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Variability in the initiation of resuscitation attempts by emergency medical services personnel during out-of-hospital cardiac arrest

Steven C. Brooks, MD, MHSc^{1,2}, Robert H. Schmicker, MS³, Sheldon Cheskes, MD², James Christenson, MD⁴, Alan Craig, MScPI⁵, Mohamud Daya, MS, MD⁶, Peter J Kudenchuk, MD⁷, Graham Nichol, MD, MPH⁸, Dana Zive, MPH⁶, and Laurie J. Morrison, MSc^{2,9} on behalf of the Resuscitation Outcomes Consortium Investigators

¹Department of Emergency Medicine, Queen's University, Kingston, Ontario, Canada

²Rescu, Li Ka Shing Knowledge Institute, St. Michael's, University of Toronto, Toronto, Ontario Canada

³Clinical Trial Center, University of Washington, Seattle, Washington, USA

⁴Providence Health Care Research Institute, Department of Emergency Medicine, University of British Columbia, Vancouver, British Columbia, Canada

⁵American Medical Response, San Diego, California, USA

⁶Department of Emergency Medicine, Oregon Health & Science University, Portland, Oregon, USA

Corresponding Author: Steven C. Brooks, Kingston General Hospital, Watkins 4, 76 Stuart Street, Kingston, Ontario, Canada, K7L 2V7, (O) 613-548-6666 Ext 4575, brookss1@kgh.kari.net.

Findings: In this population-based retrospective cohort including 86,912 OHCA patients in the US and Canada, the proportion of patients receiving resuscitation attempts ranged from 23.9% to 100% across 129 EMS agencies. On average, patients were more likely to survive to hospital discharge among EMS agencies that more often initiated resuscitation. Conversely, longer response intervals and more advanced life support unit availability were associated with a lower probability of initiating resuscitation.

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⁷Department of Medicine, Division of Cardiology, University of Washington, Seattle, Washington, USA

⁸University of Washington-Harborview Center for Prehospital Emergency Care, Department of Medicine, University of Washington, Washington, USA

⁹Division of Emergency Medicine, Department of Medicine, University of Toronto, Toronto, Ontario Canada

Abstract

Background—Some patients with out-of-hospital cardiac arrest (OHCA) assessed by emergency medical services (EMS) do not receive attempts at resuscitation on the basis of perceived futility.

Aims—1) To measure variability in the initiation of resuscitation attempts in EMS-assessed OHCA patients across EMS agencies, 2) to evaluate the association between selected EMS agency characteristics and the proportion of patients receiving resuscitation attempts, and 3) to evaluate the association between proportion receiving resuscitation attempts and survival.

Methods—A retrospective cohort study using data from 129 EMS agencies participating in the Resuscitation Outcomes Consortium (ROC) epidemiologic registry (EPISTRY) - Cardiac Arrest from 12/01/2005 to 12/31/2010. We included nontraumatic OHCA patients assessed by EMS.

Results—We included 86,912 OHCA patients. Overall, 54.8% had resuscitation attempted by EMS providers, varying from 23.9% to 100% ($p<0.001$) across EMS agencies. The proportion of patients receiving a resuscitation attempt was 7.87 % less (95% CI 3.73-12.0) among agencies with longer average response intervals (≥ 6 minutes) compared with shorter average response intervals (<6 minutes) and 16.9% less (95% CI 11.9-21.9) among agencies with higher levels of advanced life support (ALS) availability (≥ 50% of available units) compared with lower levels of ALS availability (<50% of available units). There was a moderate positive correlation between the proportion of patients with resuscitation attempts and survival to hospital discharge ($r=0.54$, $p<0.001$).

Conclusions—The proportion of patients with OHCA who receive resuscitation attempts is variable across EMS agencies and is associated with EMS response interval, ALS unit availability and geographic region. On average, survival was higher among EMS agencies more likely to initiate resuscitation.

