	1.02	(0.57, 1.85)
Shock delivered	2.92	(2.10, 4.07)	3.41	(1.88, 6.18)
EMS response time	0.96	(0.90, 1.01)	0.95	(0.86, 1.05)
Public location	2.23	(1.60, 3.10)	2.60	(1.54, 4.37)
Witnessed by EMS	4.06	(2.60, 6.35)	3.47	(1.60, 7.52)
Witnessed by bystander	1.38	(0.94, 2.05)	1.46	(0.79, 2.70)
Bystander CPR	1.22	(0.84, 1.75)	1.68	(0.96, 2.93)

* Also adjusted for site (not shown). CI = Confidence Interval; EMS = Emergency Medical Services; CPR = Cardiopulmonary Resuscitation