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Clinical paper

Out-of-hospital cardiac arrest without return of spontaneous circulation in the field: Who are the survivors?☆

Yan Xiong[a,b,**,1], Hong Zhan[a,1], Yuanzheng Lu[a,b], Kaipan Guan[a,1], Ngozi Okoro[b], Denise Mitchell[b], Megan Dwyer[b], Auna Leatham[b], Gilberto Salazar[b], Xiaoxing Liao[a], Ahamed Idris[b,*]

[a] Department of Emergency Medicine, the First Affiliated Hospital of Sun Yat-sen University, 58 Zhongshan 2nd Road, Guangzhou 510080, China
[b] Department of Emergency Medicine, University of Texas, Southwestern Medical Center, 5323 Harry Hines BLVD, Dallas, TX 75390-8579, USA

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ABSTRACT

Background: Return of spontaneous circulation (ROSC) in the field is a vital determinant contributing to survival from out-of-hospital cardiac arrest (OHCA). However, nearly one third of survivors at the Dallas-Fort Worth (DFW) Resuscitation Outcomes Consortium (ROC) site did not obtain ROSC in the field.
Methods: A retrospective, observational analysis was performed on all adult patients with non-traumatic OHCA treated on scene and transported to hospital, who did not gain ROSC in the field at DFW ROC site between 2006 through 2011.We described the demographics, pre-hospital characteristics and outcomes of all enrolled cases. Those patients without ROSC in the field, who did and did not meet Termination of Resuscitation (TOR) criteria in the field, were also compared.
Results: Among a total of 5099 treated and transported non-traumatic OHCA cases, 83.2% (4243) were included in this study as patients without ROSC gained in the field, of which 66.6% (2827) met TOR criteria but still were treated and transported; 1.9% (79) survived to hospital discharge. Further analysis showed that 39.2% (31) of survivors met TOR rule, accounting for 1.1% of those patients who should have been declared dead in the field. Shockable initial rhythms, EMS-witnessed arrest, bystander CPR and age were factors significant to predict survival from OHCA without ROSC in the field. Of concern, 1.7% (47) of patients who met TOR presented initially shockable rhythms but no shocks were delivered in the field.
Conclusions: We suggest that all treated non-traumatic OHCA patients should be transported to hospital.

Introduction

Out-of-hospital cardiac arrest (OHCA) is a leading cause of death in the world, afflicting an estimated 326,200 persons in the United States per year.[1] Return of spontaneous circulation (ROSC) achieved in the field, which is usually the first goal of immediate resuscitative efforts, is considered as the most crucial factor contributing to survival and favorable neurological outcomes following OHCA. Survival is believed rare without pre-hospital ROSC for OHCA victims.[2] In fact, the Termination of Resuscitation (TOR) criteria, validated by Morrison LJ et al., which consists of three components including no ROSC achieved, not witnessed by emergency medical services (EMS) providers, and no shock delivered in the field, has been accepted as a universal clinical rule in the 2010 AHA resuscitation guidelines for cessation of resuscitation efforts in pre-hospital setting.[3]

However, the implementation of this universal TOR rule is still challenging due to ethical concerns and thus shows great variation in pre-hospital practice worldwide, even though it has been validated to significantly reduce futile transport for OHCA patients.[4] Many regional EMS agencies including those in the United States have adopted their own local protocols for EMS providers to make decisions for OHCA patients when they did not gain ROSC in the field or even met the TOR rule. The reality is, consequently, as reported by some observational studies, that a certain number of "lucky" victims may survive from OHCA without field ROSC obtained[5] and even some of them should have been terminated and pronounced dead according to the pre-hospital TOR rule.[6,7] In the Dallas-Fort

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* Corresponding author at: 5323 Harry Hines BLVD, Dallas, TX 75390-8579, USA.
** Corresponding author at: 58 Zhongshan 2nd Road, Guangzhou 510080, China.
E-mail addresses: xiongyan@mail.sysu.edu.cn (Y. Xiong), aidris@sbcglobal.net, way1111@126.com (A. Idris).