Keywords

Cardiac arrest; emergency medical services; health services research

Introduction

Out-of-hospital cardiac arrest (OHCA) remains a major public health problem with approximately 400,000 victims assessed by emergency medical services (EMS) every year in the United States and Canada. (1, 2). Outcomes after OHCA vary markedly from one region to another. (3, 4) Understanding how each component of care might contribute to this variability is a key step towards optimizing outcomes for all cardiac arrest patients.

One such component is the decision to initiate resuscitation in patients without signs of life. Core to the mission and training of EMS personnel is to save life. However, resuscitation attempts are not always appropriate. Resuscitation attempts in the setting of irreversible death are futile, may cause distress to family members, pose harm to providers, and waste limited resources. Resuscitation attempts on patients with advance directives against resuscitation (e.g. Do-Not-Resuscitate (DNR) orders) violate patient autonomy. Conversely, failing to initiate resuscitation in a potentially salvageable patient may be a missed opportunity to save a life.

Initiation of resuscitation for patients with OHCA varies across regions in the US and Canada. (5) Understanding this variability and how it relates to clinical outcomes is relevant in the quest for optimized clinical outcomes and also has implications for how we should design future comparative clinical trials. Most prior analyses reporting survival outcomes after cardiac arrest define the denominator as patients with resuscitation attempted by EMS and exclude those where resuscitation was not initiated. The most recent Utstein recommendations for the standard reporting of OHCA, suggest that “primary reporting by systems should state the outcomes of all *EMS-treated* cardiac arrests” without any acknowledgement that the selection of this group may be variable across EMS agencies and geographic regions.(6, 7) Variable selection of patients for resuscitation attempts across EMS agencies could result in selection bias during clinical studies or inaccurate comparisons during benchmarking activities when comparing outcomes across sites. Variability in the initiation of resuscitation attempts across sites in randomized controlled trials could introduce heterogeneity in the study population and decrease power.

The objectives of our study were to 1) measure the variability in the proportion of EMS-assessed OHCA patients who had any attempt at resuscitation at the level of participating EMS agencies, 2) to evaluate the association between proportion treated and selected EMS agency and population characteristics to generate hypotheses about factors driving differences between agencies, and 3) to measure the relationship between the proportion of EMS-assessed OHCA having resuscitation initiated and survival to hospital discharge.

Methods

Design

This was a population-based retrospective cohort study using data from the Resuscitation Outcomes Consortium Epidemiologic Registry – Cardiac Arrest (ROC EPISTRY).(8) Ethics approval for participation in the ROC EPISTRY was obtained from 74 US Institutional Review Boards and 34 Canadian Research Ethics Boards as well as 26 EMS Agency Institutional Review Boards. The present study which used de-identified data was considered exempt from regulations related to research involving human subjects.

Study setting and data source

The ROC EPISTRY – Cardiac Arrest captures data from all individuals with EMS-assessed out-of-hospital cardiac arrest (treated or untreated) within participating regions. The ROC originally included 11 regional centers across the USA and Canada serving a population of

more than 21 million individuals. The methods for EPISTRY, including a complete description of the included population and EMS services have been previously described.(8, 9)

The full ROC EPISTRY-Cardiac Arrest dataset includes dispatch data, patient and event characteristics, details of prehospital treatment, and clinical outcomes. Data capture for patients not receiving EMS treatment was limited to dispatch information and patient demographics.

Patient selection

We included all patients assessed by EMS agencies participating in the ROC PRIMED (Prehospital Resuscitation using an Impedance valve and Early vs. Delayed Analysis; www.clinicaltrials.gov NCT00394706) trial with non-traumatic out-of-hospital cardiac arrest occurring between 12/01/2005 and 12/31/2010. PRIMED was a partial factorial design which tested two interventions: a brief versus longer period of CPR by EMS prior to analysis for defibrillation and assessing the effectiveness of an active vs. sham Impedance Threshold Device (ITD).(10, 11) Neither the CPR strategies nor the ITD device was significantly associated with survival to hospital discharge or functional outcome.(12, 13) Concurrently with PRIMED which recruited from 06/2007 to 03/2009, ROC also completed a real-time CPR feedback trial at selected EMS agencies from three sites which showed no significant difference in outcomes between control and intervention arms.(14) Regardless of trial participation, all sites maintained EPISTRY entry for non-enrolled cases, and the trial data were later merged, generating a full OHCA dataset across the study time frame.

