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Clinical paper

The influence of comorbidity on survival and long-term outcomes after out-of-hospital cardiac arrest☆

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ABSTRACT

Introduction: Comorbid conditions have been associated with morbidity, functional status and quality of life for patients with a wide range of diseases. Previous studies have attempted to elucidate the influence of pre-arrest comorbidities on survival and neurological recovery following out-of-hospital cardiac arrest (OHCA), however the findings are conflicting.
Methods: Baseline comorbidities recorded within prehospital patient care records were linked with baseline and 12-month follow-up data from the Victorian Ambulance Cardiac Arrest Registry for adult (≥16 years) non-traumatic OHCA patients. Dates of death from the Victorian death registry were also obtained for patients surviving to hospital discharge. Multivariable logistic, linear and Cox proportional hazards regression models were used to assess the influence of the Charlson Comorbidity Index (CCI) on survival to hospital discharge, 12-month functional recovery and health-related quality of life (HR-QOL), and long-term mortality over an eight-year period.
Results: A total of 15,953 patients were included. Increasing CCI was independently associated with reduced odds of survival to hospital discharge (CCI = 1: OR = 0.87 [95% CI 0.76–1.00]; CCI = 2: OR = 0.80 [95% CI 0.68–0.94]; CCI = 3: OR = 0.62 [95% CI 0.50–0.78]; CCI ≥ 4: OR = 0.53 [95% CI 0.41–0.68]). Additionally, increasing CCI was associated with reduced odds of 12-month functional recovery, a reduced chance of favourable 12-month HR-QOL, and an increased hazard of mortality after discharge from hospital.
Conclusion: Consideration of a patient's baseline comorbidity may assist prognostication decisions for cardiac arrest patients. Exploration of the effect of additional rehabilitation on HR-QOL and long-term survival outcomes for OHCA patients with a high baseline comorbidity burden may be warranted.

Introduction

Globally, less than 10% of out-of-hospital cardiac arrest patients survive to hospital discharge.[1] In patients aged greater than 70 years, the survival rate drops to approximately 4%.[2] The presence of chronic conditions, such as heart disease, hypertension and diabetes, is known to increase with age,[3] and evidence suggests that the majority of OHCA patients have at least one comorbid condition.[4–6] However, to date the influence of pre-arrest comorbidities on outcomes following OHCA has not been well established.

Comorbid conditions have been associated with morbidity, functional status and quality of life for patients with a wide range of diseases.[3] Although previous studies have attempted to elucidate the influence of pre-arrest comorbidities on survival and neurological recovery following OHCA, the findings are conflicting.[4,6–10] For example, some studies have demonstrated a deleterious association between chronic health conditions and OHCA outcomes,[4,9] while others have reported that comorbid factors do not influence survival or neurological outcomes.[7,8] In addition, few studies have assessed the influence of baseline comorbidity on long-term survival following OHCA.

Understanding the influence of comorbidity on short- and long-term outcomes after OHCA may offer patients and clinicians a greater understanding of the prospect of living a normal life. In this

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study, we sought to assess the influence of comorbidity according to the Charlson Comorbidity Index (CCI) on survival to hospital discharge and 12-month health-related quality of life (HR-QOL) and functional recovery outcomes following OHCA. In addition, we sought to describe the association between comorbidity and longer-term survival over an eight year period.

Methods

Study design

We conducted a retrospective observational study of adult (≥16 years), non-traumatic OHCA patients within the Victorian Ambulance Cardiac Arrest Registry (VACAR) in whom resuscitation was attempted by emergency medical services (EMS) between 1st January, 2007 and 31st December, 2014. The primary outcomes were survival to hospital discharge, favourable 12-month HR-QOL and functional recovery, and duration of survival after OHCA. The collection and use of VACAR data is approved by the Victorian Government Department of Health Human Research Ethics Committee as a quality assurance project. Access to hospital follow-up data is approved by all participating hospitals.

Setting

The state of Victoria, Australia covers more than 229,000 square kilometres and has a population of approximately 5.9 million residents. Ambulance Victoria is the state-wide EMS provider. Most OHCA events receive a dual-response by both Advanced Life Support and Intensive Care Paramedics. Basic-life support trained first responders are also dispatched in select areas of the state. Resuscitation protocols in Victoria follow the recommendations of the Australian Resuscitation Council (www.resus.org.au). Resuscitation may be withheld by paramedics in Victoria where there is clear evidence of prolonged cardiac arrest, injuries incompatible with life, or where there are no compelling reasons to commence resuscitation.

