Original article

Socioeconomic status and survival from ventricular fibrillation out-of-hospital cardiac arrest

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ABSTRACT

Purpose: Out-of-hospital cardiac arrest (OHCA) is a major cause of death in the United States. How individual-level socioeconomic status (SES) influences survival is uncertain.
Methods: The investigation is a retrospective cohort study of adults who suffered OHCA and presented with a shockable rhythm in a metropolitan county from January 1, 1999–December 31, 2005. Individual-level measures of SES were obtained from vital records and surveys. SES measures included education and occupation. We used multivariable logistic regression to assess the independent association between SES measures and survival to hospital discharge.
Results: Of the 1390 eligible OHCA patients, 374 (27%) survived to hospital discharge. Compared to those with less than high school diploma, the multivariable-adjusted odds ratio of survival was 1.36 (95% confidence interval [CI], 0.87–2.14) for high school graduates, 1.54 (95% CI, 0.95–2.48) for those with some college, and 1.96 (95% CI, 1.17–3.27) for those with college degrees (test for trend across the categories $P < .001$). We did not observe an independent association between occupation and survival.
Conclusions: Higher education was associated with greater survival after OHCA. This relationship was not explained by key demographic or clinical characteristics. A better understanding of the mechanism by which individual-level SES characteristics influence prognosis may provide opportunities to improve survival.

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Out-of-hospital cardiac arrest (OHCA) is a leading cause of death in the United States, claiming hundreds of thousands of lives annually [1]. Although treatment of OHCA by emergency medical responders is well-established, only a small proportion of patients are successfully resuscitated and survive to hospital discharge [2]. One strategy to improve outcome is to identify characteristics associated with poorer survival and determine the mechanisms by which they relate to outcome. The identification of socioeconomic disparities in outcomes for chronic health conditions such as cardiovascular disease, diabetes, and obesity has informed targeted approaches to improve care [3,4]. For OHCA, incidence appears to be higher among communities of lower socioeconomic status (SES); yet, there is incomplete understanding of the role of an individual's SES characteristics in OHCA survival [5].

SES is a complex, multidimensional construct that can be studied directly using individual-level measures (e.g., education, income) or indirectly via surrogate, area-level measures (e.g., census tract data) and is often evaluated alongside demographic factors such as race, sex, and marital status. Geospatial analyses using area-level measures of SES have been helpful in revealing clusters of frequent OHCA and neighborhood deficits in bystander-provided cardiopulmonary resuscitation (CPR) [6]. Results of studies examining area-level characteristics and outcome have been inconsistent; for instance, neighborhood poverty has been associated with lower likelihood of survival from OHCA [7], whereas median household income does not appear to predict survival [8,9]. Individual-level measures of SES can provide greater predictive value for many health outcomes such as mortality and disability [10,11]; yet, tax-assessed property value is the sole individual-level SES characteristic studied for OHCA outcome [8,12].

Individual-level SES characteristics could influence an OHCA patient's chances of surviving from OHCA, and an understanding of

how SES impacts outcome could provide important opportunities to improve resuscitation and in turn improve public health. We investigated the relationship between individual-level measures of SES and survival after shockable OHCA to determine if and how individual-level SES characteristics predict clinical OHCA outcome.

Methods

Study design and population

The investigation is a retrospective cohort study of persons aged 18 years or older who suffered a nontraumatic OHCA presenting with a shockable rhythm and who were treated by emergency medical services (EMS) in greater King County (excluding Seattle) from January 1, 1999 until December 31, 2005. We a-priori chose to evaluate those with shockable rhythm given its feature as a focus of the Utstein template. The study was approved by the institutional review boards at the University of Washington and Public Health—Seattle & King County.

Study setting and data collection

Greater King County has a population of 1.2 million and comprises urban, suburban, and rural areas. King County EMS follows the American Heart Association's guidelines for resuscitation and maintains a registry of all treated OHCA events followed until death or hospital discharge. The registry is organized according to the Utstein guidelines and includes information about patient characteristics, event circumstances, care, and outcome abstracted from dispatch, EMS, defibrillator, death certificate, and hospital records [13]. This registry and King County's EMS practice have been previously described in detail [8].