Approximately 100 public safety agencies (which included all of the agencies within one ROC site) discontinued their participation in ROC EPISTRY before or during the ROC PRIMED study and were excluded from our analysis. We excluded data from periods of time with known inconsistent case capture by calculating a 95% lower bound of enrollment rate (with assumed Poisson distribution) for each agency and excluded data from months where enrollment was less than this value.

Analysis

To measure variability in the treatment rate for patients with OHCA, we calculated the proportion of EMS-assessed OHCA patients who had resuscitation attempted. We defined “resuscitation attempted” as any patient receiving chest compressions or external defibrillation by EMS personnel. (8) We used descriptive statistics to characterize the distribution of proportion treated across ROC EMS agencies, testing for differences with a Chi-squared test.

To determine if there was an association between proportion with resuscitation attempted and agency/population factors, we used multiple linear regression. The unit of analysis for the regression was the EMS agency defined as an emergency medical service or fire department undertaking medical response. We included selected agency characteristics and features of the population served to explore the independent association between each of these characteristics and the proportion of OHCA patients receiving any resuscitation attempt.

We developed several a priori hypotheses: 1) Longer response intervals may be associated with less favorable initial rhythms and patient appearance resulting in a higher probability of no resuscitation attempt, 2) a higher level of training, experience and authority typically associated with the advanced life support (ALS) designation, when compared with the basic life support (BLS) designation may be associated with a lower likelihood of a resuscitation attempt in the prehospital setting, and 3) geographic region may influence provider decisions to attempt resuscitation due to local culture, legislation or leadership. Accordingly, agency characteristics entered into the model included mean response interval (time of 9-1-1 call to time of scene arrival) (<6 minutes versus ≥6 minutes), the proportion of units with advanced life support capability (<50% versus ≥50%) and the ROC site which acted as a surrogate for geographic region. These variables were chosen on the basis of our hypotheses and data availability as opposed to any prior evidence suggesting an association with outcomes of interest. Agency size (total number of units) was included in the model as an analytic weight.

In addition to these a priori hypotheses, we undertook a post hoc analysis to examine the correlation between the proportion of patients determined to be “obviously dead” within a given agency and the proportion receiving any resuscitation. We hypothesized that agencies with higher rates of obvious death determination might be reflected in lower rates of attempted resuscitation.

Some regions had a tiered response which involved dispatch of multiple agencies to a single patient (e.g. basic life support providers from a fire department and advanced life support providers from an emergency medical service). Mean response interval for each agency was calculated using all episodes where that agency was first to arrive on scene. Population level data was abstracted from the 2000 US Census and the 2006 Statistics Canada Census Report. To determine which census tract data to associate with each agency, each had a geographic footprint defined. The footprint was primarily based on the distribution of first arriving agency for every census tract within the catchment area of 10 ROC sites included in the dataset. Population characteristics included median household income (per \$10,000), proportion of individuals with no high school diploma (<20% versus ≥20%), proportion of males, proportion over age 64, and population density (<2000 residents per square mile versus ≥2000).

We hypothesized that the process of selection of patients for resuscitation attempts in an EMS agency would have clinical consequences for patients assessed and treated by that EMS agency. To measure the relationship between proportion treated and survival among patients assessed for OHCA by agency, we used a scatter plot and calculated the Pearson correlation co-efficient.

