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Clinical paper

The impact of hospital experience with out-of-hospital cardiac arrest patients on post cardiac arrest care☆

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ABSTRACT

Objective: Patient volume as a surrogate for institutional experience has been associated with quality of care indicators for a variety of illnesses. We evaluated the association between hospital experience with comatose out-of-hospital cardiac arrest (OHCA) patients and important care processes.
Methods: This was a population-based, retrospective cohort study using data from 37 hospitals in Southern Ontario from 2007 to 2013. We included adults with atraumatic OHCA who were comatose on emergency department arrival and survived at least 6 h. We excluded patients with a Do-Not-Resuscitate order or severe bleeding within 6 h of hospital arrival. Multi-level logistic regression models estimated the association between average annual hospital volume of OHCA patients and outcomes. The primary outcome was successful targeted temperature management (TTM) and secondary outcomes included TTM initiation, premature withdrawal of life-sustaining therapy, and survival with good neurologic function.
Results: Our analysis included 2723 patients. For every increase of 10 in the average annual volume of eligible patients, the adjusted odds increased by 30% for successful TTM (OR 1.29, 95% CI 1.03–1.62) and by 38% for initiating TTM (OR 1.38, 95% CI 1.11–1.72). No significant association between patient volume and other secondary outcomes was observed.
Conclusions: Patients arriving at hospitals with more experience treating comatose post cardiac arrest patients are more likely to have TTM initiated and to successfully reach target temperature. Our findings have implications for regional systems of care and knowledge translation efforts aiming to improve quality of care for this patient population.

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Introduction

Out-of-hospital cardiac arrest (OHCA) is an important public health concern, with an annual incidence rate of 95 per 100,000 and mortality of approximately 90% in North America.[1] The high in-hospital mortality of resuscitated patients[2,3] is attributable to post-cardiac arrest syndrome.[4] Brain injury accounts for the majority of deaths after cardiac arrest, but multi-organ dysfunction and post-resuscitative shock are common.[5]

There are several features of post-cardiac arrest care that have been emphasized in treatment guidelines.[6] Targeted temperature management (TTM) and the avoidance of premature withdrawal of life-sustaining therapy on the basis of neuroprognostication are recommended processes that could be feasibly implemented regardless of individual hospital facilities.[4,7] Yet, these best practices are not universally implemented for eligible patients.[8] Significant variability in survival between hospitals has been reported by several studies from various regions around the world.[9–12]

Regionalized systems of post-cardiac arrest care wherein patients are directly transported to specialized, high volume, cardiac arrest care centres have been implemented in the US and around the globe.[7,13–18] The volume–quality relationship has been studied extensively in other complex medical emergencies such as myocardial infarction,[19] stroke,[20] and trauma,[21] but there is a relative paucity of data to examine the question of whether diversion of post cardiac arrest patients to higher volume specialty centres is advisable. Our primary objective was to evaluate the relationship between hospital experience with post-cardiac arrest patients and the use of TTM. Our secondary objectives were to evaluate the relationship between hospital experience with post cardiac arrest patients and (1) the occurrence of premature withdrawal of life-sustaining therapy on the basis of neuroprognosis and (2) neurologically intact survival.

Methods

Design and setting

This was a population-based retrospective cohort study of consecutive out-of-hospital cardiac arrest cases conducted with data from 37 hospitals within the Toronto Regional RescuNet (http://www.emergencymedicine.utoronto.ca/research/ptmr/CS/ROC/rescunet.htm). The Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board approved the study.

Data sources

We used data from the Rescu Epistry which is a population-based database capturing consecutive out-of-hospital cardiac arrest events occurring within the Toronto Regional RescuNET. The Rescu Epistry database is a composite of two precursors; the Toronto Epistry-Cardiac Arrest database of the Resuscitation Outcomes Consortium and the Strategies for Post Arrest Care (SPARC) database, the methodologies of which have been described elsewhere.[22–25] Rescu Epistry captures all patients with cardiac arrests or trauma for which there was a 911 response occurring in the City of Toronto and 6 adjacent regions with a total population of 6.6 million.

Study population

Patients who were treated for OHCA and delivered to a participating hospital in a comatose state with sustained return of spontaneous circulation (ROSC) between September 1, 2007 and December 31, 2013 were considered for inclusion in the study. Patients were excluded if they had a Do-Not-Resuscitate (DNR) order identified in the prehospital setting, were less than 18 years old, or suffered a cardiac arrest with an obvious non-cardiac cause identified by paramedics or in-hospital staff. Additionally, patients were excluded if any of the following occurred within six hours of emergency department arrival: A DNR order, withdrawal of life sustaining therapy, intracranial bleeding, severe bleeding, or death.

Outcome measures

The primary outcome was successful TTM, defined as achieving a core body temperature of $\leq$34 °C within 6 h of hospital arrival. Secondary outcomes included having cooling initiated, the proportion of patients who had life-sustaining therapy withdrawn within 72 h of emergency department arrival on the basis of neuroprognostication among those patients at risk for premature withdrawal of life-sustaining therapy and survival to hospital discharge with good neurologic function (defined as having a Cerebral Performance Category (CPC) score of 1 or 2). Patients who died within 72 h of first emergency department arrival despite full and aggressive intensive care and those who had life-sustaining therapy withdrawn after meeting criteria for brain death were not considered "at risk" for the premature withdrawal outcome and were excluded from these calculations. For all patients who died in hospital, mode of death was categorized as one of the following: death despite full medical care (the subject was unstable with continued life support impossible), death after meeting brain death criteria,[26] death after withdrawal of life sustaining therapy on the basis of neuroprognostication, and death after withdrawal of life sustaining therapy for reasons other than neuroprognostication (e.g., family/patient wishes, pre-exiting DNR, poor pre-morbid function, pre-existing terminal status, etc.).

Those patients who were alive but had a missing CPC score were classified as "poor neurologic function" by convention (CPC score of 3 or 4).[27]

Statistical analyses

For the purposes of our descriptive analysis only, institutions were categorized by average annual volume of patients eligible for TTM as: low (less than 15 patients per year), moderate (between 15 and 25 patients per year), and high (greater than 25 patients per year). These categories were determined taking into consideration what would be considered a meaningful difference in volume based on consensus among the investigators, while maintaining a sufficient number of hospitals and patients in each category for analysis. Patients were stratified by hospital volume category based on the hospital at which treatment was first received.

Variables were compared across volume categories using χ^2 and *t*-tests as appropriate, adjusting for the clustered nature of the data within hospitals. A p-value <0.05 was considered significant.

Several multi-level logistic regression models were built to assess the relationship between each outcome and average annual hospital volume of eligible OHCA patients (Proc GLMMIX, SAS v 9.4, Cary, NC, 2013). Multivariate multi-level regression models were constructed for each of the outcomes of interest adjusting for covariates. Covariates at the patient level included sex, age, initial rhythm, bystander witnessed arrest, EMS witnessed arrest, location of arrest (public versus private), bystander resuscitation (any CPR or AED use), bystander CPR, bystander AED use, EMS response time interval, ROSC in the field, ROSC at emergency department arrival, and whether the patient was admitted to a hospital in the active phase of the SPARC TTM trial (NCT00683683).[25] SPARC TTM was a step-wedge randomized controlled study which involved active and passive knowledge translation interventions aimed at increasing the number of eligible patients who received TTM.

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