



Clinical paper

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



Steven C. Brooks^{a,b,*}, Robert H. Schmicker^c, Sheldon Cheskes^b, Jim Christenson^d, Alan Craig^e, Mohamud Daya^f, Peter J Kudenchuk^g, Graham Nichol^h, Dana Zive^f, Laurie J. Morrison^{b,i}, on behalf of the Resuscitation Outcomes Consortium Investigators

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

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

^c Clinical Trial Center, University of Washington, Seattle, WA, USA

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

^e Toronto Emergency Medical Services, Toronto, Ontario, Canada (Retired)

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

^g Department of Medicine, Division of Cardiology, University of Washington, Seattle, Washington, USA

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

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

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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 non-traumatic 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 min) compared with shorter average response intervals (< 6 min) and 16.9% less (95% CI 11.9–21.9) among agencies with higher levels of advanced life support (ALS) availability ($\geq 50\%$ 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.

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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

* Corresponding author at: Kingston General Hospital, Watkins 4, 76 Stuart Street, Kingston, Ontario, K7L 2V7, Canada.

E-mail address: brookss1@kgh.kari.net (S.C. Brooks).

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 min versus ≥6 min), 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.

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