[1] Contributed to this paper equally.

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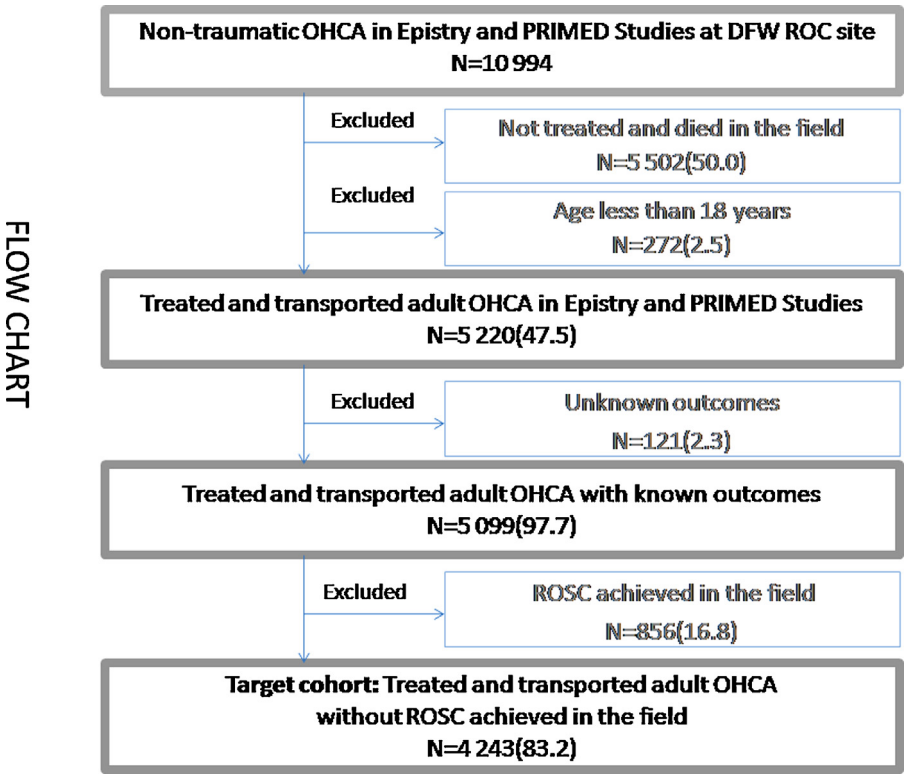

Fig. 1. Target cohort and exclusions. OHCA indicates out-of-hospital cardiac arrest; Epistry, Epidemiological Cardiac Arrest Registry; PRIMED, Pre-hospital resuscitation using an impedance valve and early versus delayed analysis; DFW, Dallas-Fort Worth; ROC, Resuscitation Outcomes Consortium; ROSC, return of spontaneous circulation; N, number.

Table 1
Demographics and characteristics of adult non-traumatic OHCA without ROSC in the field surviving and those not surviving to hospital discharge.