Data management was performed in S-PLUS version 6.2.1 (Insightful Corporation, Seattle, WA) while regression analyses were performed in Stata Statistical Software: Release 11. (StataCorp LP, College Station, TX)

Results

There were 102,787 non-traumatic out-of-hospital cardiac arrests between 12/1/05 and 12/31/10 (Figure 1). After removing cases during periods of incomplete capture and from agencies not participating throughout the time period of data capture, there were 86,912 patients with OHCA assessed by EMS personnel from 129 distinct EMS agencies across 10 ROC sites included in the final analysis. Of these, 47,660 (54.8%) received resuscitation attempts. Of those receiving resuscitation attempts, 63% were male and the median (IQR) age was 67 (27) (Table 1). Only limited demographic data were available from the group of patients who did not receive resuscitation attempts (n=42,252). Of those with available data, the median (IQR) age was 68 (29) (n=24,227) and 58% (12,342/21,279) were male. Table 2 summarizes characteristics of EMS agencies and the populations served according to ROC site.

Variability in the attempted resuscitation across the Resuscitation Outcomes Consortium

The proportion of EMS-assessed OHCA patients receiving resuscitation attempts varied markedly at the level of ROC site and EMS agency. The proportion treated ranged from 33% at ROC site 1 to 67.5% at ROC site 10 ($p<0.001$) (Table 1). At the EMS agency level (n=129), the proportion treated varied from 23.9% to 100% (25th, 75th percentiles = 48%, 71%, respectively, $p<0.001$).

Agency and population characteristics associated with the proportion of EMS-assessed patients receiving resuscitation attempts

Results from the multiple linear regression model exploring the association between the proportion of EMS-assessed patients receiving attempts at resuscitation and agency/population characteristics are summarized in Table 3. All three selected EMS agency characteristics were independently associated with proportion of EMS-assessed patients receiving any resuscitation, including average interval from 9-1-1 call to scene arrival, percentage of units having ALS capabilities and ROC site affiliation. On average, the proportion of patients receiving any resuscitation attempt was 7.87% less (95% CI 3.73-12) among agencies with longer average response intervals (≥ 6 minutes) compared with those agencies having shorter average response intervals (<6 minutes). On average, the proportion of patients receiving any resuscitation attempt was 16.9% less (95% CI 11.9-21.9) among agencies with higher levels of ALS availability ($\geq 50\%$ of available units) compared with agencies having lower levels of ALS availability ($<50\%$ of available units).

Our hypothesis that EMS agencies with higher rates of obvious death determination might be reflected in lower rates of attempted resuscitation was not supported by our data. The correlation between these two quantities by EMS agency was positive, but very weak (Pearson $r=0.06$, $p=0.5$).

Relationship between proportion treated and survival

At the EMS agency level, median survival to hospital discharge was 5.9% (range 0-50%, IQR 6.1%). There was a positive correlation between a higher rate of agency treatment and

greater likelihood of survival to hospital discharge among those assessed by EMS (Pearson $r=0.53$, $p<0.001$) (Figure 2).

Discussion

In this study of more than 86,000 EMS-assessed OHCA patients across North America, we observed that the proportion of patients receiving attempts at resuscitation from prehospital providers varied markedly across EMS agencies and ROC sites. We observed that EMS agency characteristics were associated with the likelihood of providers within that agency to initiate resuscitation on cardiac arrest patients. Specifically, we observed that average response intervals > 6 minutes and having ALS capabilities in $>50\%$ of agency vehicles were independently associated with a lower propensity to initiate resuscitation on cardiac arrest victims. We observed a moderately strong correlation between the likelihood of providers within an agency to attempt resuscitation and survival among those assessed, supporting the hypothesis that a more aggressive approach to attempting resuscitation may result in a higher proportion of survivors. Our data did not support the hypothesis that variability in attempted resuscitation could be entirely explained by variation in determination of “obvious death” across agencies.

Agencies with mean response intervals >6 minutes were 7.8 % less likely, on average, to initiate resuscitation compared to agencies with mean response intervals <6 minutes. It is well known that longer EMS response intervals are associated with worse outcomes after cardiac arrest.⁽¹⁵⁾ Providers who experience a longer response interval because of initial distance from the scene, poor traffic conditions or difficulty in accessing the patient (e.g. vertical response interval in apartment buildings) may have been less inclined to attempt resuscitation on arrival because of a pessimistic outlook or a higher likelihood of the patient meeting local criteria for “obvious death”.