Data sources

The VACAR is a state-wide OHCA clinical quality registry which has been previously described.[11] In brief, all potential OHCA events occurring in Victoria are identified via an automated search of paramedic electronic patient care records before being manually reviewed by registry personnel for eligibility. Data relating to confirmed OHCA events are entered into the registry in accordance with Utstein recommendations.[12] Hospital discharge status is collected from hospital records for transported patients.

For this analysis, pre-arrest comorbidities, as obtained from paramedic electronic patient care records, were linked with baseline arrest data. In addition, all OHCA survivors were linked with the Victorian Registry of Births, Deaths and Marriages to ascertain the date of death for deaths occurring more than 12 months post-arrest.

Since 2010, all adult patients who are identified as alive 12 months post-arrest are invited to participate in 12-month telephone follow-up. The follow-up process and outcomes have been described in detail previously.[13] A search of the Victorian Registry of Births, Deaths and Marriages is conducted in the 12 months post-arrest to identify survivors. Participants (patients or proxies) are invited to respond to the 12 Item Short Form Health Survey (SF-12), EuroQol-5D (EQ-5D) and Glasgow Outcome Scale-Extended (GOSE), and also answer questions related to work and residential status. Responses from the SF-12 can also be used to derive the SF-6D, a single value of health state ranging from 0.345 to 1.

Definitions

For this study, we used pre-existing comorbidities to calculate the CCI. The CCI is a weighted comorbidity index that classifies patients with comorbid conditions according to their risk of death.[14] Patients who could not be linked with pre-arrest comorbidities were excluded from analyses (n = 201). Patients were also excluded if pre-arrest comorbidities or hospital discharge status was unknown (n = 1009 and n = 156, respectively).

Statistical analyses

Unadjusted baseline characteristics and 12-month outcomes are presented as frequencies and proportions for categorical data, and median (interquartile range (IQR)) for continuous data. Comparisons between groups of CCI were made using a nonparametric test for trend across ordered groups.[15] Unadjusted long-term survival outcomes are presented in the form of a Kaplan–Meier survival curve across categories of CCI. Follow-up years were calculated from the date of OHCA to death or censoring (September 2015), as appropriate. Survival durations were also compared across CCI categories using a log-rank test for trend.

To understand the independent association between CCI and the primary outcomes, multivariate regression models were constructed. The influence of CCI on survival to hospital discharge and good GOSE recovery (GOSE ≥ 7) was assessed using logistic regression analysis, while the influence of CCI on SF-6D score was assessed using a linear regression analysis. Only patients responding to 12-month follow-up between 2011 and 2015 were included in the GOSE and SF-6D models. To assess the influence of CCI on long-term mortality, we used Cox proportional hazards regression analysis. In order to satisfy the assumption of proportional hazards, the baseline hazard was stratified by groups of age and initial arrest rhythm. Patients with a missing date of birth were excluded from this analysis, as this missing information prevented their linkage with the death registry. Models were adjusted for CCI in addition to resuscitation factors. The covariates included in all final models are detailed within the results.

To understand the association between individual comorbidities and survival to hospital discharge, models were constructed in which the overall CCI score was replaced with the individual CCI components. Additionally, to assess whether the influence of CCI on survival to hospital discharge differed according to initial cardiac arrest rhythm, models were constructed separately for shockable and non-shockable arrests. Twelve-month and long-term outcomes were not assessed according to arrest rhythm due to the small number of patients surviving a non-shockable arrest. The fit of logistic regression models was assessed using Hosmer–Lemeshow goodness-of-fit tests, while the fit of the linear regression analysis was assessed via Normality of residuals. The goodness of fit of Cox proportional hazards models were assessed using Cox–Snell residuals. All analyses were conducted using Stata Statistical Software: Release 14 (College Station, TX: StataCorp LP). A p-value less than 0.05 from a two-sided test was considered statistically significant.

Results

A total of 17,319 adult (≥16 years) non-traumatic OHCA cases with an attempted resuscitation were attended in Victoria during the eight-year study period. After excluding patients who could not be linked with an electronic patient care record, and patients with unknown comorbidities or an unknown hospital discharge status, 15,953 patients were included in the final analyses (Fig. 1).