Demographics & characteristics	OHCA without ROSC in the field (N = 4243)	Survived to hospital discharge (N = 79)	Deceased cases (N = 4164)	P
Age, year, mean (SD)	63.0 (17.6)	56.7 (14.5)	63.1 (17.7)	0.000
Male, n (%)	2538 (59.8)	49 (62.0)	2489 (59.8)	0.686
Witnessed by EMS, n (%)	434 (10.2)	17 (21.5)	417 (10.0)	0.001
Bystander CPR, n (%)				0.431
Not attempted	1871 (44.1)	34 (43.0)	1837 (44.1)	
Attempted	1148 (27.1)	26 (32.9)	1122 (26.9)	
Not noted or unknown	1224 (28.8)	19 (24.1)	1205 (28.9)	
Witnessed by bystander, n (%)				0.305
Not witnessed	1944 (45.8)	38 (48.1)	1906 (45.8)	
Witnessed	967 (22.8)	22 (27.8)	945 (22.7)	
Not noted or unknown	1332 (31.4)	19 (24.1)	1313 (31.5)	
Public location, n (%)	537 (12.7)	20 (25.3)	517 (12.4)	0.001
Initial rhythms, n (%)				
VT or VF	645 (15.2)	27 (34.2)	618 (14.8)	0.000
PEA	946 (22.3)	20 (25.3)	926 (22.2)	
Asystole	1997 (47.1)	14 (17.7)	1983 (47.6)	
AED-no shock advised	37 (0.9)	0 (0.0)	37 (0.9)	
Cannot determine or missing	618 (14.6)	18 (22.8)	600 (14.4)	
EMS response time, min, mean (SD)	4.6 (3.6)	4.4 (4.5)	4.6 (3.6)	0.593
Shock delivered in the field, n (%)	1057 (24.9)	34 (43.0)	1023 (24.6)	0.000
Field resuscitation interval, min, mean (SD)	19.2 (9.7)	15.5 (9.3)	19.2 (9.6)	0.001
Met TOR criteria, n (%)	2827 (66.6)	31 (39.2)	2796 (67.1)	0.000

OHCA indicates out-of-hospital cardiac arrest; ROSC, return of spontaneous circulation; SD, standard deviation; EMS, emergency medical services; CPR, cardio-pulmonary resuscitation; VT, ventricular tachycardia; VF, ventricular fibrillation; PEA, pulse-less electrical activities; AED, automatic external defibrillator; TOR, Termination of Resuscitation; min, minute; n, number; N, number.

Worth (DFW) Resuscitation Outcomes Consortium (ROC) site, data showed that nearly one third of survivors were patients who did not have ROSC in the field. In this study we described the characteristics and outcomes of adult patients with non-traumatic OHCA treated on scene without ROSC gained in the field and transported to hospital at the DFW ROC site, and compared those who did and did not meet TOR rule in the field as well.

Methods

Study population

Resuscitation Outcomes Consortium (ROC) is a network of 10 regional research centers in North America and a data coordinating center (DCC) in the United States that conducts research focused

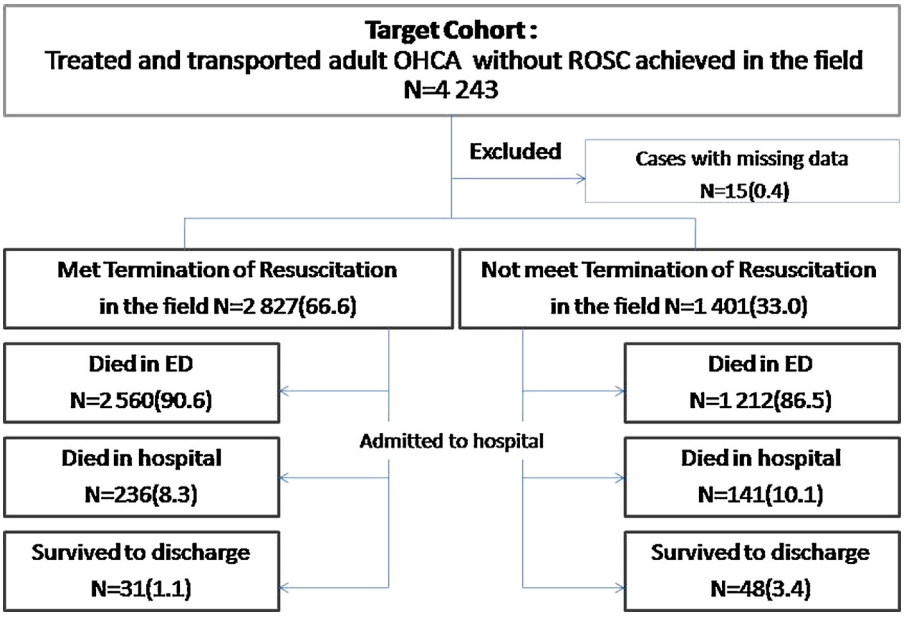

Fig. 2. Subgroups in the study population and outcomes within the subgroups. OHCA indicates out-of-hospital cardiac arrest; ROSC, return of spontaneous circulation; ED, emergency department; N, number.