The proportion of patients receiving resuscitation attempts was, on average, 16.9% less (95% CI 11.9 -21.9) among agencies with higher levels of ALS personnel availability (50% of available units) compared with agencies having lower levels of ALS personnel availability ($<50\%$ of available units). This finding generates several hypotheses. Local protocols for ALS versus BLS management of suspected cardiac arrest may allow for more discretion among ALS crews with respect to the decision to initiate resuscitation for OHCA. ALS crews have more training and more experience dealing with critically ill patients potentially lending to increased comfort when making the decision to withhold CPR in a patient without vital signs on the basis of presumed futility.

Consistent with a previous ROC analysis, (5) we observed ROC site-to-site differences in the probability of resuscitation attempt (Table 3). This may reflect the influence of ROC site leadership on the operations of the EMS agencies in that region, regional differences in legislation or medical directives, geographically distributed cultural and socioeconomic factors, or geographic variability in patient characteristics that were not measured in this study. There are many other factors which were not directly measured in this study that may be contributing to the observed variation in the proportion of OHCA patients receiving resuscitation attempts. Patient characteristics (e.g. comorbidities, age, race, and

socioeconomic status), organizational culture, provider preferences, economic factors, local legislation and EMS policy may all be contributing. Another source of variability across communities may be the types of situations which prompt a 9-1-1 call and EMS assessment. For example, in some communities, there may be well-established pathways for expected deaths at home that do not involve the 9-1-1 system (e.g. palliative care physicians, family physicians, coroners, etc.), whereas in others, all deaths prompt a 9-1-1 call, regardless of whether there is an indication for resuscitation.

Our data support the hypothesis that a more aggressive approach to attempting resuscitation may result in a higher proportion of survivors. It is possible that agencies initiating resuscitation less often may be missing opportunities to achieve return of spontaneous circulation in salvageable patients. The correlation we observed may have been due to unadjusted confounding variables so it should be treated as hypothesis-generating only.

Our results have some implications for research and quality improvement methodology. Classically, survival metrics are reported as a percentage of patients *in whom resuscitation was attempted*. Patients without resuscitation attempts are typically excluded from the denominator. Since OHCA warranting resuscitation is a relatively rare event with survival being even rarer, this calculation is very sensitive to changes in either the denominator or the numerator. Although the numerator for this proportion is dichotomous and largely unambiguous, the denominator (OHCA patients with attempted resuscitation) reflects the on-scene judgment of a diverse group of rescuers influenced by multiple factors including local legislation, policies, culture, patient presentation and provider expertise. Our data support the notion that the selection of patients in the denominator is variable across EMS agencies and regions.

Variation in the percentage of OHCA cases where resuscitation is attempted could distort benchmarking of OHCA survival rates and decrease the signal-to-noise ratio in multi-site projects. Analysis of factors associated with improved survival rates across multiple sites or regions (such as new interventions or population characteristics) would be more interpretable if this denominator was selected in a uniform manner. Continued focus on the Utstein (7) subgroup of bystander witnessed VF cardiac arrest for benchmarking and comparisons across agencies may reduce heterogeneity in the denominator.

The decision to begin resuscitation in a patient without vital signs is a complex one faced by EMS care providers in a challenging setting that may include and uncontrolled setting, emotional family members and other bystanders. Despite extensive research on the development of decision rules around termination of resuscitation efforts once they have begun (16-19), there are no evidence-based guidelines to support the decision-making process around attempting resuscitation in the first place. Studies exploring the predictive power of patient characteristics available to prehospital providers at the time of initial assessment with respect to probability for successful resuscitation could inform rational decisions around when to attempt resuscitation. This information could contribute to the development of standardized guidelines to identify salvageable patients who should receive resuscitation attempts and those where attempts are futile.

