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Clinical paper

Impact of the direct transfer to percutaneous coronary intervention-capable hospitals on survival to hospital discharge for patients with out-of-hospital cardiac arrest

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ABSTRACT

Aims: Patients suffering from out-of-hospital cardiac arrest (OHCA) are frequently transported to the closest hospital. Percutaneous coronary intervention (PCI) is often indicated following OHCA. This study's primary objective was to determine the association between being transported to a PCI-capable hospital and survival to discharge for patients with OHCA. The additional delay to hospital arrival which could offset a potential increase in survival associated with being transported to a PCI-capable center was also evaluated.

Methods: This study used a registry of OHCA in Montreal, Canada. Adult patients transported to a hospital following a non-traumatic OHCA were included. Hospitals were dichotomized based on whether PCI was available on-site or not. The effect of hospital type on survival to discharge was assessed using a multivariable logistic regression. The added prehospital delay which could offset the increase in survival associated with being transported to a PCI-capable center was calculated using that regression.

Results: A total of 4922 patients were included, of whom 2389 (48%) were transported to a PCI-capable hospital and 2533 (52%) to a non-PCI-capable hospital. There was an association between being transported to a PCI-capable center and survival to discharge (adjusted odds ratio = 1.60 [95% confidence interval 1.25–2.05], $p < .001$). Increasing the delay from call to hospital arrival by 14.0 min would offset the potential benefit of being transported to a PCI-capable center.

Conclusions: It could be advantageous to redirect patients suffering from OHCA patients to PCI-capable centers if the resulting expected delay is of less than 14 min.

Introduction

Approximatively 326 000 patients are afflicted annually by a non-traumatic out-of-hospital cardiac arrest (OHCA) in the United States.[1] Most of these are presumed to result from a cardiac etiology, the most frequent being an acute coronary syndrome (ACS).[2,3] Coronary angiography with appropriate percutaneous coronary intervention (PCI) is the diagnostic and therapeutic procedure of choice in ACS and is recommended after cardiac arrest both in patients with ST-segment elevation and without ST-segment elevation on their initial 12-lead

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electrocardiogram (Class I, level of evidence B and Class IIa, level of evidence B, respectively).[4–7] Additionally, early access to a cardiac catheterization laboratory allows for timely consideration of percutaneous hemodynamic support. However, considering the specialized resources and expertise required, such services tend to be centralized.

Given these recommendations and the fact that regionalized prehospital systems have already helped decrease morbidity and mortality in patients suffering from ST-segment elevation myocardial infarction (STEMI), it has been proposed that a similar regionalized approach for the treatment of OHCA, including direct transport to a specialized cardiac resuscitation center, might be beneficial (Class IIb, level of evidence C).[8–10] One of the main features of a cardiac resuscitation center is its ability to perform diagnostic angiography and PCI on-site at all times. Patients with an initial shockable rhythm (ventricular tachycardia or ventricular fibrillation) might benefit even more from being transported directly to a PCI-capable center owing to their higher likelihood of suffering from a significant coronary lesion amenable to PCI.[11] However, since OHCA might be a more time sensitive condition than STEMI, the increased delay before hospital arrival when bypassing primary or secondary care centers could possibly be harmful to some patients. Patients having experienced prehospital return of spontaneous circulation (ROSC) might be more stable and less affected by longer prehospital delays than those who have not. Whether survival after OHCA can be improved by direct transfer to cardiac resuscitation centers and the transport delay that would be acceptable have yet to be determined.

The main objective of this study was to evaluate the independent impact of direct transport to a PCI-capable center on survival to discharge among patients suffering from OHCA. Secondary objectives included determining whether or not two specific prehospital characteristics (e.g. prehospital ROSC or an initial shockable rhythm) would influence this association and the acceptable incremental delay for direct transfer.

