Socioeconomic Status and Prediction of Ventricular Fibrillation Survival

Alfred Hallstrom, PhD, Paul Boutin, MS, Leonard Cobb, MD, and Elise Johnson

ABSTRACT

Objectives. The association between socioeconomic status and cardiac arrest is less well known than some other associations with cardiac arrest. We used property tax assessments as a measure of socioeconomic status in a study of victims of out-of-hospital cardiac arrest found in ventricular fibrillation.

Methods. We studied patients attended by the Seattle Fire Department's emergency medical services system between May 1986 and August 1988. During the period studied, 356 episodes met the study criteria; 114 (32%) of these patients survived without major neurologic deficit. Residential property tax assessments were available for 253 of the patients.

Results. After adjustments were made for age, witnessed collapse, bystander-initiated cardiopulmonary resuscitation, time from call to paramedic arrival, activity, location of collapse, and chronic morbidity, an association of survival with greater assessed value per living unit was observed. An increase of $50 000 in value per unit was associated with a 1.6-fold increase in survival rate.

Conclusions. Not only are persons in the lower socioeconomic strata at greater risk for cardiac mortality, but they are also less likely to survive an episode of out-of-hospital cardiac arrest. (*Am J Public Health.* 1993;83:245–248)

Introduction

Unexpected cardiac arrest in industrialized nations is associated primarily with coronary atherosclerosis and often with depressed ventricular function.[1,2] However, socioeconomic status,[3,4,5] ethnicity,[6] and certain genetic factors[7] are also associated with unexpected cardiac arrest. Factors that are predictive of survival from unexpected cardiac arrest include the time from collapse to arrival of emergency medical services personnel, whether the collapse was witnessed, whether a bystander initiated cardiopulmonary resuscitation, location of the episode, and age and activity of the patient just prior to collapse.[8–12] In an analysis of resuscitation in Seattle, M. Cowie (personal communication, 1990) observed that initial resuscitation rates were significantly lower for Blacks than for Whites. This difference, if real, might be explained by race (e.g., a genetic factor), cultural influences, or socioeconomic factors. To attempt to elucidate this relationship, census tract data were used to provide indirect information about socioeconomic status; however, that analysis was inconclusive, possibly because a census tract represents grouped data and does not necessarily reflect the socioeconomic characteristics of a specific individual.

While conducting a study of cases in which prearrival cardiopulmonary resuscitation instruction was provided by emergency dispatchers, we collected clinical histories and detailed information surrounding the occurrence of cardiac arrest for most out-of-hospital cardiac arrests attended by the Seattle Fire Department's emergency medical service personnel between May 1986 and August 1988. Exclusions were primarily for episodes not due to underlying heart disease (e.g., trauma or drug overdoses) or for situations in which the caller would not be able to provide cardiopulmonary resuscitation (e.g., relayed calls or instances in which the victim was inaccessible). Race and home address were obtained from the prehospital treatment records (i.e., paramedic field reports). Patients were followed until they were discharged from the hospital and their status at discharge was recorded. To examine the possible role of socioeconomic status in survival after unexpected cardiac arrest, we used residential property tax assessment data, which are a matter of public record and may be freely accessed through the use of tax assessment numbers, addresses, or names. Thus we evaluated the relationship between survival, race, and a measure of socioeconomic status, adjusting for other factors known to be associated with survival after out-of-hospital cardiac arrest.

Methods

Data sources included the fire department's medical incident reports, transcripts of the emergency telephone calls, and interviews with the individuals who made those calls. Patient outcome was determined by a long-standing follow-up program[13] and the favorable outcome was categorized as "discharged from the hospital

Alfred Hallstrom and Paul Boutin are with the Department of Biostatistics, and Leonard Cobb and Elise Johnson are with the Department of Medicine, all at the University of Washington and Harborview Medical Center, Seattle.

Requests for reprints should be sent to Alfred Hallstrom, PhD, University of Washington, CAST Coordinating Center, 1107 NE 45th St, Room 505, Seattle, WA 98105.

This paper was submitted to the Journal September 10, 1991, and accepted with revisions August 24, 1992.

TABLE 1—Descriptive Statistics, Victims of Out-of-Hospital Ventricular Fibrillation

	Mean or Percentage	SD	Minimum	Maximum	Valid Cases
Age	65.9 y	12.8	1 y[a]	92 y	356
Time to first unit's arrival	4.9 min	1.8	.8min	14.4 min	335
Time to first defibrillator unit's arrival	5.3 min	2.0	.8min	14.4 min	330
Assessed value per unit	$81 600	63 100	$11 100	$738 100	253
CPR attempted by bystander	53%				326
Male	79%				355
White	90%				327
Event witnessed	85%				313
Activity before collapse					323
None	51%				
Low	30%				
Moderate or higher	19%				
Location of collapse					332
In home	64%				
Outside home	5%				
Away from residence	31%				
Chronic comorbidity index	.38	.21	0	1.00	310

Note. CPR = cardiopulmonary resuscitation.
[a]There were three children in the cohort (ages 1, 1, and 7 years).

without obvious neurological deficit." Finally, the home addresses of the patients as listed on the incident reports were used to obtain property tax assessment data from the King County assessor's office. We excluded from consideration patients who resided outside King County.