Table 2
Odds ratios of key pre-hospital factors for OHCA patients without ROSC gained in the field.

Key pre-hospital factors	Survival to hospital discharge		
	OR	95% CI	P
Age(10-year increase)	0.826	0.725–0.942	0.004
Male	0.832	0.516–1.342	0.451
Public location	1.588	0.909–2.776	0.104
Bystander witnessed	1.130	0.600–2.129	0.705
Bystander CPR	1.901	1.014–3.566	0.045
EMS witnessed	2.915	1.163–7.305	0.022
Shockable initial rhythms	3.037	1.428–6.456	0.004
Shock delivered in the field	1.246	0.634–2.449	0.524
EMS response time	1.019	0.972–1.069	0.427
Field resuscitation interval	0.971	0.941–1.001	0.061

OHCA indicates out-of-hospital cardiac arrest; ROSC indicates return of spontaneous circulation; OR, odds ratio; CI, confidence interval; EMS, emergency medical services; CPR, cardio-pulmonary resuscitation.

on OHCA and severe traumatic injury. The goal of this research network is to evaluate strategies for treatment of patients with OHCA or life-threatening traumatic injury with the primary focus on the out-of-hospital emergency setting.

Epidemiological Cardiac Arrest Registry (Epistry), was established by ROC as the first prospectively acquired, retrospectively analyzed, multicenter, population-based observational registry study for OHCA since January 2006. An important component of this clinical registry system is the collection of data that recorded the demographic characteristics of OHCA patients and event factors concerning arrest episodes, the vital information about field interventions during treatment given by professional responders on scene, as well as in-hospital post-resuscitation management and outcomes for each subject enrolled in the study. It has been previously described in detail about how these data were collected, managed and audited in order to ensure uniformity and quality of data entry.[8] Particularly, based on Epistry, PRIMED study was a ROC clinical trial performed from June 2007 through November 2009, and designed to compare Pre-hospital Resuscitation using an Impedance valve and an Early versus Delayed analysis (PRIMED) (Clinical Trial Registration URL: clinicaltrials.gov/ct2/show/NCT00394706) of cardiac rhythms on adult OHCA. The results revealed that no outcome difference existed between using impedance threshold device (ITD) versus sham device or early versus later rhythm analysis in patients with OHCA.[9,10] Patients in Epistry, together with all cases enrolled in PRIMED study, comprised all OHCA cases registered and enrolled in ROC clinical research from January 2006 through April 2011. Both studies were approved by Institutional Review Boards (IRB) of all participating ROC sites. IRBs waived the requirement for informed consent for enrollment because it was considered to meet criteria for minimal risk.

Dallas-Fort Worth (DFW) ROC site, as one of those ten research sites, is located in Texas with 15 EMS agencies and a total of 5300 firefighters and paramedics enrolled in the study. It includes 41 regional hospitals serving a population of 4 million in the DFW area. From 2006 throughout April 2011, a total of 10,994 non-traumatic OHCA patients were screened and enrolled in Epistry and ROC PRIMED Studies at DFW ROC site. Of them, 5502 cases were not treated and pronounced dead on scene, 272 patients were less than 18 years old and 121 had missing data concerning their outcome status. Of the 5099 treated and transported adult OHCA cases with known outcomes, 4243 patients without ROSC gained in the hospital were identified as subjects of the target cohort in this study (Fig. 1).