Methods

Design

This cohort study used a registry of OHCA from the region of Montreal, Canada. It was carried out in association with the Hôpital du Sacré-Coeur de Montréal, the regional emergency medical service (EMS) agency (Urgences-santé) and the Université de Montréal. It was approved by the Institutional Review Board of the Hôpital du Sacré-Coeur de Montréal and conducted in accordance with the Declaration of Helsinki. Given the nature of the study, a waiver of written informed consent from the participant was granted.

Setting

In Montreal, a single public EMS agency coordinates all prehospital care for a population of over 2 000 000 people. First responders and paramedics treat patients suffering from OHCA following resuscitation protocols based on the American Heart Association guidelines.[12–14] According to these protocols, patients suffering from OHCA are transported to the closest of the region's 20 hospitals. Seven of these centers are capable of performing PCI.

Study population

All patients aged 18 years and older treated for an OHCA from April 2010 until December 2015 were screened for inclusion. Patients with traumatic causes for arrest, 'do-not-resuscitate' directives or with 'obviously deceased' criteria (e.g. decapitation, advanced putrefaction) were excluded from the registry described above.[12] In addition to these, patients not transported to hospital were excluded.

Study groups

The OHCA cohort was dichotomized according to the first hospital to which these patients were transported (PCI-capable vs non–PCI-capable). All PCI-capable hospitals in the region are designated STEMI centers and are therefore able to provide emergent diagnostic and interventional procedures (PCI or hemodynamic support) 24 h a day, all year round.[15]

Study outcomes

For the primary objective and the first two secondary objectives, the outcome measure was survival to hospital discharge. For the last secondary objective, the outcome measure was the additional delay in prehospital transport time (in min) that would result in equipoise between the two transport strategies (nearest hospital vs PCI-capable hospital).

Data collection

According to provincial law, OHCA patient data are entered by paramedics on a 'run-sheet' following every call. This information is then entered into a database that includes demographic (gender, age) and clinical characteristics (chief complaint, core Utstein-style data, etc.).[16] Call times are automatically registered in a separate database that is linked to the patient-care information collected. Resuscitation outcome data were transferred from the discharge hospitals to the regional EMS agency.

Power and statistical analysis

With a survival rate to hospital discharge of 15%, including 4100 patients would generate more than 90% power to detect a difference of 4% in survival between groups, using a two-tailed alpha of 5% (assuming that 75% of the variability is explained by other factors included in the model).[17]

The effect size of cohort differences for demographic, clinical and time variables were assessed using Cohen's d for continuous variable and Cramér's v for categorical variables. For Cohen's d, it was considered that an effect size of 0.2 was small, 0.5 moderate and 0.8 large.[18] For Cramér's v, it was considered that an effect size of 0.1 was small, 0.3 moderate and 0.5 large.[19] A Pearson's chi-squared test was first used to evaluate the difference in survival to discharge between both cohorts. The primary objective analysis consisted of a multivariable logistic regression model, using pertinent demographic (age, gender, initial call time moment) and clinical variables (initial rhythm, witnessed arrest, bystander cardiopulmonary resuscitation [CPR], presence of first responders, presence of advanced care paramedics, time from call to hospital arrival, prehospital intubation, presence of a prehospital ROSC). The predictive power of the model was evaluated using a Nagelkerke R^2. Interaction between the capabilities of the destination hospital (PCI-capable vs non–PCI-capable) and either of the two predefined clinical variables of interest (presence or not of a prehospital ROSC, shockable vs non-shockable initial rhythm) was tested using the same multivariable logistic regression model. If one of these interactions was significant, it was planned to perform separate multivariable logistic regression analyses for each pertinent subgroup. Finally, if a positive association was observed between survival to discharge and direct transport to a PCI-capable center, calculation of the additional acceptable prehospital delay of transport to such a center over the nearest center was to be performed using the adjusted odds ratio obtained in the main logistic regression model, which are calculated as exponential of regression coefficients based on the mathematical properties of such models.[20] Given the nature of this analysis, it is not possible to provide a confidence interval for its result.

Continuous variables are presented as means with standard