Our study has several limitations. Data was derived from a group of EMS agencies selected via a competitive process to participate in the Resuscitation Outcomes Consortium and therefore our results may not be reflective of the situation outside of this trials network. This was a retrospective study, and therefore the associations observed cannot be confirmed as a cause-effect relationship. The limited data available for patients who did not receive resuscitation attempts could not support an analysis with the patient as the unit of analysis. As a result, there may have been unmeasured confounders excluded from our regression analysis resulting in biased associations. Some EMS agency level data was also missing, including local criteria for futility or “obvious death” determination. This prevented us from undertaking analyses which incorporated this potential source of variability in resuscitation rates from one EMS agency to another. Future work should characterize the heterogeneity of futility determination practices across EMS agencies and how this may impact on patient outcomes.

Conclusion

The proportion of atraumatic out-of-hospital cardiac arrest patients having resuscitation attempted varies markedly by EMS agency and is associated with EMS response interval, ALS unit availability and geographic region. Selection of patients for resuscitation may have implications for the survival rate achievable in the group that receives resuscitation attempts and should be considered when evaluating system survival rates. Heterogeneity in patient selection for resuscitation should be considered in the design and analysis of future cardiac arrest studies, especially those that involve multiple public safety agencies and geographic regions.

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Australian and New Zealand Council on Resuscitation, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Council of Southern Africa, Resuscitation Council of Asia); and the American Heart Association Emergency Cardiovascular Care Committee and the Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation. *Circulation*. 2015; 132(13):1286–1300. [PubMed: 25391522]

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Key Points**Question**

How does the proportion of out-of-hospital cardiac arrest (OHCA) patients who receive resuscitation attempts vary across emergency medical services (EMS) agencies?

Meaning

The proportion of EMS-assessed OHCA patients receiving resuscitation may be an important factor to consider when optimizing the treatment of OHCA and the design of comparative studies.

Figure 1.

Derivation of the study cohort.

OHCA = out-of-hospital cardiac arrest, ROC = Resuscitation outcomes consortium, EMS = Emergency medical services

Figure 2.

A scatter plot of survival to hospital discharge and proportion treated at the EMS agency level.

Each diamond-shaped point on the graph represents one EMS agency. The black line represents a line of best fit. EMS = Emergency medical services.

Table 1

Event, treatment and outcome characteristics of patients receiving resuscitation attempts at ROC sites.

ROC site #	1	2	3	4	5	6	7	8	9	10	ALL
Treated Episodes, %	33	53	55	58	46	57	62	50	56	68	55
Median Age (IQR)	62 (25)	62 (27)	63 (28)	68 (24)	66 (26)	63 (26)	67 (27)	65 (27)	71 (26)	67 (26)	67 (27)
Male, %	59	59	60	66	60	65	62	64	63	66	63
Witness Status EMS, %	16	11	11	11	10	8	9	12	11	9	10
Bystander, %	44	24	35	39	34	46	36	36	41	40	38
Unwitnessed, %	32	35	48	50	44	39	51	51	48	50	46
Unknown, %	7	31	7	1	11	7	4	1	1	1	5
Bystander CPR, %	30	28	19	32	41	45	45	50	34	40	37
First EMS Rhythm VT/VF, %	24	15	16	25	18	29	17	25	21	26	22
PEA, %	27	22	20	20	20	21	24	28	21	17	22
Asystole, %	37	45	61	40	47	48	56	41	42	35	44
Non-Shockable, NOS ^a %	6	1	1	8	8	1	0	2	9	12	5
Unknown ^b , %	5	15	1	5	3	1	2	3	5	8	5
Public Location, %	13	13	11	13	14	16	11	18	16	19	15
Survival to hospital discharge among EMS-assessed patients, %	2	3	5	4	4	7	6	8	4	8	5
Survival to hospital discharge among EMS- treated patients, %	5	5	9	7	9	12	9	17	7	11	9

^aIndicates that no electrocardiogram strip was available for analysis but the patient care record indicated a non-shockable rhythm not otherwise specified.