Outcomes and selected variables

The primary outcome was survival to hospital discharge. According to the operational definition in ROC, ROSC means a palpable pulse detected in any vessel for any length of time during the process of resuscitation. We defined failure of ROSC in the field as no ROSC achieved prior to ED arrival. Pre-hospital characteristics that were potentially associated with outcomes were selected as factors for comparison among groups. These include demographics, episode characteristics and critical interventions performed in the field, such as age, gender, bystander or EMS witness status, bystander CPR attempts, public location of arrest, presenting initial rhythms, shock delivered on scene, ROSC in the field, EMS response time, field resuscitation interval prior to ED arrival, and outcome of each individual enrolled in the study.

Table 3
Demographics and characteristics of OHCA patients without field ROSC who did or did not meet TOR criteria in the field.

Demographics & characteristics	Overall (N = 4228)	① No ROSC, but not meeting TOR criteria				② No ROSC, and meeting TOR criteria				P ① versus ②
		Survived (N = 48)	Deceased (N = 1353)	p	Total (N = 1401)	Survived(N = 31)	Deceased (N = 2796)	P	Total (N = 2827)	
Age, year, mean (SD)	63.0 (17.6)	55.1 (13.5)	62.8 (16.6)	0.000	62.5 (16.5)	59.2 (15.8)	63.2 (18.2)	0.227	63.1 (18.1)	0.252
Male, n (%)	2531 (59.9)	29 (60.4)	867 (64.1)	0.603	896 (64.0)	20 (64.5)	1615 (57.8)	0.449	1635 (57.8)	0.000
EMS witnessed, n (%)	434 (10.3)	17 (35.4)	417 (30.8)	0.499	434 (31.0)	–	–	–	–	–
Bystander witnessed, n (%)				0.847				0.781		0.000
Not witnessed	1938 (45.8)	25 (52.1)	705 (52.1)		730 (52.1)	13 (41.9)	1195 (42.7)		1208 (42.7)	
Witnessed	962 (22.8)	14 (29.2)	355 (26.2)		369 (26.3)	8 (25.8)	585 (20.9)		593 (21.0)	
Not noted or unknown	1328 (31.4)	9 (18.8)	293 (21.7)		302 (21.6)	10 (32.3)	1016 (36.3)		1026 (36.3)	
Bystander CPR, n (%)				0.349				0.692		0.000
Not attempted	1871 (44.3)	24 (50.0)	794 (58.7)		818 (58.4)	10 (32.3)	1043 (37.3)		1053 (37.2)	
Attempted	1133 (26.8)	15 (31.3)	306 (22.6)		321 (22.9)	11 (35.5)	801 (28.6)		812 (28.7)	
Not noted or unknown	1224 (28.9)	9 (18.8)	253 (18.7)		262 (18.7)	10 (32.3)	952 (34.0)		962 (34.0)	
Public location, n (%)	533 (12.6)	16 (33.3)	232 (17.1)	0.004	248 (17.7)	4 (12.9)	281 (10.1)	0.547	285 (10.1)	0.000
Shockable initial rhythms, n (%)				0.139				0.003		0.000
Shockable (VT/VF)	644 (15.2)	25 (52.1)	572 (42.3)		597 (42.6)	2 (6.5)	45 (1.6)		47 (1.7)	
Non-shockable	2969 (70.2)	16 (33.3)	644 (47.6)		660 (47.1)	18 (58.1)	2291 (81.9)		2309 (81.7)	
Cannot determine or missing	615 (14.5)	7 (14.6)	137 (10.1)		144 (10.3)	11 (35.5)	460 (16.5)		471 (16.7)	
Shock delivered in the field, n (%)	1051 (24.9)	34 (70.8)	1017 (75.2)	0.496	1051 (75.0)	–	–	–	–	–
EMS response time, min, mean (SD)	4.6 (3.7)	3.1 (2.6)	3.4 (3.4)	0.540	3.4 (3.4)	6.2 (5.9)	5.1 (3.6)	0.295	5.1 (3.6)	0.000
Field resuscitation interval, min, mean (SD)	19.2 (9.7)	14.0 (.8)	17.0 (11.0)	0.076	16.8 (10.9)	18.0 (8.8)	20.3 (8.7)	0.172	20.4 (8.7)	0.000

OHCA indicates out-of-hospital cardiac arrest; ROSC, return of spontaneous circulation; TOR, Termination of Resuscitation; SD, standard deviation; CPR, cardio-pulmonary resuscitation; VT, ventricular tachycardia; VF, ventricular fibrillation; EMS, emergency medical services; min, minute; n. number; N, number.