Measures of SES, race, and marital status

Education, occupation, race, and marital status are not routinely captured in the King County EMS OHCA registry; therefore, these variables were ascertained using the Washington State Death Certificate database and surveys of survivors by mail and phone after obtaining informed consent. For 24 subjects who survived to hospital discharge, information was available initially from the survey and subsequently from the vital records after death. Agreement between the two sources of data was 100% for the measures of education, occupation, and race and 88% (21 of 24) for marital status.

Education was classified as "less than high school," "high school diploma or General Education Development," "some college," and "4 years of college or greater (including graduate education)" according to well-established categories of educational attainment [14,15]. Marital status was classified as "married" or "not married" (including separated, divorced, widowed, and never married). Occupation was assessed using a previously studied model that is based on the United Kingdom's National Statistics Socio-Economic Classification [16,17]. This measure has been validated with respect to smoking and other cardiovascular risk factors and may better capture disparities in health outcomes across occupational gradients compared to conventional U.S.-based classifications.[16] For analysis, we used the National Statistics Socio-Economic Classification's collapsed, three-category scheme intended as an ordinal variable [18]. We shortened the "routine and manual" category name to "blue collar"; "intermediate" to "service"; and "higher managerial, administrative, and professional" to "white collar" [18]. Subjects who reported their occupation as homemaker or were listed by vital records as "homemakers" were included in analyses as a separate fourth occupational category.

Outcome measures

The primary outcome was survival to hospital discharge. Secondary outcomes included survival to hospital admission and discharge destination. Discharge destination was classified according to whether the patient was discharged home versus an alternate destination (e.g., nursing home, rehabilitation center, or adult family home).

Data analysis

Bivariate analyses were conducted using χ^2 tests of frequency distributions for categorical variables and ANOVA and Kruskal—Wallis tests for continuous variables. The association between SES indicators and outcomes were initially evaluated using χ^2 tests and Cochran-Armitage trend tests. In the tests for trend, SES variables were modeled as ordinal variables with each progressive education or occupation group constituting a one-unit difference. We fit multivariable logistic regression models adjusting for demographic factors, characteristics of the OHCA event, and EMS care factors known to predict survival [2]. Models included age, sex, race, marital status, location, witnessed status, bystander CPR, EMS response interval from call to scene, and arrest etiology (cardiac vs. other). In further analyses, models also adjusted for the alternate SES characteristic (education or occupation). Because the "homemaker" category included only female subjects, the regression analyses evaluating occupation as a predictor of outcomes were stratified by sex.

We also evaluated sex as a potential effect modifier of relationships between education and outcomes by determining whether the addition of an interaction term between sex and education significantly improved the fit of the model. We used comparable methods to evaluate whether occupation was an effect modifier of relationships between education and the primary outcome. To evaluate the validity of the discharge destination outcome, we conducted sensitivity analyses using discharged alive with functional neurologic status as an alternative outcome on a subset of study participants for whom a Cerebral Performance Category score was available (all participants from 2001 forward) [19]. Missingness in the SES data was addressed using inverse probability weighting, a useful approach when the "missingness" does not occur completely at random [20]. Accordingly, we fit a model to predict the probability of a subject having complete data. Subjects were then weighted by the inverse of their probability of having complete data, effectively giving more weight to subjects with complete data that had characteristics similar to those with missing SES data. All regression analyses were initially conducted using the unweighted data and then re-run using the weighted data and robust standard errors. Models were assessed for goodness-of-fit using the Hosmer—Lemeshow test; goodness-of-fit was defined as $P > .05$. All statistical analyses were conducted with STATA version 11.2 (StataCorp LP, College Station, TX), and statistical significance was defined as $P \leq .05$.

Results

During the study period, 1544 adults were presented with nontraumatic, shockable OHCA. Of these, 1390 (90%) had complete information and compose the primary analytic cohort (Fig. 1). Of the 154 eligible patients with missing SES information, 14 were decedents and 140 were survivors. Compared to survivors in the primary analytic cohort, eligible survivors without SES information were significantly younger (53.6 ± 13.2 vs. 63.9 ± 13.8, $P < .001$) and were more frequently discharged home (82.9% vs. 70%, $P = .002$) but did not vary significantly according to circumstantial factors or EMS care.