^bIndicates that no strip was available and no indication of rhythm being shockable or non-shockable was found in the patient care records

ROC = Resuscitation Outcomes Consortium, IQR = interquartile range, EMS = emergency medical services, CPR = cardiopulmonary resuscitation, VT/VF = ventricular tachycardia or ventricular fibrillation, PEA = pulseless electrical activity, NOS = not otherwise specified

Table 2
Characteristics of EMS agencies included in the analysis and the population served by ROC site

ROC site #	1	2	3	4	5	6	7	8	9	10	ALL
Treated episodes, %	33	53	55	58	46	57	62	50	56	68	55
Mean response interval ^a , minutes (SD)	6.0 (3.3)	5.2 (11.7)	4.2 (1.9)	6.0 (3.0)	6.3 (3.2)	5.0 (2.1)	6.1 (2.1)	5.4 (2.2)	6.3 (3.6)	7.4 (7.2)	5.9 (5.1)
Proportion of EMS agencies within the ROC site with 50% of their units with ALS capability, %	88	100	8	39	50	93	100	3	23	0	32
Median household income among inhabitants ^b , median USD (IQR)	44,864 (24,535)	42,728 (8,727)	47,882 (14,732)	61,073 (7,903)	31,415 (6,875)	50,684 (9,736)	47,277 (7,934)	57,462 (17,902)	78,611 (5,947)	61,639 (15,874)	55,625 (15,322)
Proportion of inhabitants without a high school diploma**, mean % (SD)	17 (11)	25 (6)	14 (6)	20 (4)	19 (2)	14 (6)	17 (5)	11 (6)	15 (3)	16 (10)	15 (7)
Male ^b , mean proportion % (SD)	48 (1)	50 (1)	48 (2)	49 (1)	48 (1)	51 (5)	50 (2)	50 (1)	49 (1)	46 (8)	48 (6)
Age >64years ^b , mean proportion % (SD)	12 (3)	7 (1)	16 (3)	14 (3)	17 (1)	9 (2)	12 (3)	9 (4)	10 (2)	14 (5)	12 (4)
Proportion of census tracts with a population density >2000 people per square mile %	13	100	77	6	50	27	60	50	55	57	28

^a Average across all cases within ROC site^b Median or mean across census tracts served by EMS agencies within each ROC site

ROC = Resuscitation Outcomes Consortium, SD = Standard deviation, EMS = Emergency Medical Service, USD = United States Dollars, IQR = Interquartile Range, ALS = Advanced Life Support, IQR = interquartile range

Table 3
Co-efficient estimates from a linear regression model exploring the association between proportion treated and agency/population served characteristics among 129 ROC public safety agencies

Variable		Average percentage points change in proportion receiving resuscitation attempts (95% CI)
Public Safety Agency Characteristics		
9-1-1 toscene arrival interval^a	<6 minutes	Reference
	>6 minutes	-7.87 (-12.0 to -3.73)
Percentage of total available units in an agency with ALS capabilities^a	<50%	Reference
	50%	-16.9 (-21.9 to -11.9)
ROC site^a	1	Reference
	2	34.0 (22.0, 46.0)
	3	18.9 (8.36, 29.5)
	4	26.4 (17.8, 35.1)
	5	21.3 (10.4, 32.2)
	6	26.5 (15.8, 37.2)
	7	40.9 (28.2, 53.6)
	8	7.37 (-3.43, 18.2)
	9	21.0 (10.5, 31.4)
	10	56.1 (43.8, 68.5)
Characteristics of the Population Served by the Agency		
Population density^a	<2000 per square mile	Reference
	>2000 per square mile	-6.74 (-11.8, -1.64)
Median household income per 10,000 USD^b		0.28 (-0.50, 1.05)
Proportion of the population without a high school diploma^a	<20%	Reference
	20%	- 9.05 (-14.6, -3.46)
Proportion male sex†		0.19 (-0.83, 1.21)
Proportion over age 64^b		-0.49 (-1.25, 0.28)

^aEntered into the linear regression model as a categorical variable. The coefficient can be interpreted as the average change in proportion treated associated with this category of variable compared to the reference category.

^bEntered into the linear regression model as a continuous variable. The coefficient can be interpreted as the average change in proportion treated associated with a one unit increase in the variable with all other co-variates in the model fixed.

ALS = Advanced Life Support, ROC = Resuscitation Outcomes Consortium, USD = United States Dollars