Statistical analysis

Demographics and characteristics of the entire study population and each separate study group were summarized using descriptive statistics. Multiple imputation method was used to replace missing data for such variables as age, gender, public location, EMS response time and field resuscitation interval, which have a very small percentage of missing values in the whole target population (3.6%). Continuous variables were expressed as means and standard deviations (SDs) and independent t-tests were used for comparison of continuous variables between groups, whereas categorical variables were described using absolute numbers and percentages and were compared via chi-square analysis. Multivariable logistic regression analysis was performed on all cases without ROSC gained in the field to calculate the odds ratios (ORs) for those selected covariates which were considered potentially associated with survival at hospital discharge. P value < 0.05 were considered statistically significant. All statistical procedures were performed with commercially available statistical software packages (SPSS for windows, version 19.0, SPSS Inc., Chicago, IL).

Results

Of the 5099 treated and transported adult non-traumatic OHCA with known outcomes in DFW ROC site, 856 (16.8%) achieved ROSC in the field, while 4243 (83.2%) did not (Fig. 1). The overall survival rate for all treated and transported non-traumatic OHCA patients was 5.6% (287/5099), while for patients with and without ROSC in the field, the survival rates were 24.3(208/856) and 1.9% (79/4243) respectively. However, despite the relatively low survival rate, the survivors without ROSC gained in the field accounted for nearly one third of the total survivors (27.5%, 79/287). Demographics, key pre-hospital characteristics and outcomes of the study cohort (without ROSC) and those excluded because they gained ROSC in the field are shown in a Supplementary table.

Demographics and key pre-hospital characteristics were also compared between survivors and deceased cases within those patients who did not gain ROSC in the field, as shown in Table 1. Survivors were younger in age with higher percentages of EMS-witnessed arrests and those in public locations. Greater proportion of shockable initial rhythms was also seen in survivors compared with deceased cases, while PEA and asystole as non-shockable initial rhythms were more often seen in deceased cases. The proportion of cases with shock delivery was higher in survivors with a relatively shorter EMS field resuscitation interval. However, survivors were not significantly different in gender, bystander witnessed status, bystander resuscitation attempt and EMS response time from deceased cases. Although 31 individuals were seen among all those 79 survivors, a higher proportion of patients who met TOR rule in the field was found in deceased cases than that in survivors.

Table 2 shows the results of multivariate logistic regression analysis for OHCA without ROSC gained in the field. As described previously, covariates include demographic characteristics, such as age and gender, event details including public location, bystander/EMS witnessed arrest, bystander CPR and initial shockable rhythms, shock delivered in the field, EMS response time as well as field resuscitation interval. For survival to hospital discharge, the top four variables among those which would potentially impact outcomes were: shockable initial rhythms (OR 3.037, 95%CI 1.428–6.456, p = 0.004), EMS witnessed arrest (OR 2.915, 95%CI 1.163–7.305, P = 0.022), bystander CPR (OR 1.901, 95%CI 1.014–3.566, P = 0.045), and age (OR 0.826, 95%CI 0.725–0.942, p = 0.004). Of concern, odds ratio for variable “shock delivered in the field” shows no significant impact on predicting outcomes for

those cases who did not gain ROSC in the field when the variable "shockable initial rhythms" is also entered as a covariate in multivariable logistic regression analysis. When we removed the variable "shockable initial rhythms" from those selected covariates, results showed that variable "shock delivered in the field" was significantly associated with survival (OR 2.248, 95%CI 1.399–3.612, p = 0.001, data not shown in Table 2).

Among a total of 4243 cases without ROSC achieved in the field, 2827 (66.6%) were further classified as a sub-group that met field Termination of Resuscitation (TOR) criteria (no ROSC, not witnessed by EMS, and not shocked in the field), and 1401 (33.0%) as the other sub-group which did not meet TOR criteria. In the sub-group of patients who met TOR, 2560 (90.6%) died in ED, 236 (8.3%) died in hospital after they were admitted, while 31 (1.1%) survived to hospital discharge; on the other hand, in the sub-group of patients who did not meet TOR, 1212 (86.5%) and 141 (10.1%) of them died in ED and hospital respectively, and 48 (3.4) survived to hospital discharge (Fig. 2). Therefore, in those who met the TOR rule and actually accounted for more than half of the total cohort (55.4%, 2827/5099), the survival rate was 1.1% (31/2827), as shown in Fig. 2. The survival rate was 3.4% (48/1401) in the other group, which had no ROSC but did not meet TOR rule (Fig. 2).

Demographics, key factors concerning arrest episodes and field interventions of all those who did and did not meet TOR criteria, are also shown in Table 3. In this special but substantially large population who met TOR in the field, 31 victims who would have been declared dead in the field survived to hospital discharge with a survival rate of 1.1% (31/2787), accounting for 10.8% (31/287) of the total survivors in this study cohort. Of concern, a total of 47 cases were found to be in initially shockable rhythms but no shocks were delivered for unknown reasons. Further comparison revealed a significantly higher proportion of shockable initial rhythms in survivors than those not surviving to hospital discharge in OHCA victims who met TOR rule.

Discussion

The present study shows that 27.5% of OHCA survivors at the DFW ROC site were patients without ROSC gained in the field and 1.1% of those who met field TOR criteria survived to hospital discharge. We suggest that all treated OHCA patients in the field should be transported to hospital.

There is a large body of literature indicating that TOR in the field by EMS personnel maybe appropriate under specific circumstances, which consider absence of ROSC in the field as a key component,[4,11–14] particularly when the regional EMS provides Advanced Life Support (ALS) at scene. The universal TOR criteria, validated by Morrison et al., recommended that resuscitation on OHCA patients be terminated in the pre-hospital setting if there was (a) no pre-hospital ROSC, (b) no shock was delivered to the patient, and (c) the arrest was not witnessed by EMS personnel. It suggests that the TOR criteria may be useful for EMS systems with various levels (BLS, ALS, or mixed) of providers responding to OHCA and yield a specificity of 100% for recommending transport of potential survivors, and a positive predictive value of 100% for death, while at the same time reducing the transport rate to 37% without missing any potential survivors.[15–18] However, validation of this universal TOR rule in some Asian communities showed lower sensitivity and positive predictive values in identifying those OHCA patients who have little or no chance of survival, raising concern of compromising patient safety for the implementation of the rules.[6,7]

In the DFW area of the current study, EMS providers are trained to provide ALS to all OHCA patients once the EMS system is activated. However, according to the pre-existing local protocol, EMS providers are required to transport all treated OHCA patients to hospital for continual and definitive resuscitation efforts except when obvious evidence of prolonged arrest is present (e.g. rigor mortis or decomposition). Our data suggest that for some EMS systems it is reasonable to adopt a policy or develop a protocol for transport of patients without ROSC achieved in the field. Selective transportation of treated OHCA victims will inevitably lead to termination of care for potential survivors, even if the decision is made on the basis of meeting TOR criteria in the field. Currently, new technologies are emerging as options of aggressive interventions available for prolonged arrest patients and enable those who did not obtain ROSC prior to hospital arrival achieving ROSC in hospital and surviving to hospital discharge with favorable neurological outcomes. Stub et al. reported that a protocol including E-CPR instituted by critical care physicians which includes mechanical CPR, peri-arrest therapeutic hypothermia and ECMO is feasible and associated with 96% ROSC achieved in hospital and 54% survival to hospital discharge with full neurological recovery in those refractory cardiac arrest.[19]

Consistent with TOR criteria, our data showed that OHCA patients with EMS witnessed episodes, shocks delivered in the field, or bystander CPR attempts were more likely to survive to hospital discharge. Of great concern, our data also showed that 1.7% of those patients who met all components of the TOR rule presented with initial shockable rhythms but no shocks were delivered subsequently for unknown reasons. This suggests that improved recognition and accurate interpretation of arrest rhythms and defibrillation protocols, are warranted to further improve the quality of field resuscitation even in well-established resuscitation EMS systems.

In this study, we performed a retrospective, observational analysis of data from DFW ROC site, which uses up-to-date clinical practices in resuscitation. We provided evidence that resuscitation attempts may not be futile for those without ROSC in the field and even those meeting field TOR rules when definitive aggressive resuscitation interventions in hospital are usually available after transportation with ongoing resuscitation efforts. In those regions beyond the USA where either BLS-level or ALS-level EMS system is used, our findings also suggest that it may not be sensible to cease resuscitation too quickly in non-traumatic OHCA without field ROSC gained. In addition to emphasizing the importance of high-quality field resuscitation, using optimal transport devices for those without field ROSC, as well as applying definitive resuscitation attempts in hospital, is recommended for all treated refractory arrest without ROSC in the field and even for those who met TOR rule to improve the overall outcomes of OHCA patients.[20]

Our study has the following strengths. First, we showed that neither ROSC in the field alone, nor Termination of Resuscitation rule, reliably predicts survival from OHCA. Second, the data were derived from the single DFW ROC site instead of all participating ROC sites, where uniform protocols were followed particularly in the decision-making policies on transport practice of OHCA patients, which might potentially avoid the bias due to variation in field resuscitation and transport practices among different ROC sites.[21] Third, the sample size of this study is relatively large, and the data were generated by well-developed North American ROC research facilities and clinical centers that adhere to up-to-date clinical practices.

Limitations

Our study has several limitations. First, due to the nature of a retrospective, observational study, missing data were occasionally present in the variables of interest which would inevitably affect the generalizability of our conclusions and therefore our results need to be interpreted with caution. Second, we concluded that

all treated patients should be transported for further treatment. However, favorable neurological outcomes, as another important measure of outcomes for OHCA patients, such as assessment of Modified Rankin Scale (MRS) or Cerebral Performance Category (CPC), should be taken into consideration. Unfortunately, we did not have data in this dataset describing neurological outcomes for most of the survivors (only 25 for a total of 287 survivors available). Third, it was difficult for us to determine all the reasons why no shocks were given in the field to those who had initially shockable rhythms. Thus, these patients erroneously met TOR criteria because shocks were not given. However, we did determine that at least 30 of them had ventricular fibrillation with low amplitude waveforms (so-called fine VF) but were not correctly interpreted as shockable rhythms and not shocked subsequently during field resuscitation. Last, in this study we used a relatively old dataset (2006–2011) from the DFW ROC site. In fact, access to more recent data is still unavailable because of ongoing clinical trials on OHCA patients at ROC since April 2011. We are planning to validate our conclusions when the data are available. However, we do not think that analysis of the upcoming dataset will likely change the findings since increasingly aggressive interventions or strategies have been applied to more and more OHCA patients in hospital during the past several years and consequently improved the overall outcomes particularly for those without ROSC gained in the field or even those who met TOR rules.

Conclusions

At the DFW ROC site, 27.5% of OHCA survivors were patients without ROSC achieved in the field and 1.1% of those who met field TOR criteria survived to hospital discharge. Knowledge of outcome details is critically important for EMS systems and may indicate that all treated OHCA patients in the field should be transported to hospital.

Conflict of interest statement

None.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.resuscitation.2016.12.013.

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