Variables obtained from the incident reports and transcripts included time from the call to arrival of the first fire department unit, time from the call to arrival of advanced cardiac life support, gender, age, and race. Activity level of the patient at the time of collapse was obtained from one or more of the three data sources and a three-point scale was constructed: no activity (sleeping, lying down, sitting, watching television); low activity (standing, walking, socializing, eating, drinking, driving); and moderate or greater activity (chores, exercise, climbing stairs, dancing, coitus). A chronic comorbidity measure was constructed for each patient representing the proportion of positive histories of myocardial infarction, heart surgery, hypertension, chest pain, heart failure, angina, chronic pulmonary disease, diabetes, gastrointestinal problems, cancer, or other medical problems. Additional variables included whether cardiopulmonary resuscitation was attempted by a bystander, the location of the collapse (coded as in the home, outdoors but at home, or away from home), and whether or not the incident was witnessed. The tax assessment data include land value, improvement value, type of structure (single-family, multiple-family, condominium, apartment, commercial), and number of units. In this analysis we chose the constructed variable "value per unit" (land value + improvement value/number of units) as the measure of socioeconomic status. Because individual socioeconomic data were not available, the validity of the measure was analyzed by comparing the average value per unit for each census tract with 1980 census tract data. The tax valuation data showed significant (at the $\alpha = .001$ level) correlations with proportion of property owners ($r = .42$), median rental costs ($r = .51$), and median incomes for households ($r = .61$) and families ($r = .70$).[14] The tax valuation data proved to be a reasonable measure of socioeconomic status, inasmuch as these data are correlated with a number of variables previously used as measures of socioeconomic status.

Univariate comparisons are based on the score (Z) test. After normalization of response times by log transformations, the relationship between survival (discharge without obvious neurologic deficit), race, and socioeconomic status (as estimated by value per unit at the home address) were investigated by use of logistic regression, adjusting for other previously determined predictors.[15] Since the cardiac arrest survival rate for conditions other than ventricular fibrillation is extremely low (4% to 5% for electromechanical dissociation and 1% to 2% for asystole), this analysis was restricted to patients whose first recorded rhythm by the paramedics was ventricular fibrillation.

Results

During this period there were 356 patients who were experiencing ventricular fibrillation when first monitored by the paramedics and who met the other study criteria. (See Table 1 for descriptive statistics.) The average age was 66 years, 79% of the patients were male, and 86% were White. In 85% of the episodes the collapse was witnessed and in 53% a bystander had attempted cardiopulmonary resuscitation. The first responding unit arrived an average of 4.9 minutes after the call for help was received by the fire department, and a defibrillator-equipped unit (usually the first arriving unit) was on the scene an average of 5.3 minutes after the call for help. Most episodes (64%) occurred at home and half (51%) were not associated with any physical activity. On average 4 to 5 of the 11 histories were positive.

Property tax assessment data were not obtained for 87 patients because of incorrect or missing addresses and for 12 others who did not reside in King County. There were no apparent differences in demographics and other covariates between patients with and without valid addresses. In addition, four patients who lived in condominiums were excluded because we had previously observed in census tract data that the association between median family income and median value per condominium unit did not hold.[14] Thus, value-per-unit comparisons are based on 253 patients who experienced out-of-hospital cardiac arrest due to ventricular fibrillation. The mean value per unit was $81 600.

As anticipated, variables previously reported to be predictive of survival were found to be significantly different between survivors and nonsurvivors (Table 2). In the multivariate setting, gender was not significantly associated with survival ($P = .87$). Because activity was strongly correlated with location, the activity variable was eliminated from the analysis, resulting in 183 cases (54 survivors) with known data for all remaining variables.

After adjustments were made for the remaining variables known to be predictive, socioeconomic status was significantly correlated with outcome ($P = .02$), but race was not. Relative risks and confidence intervals for variables that were significant in the final analysis are shown in Table 3. For example, witnessed episodes of cardiac arrest resulted in survival five times as often as unwitnessed episodes. A decrease of 10 years of age was associated with a 50% increase in the

probability of survival, and a decrement of two comorbidities increased the probability of survival by approximately 40%. The chance of survival was significantly greater when cardiac arrest occurred outside or away from home than when the episode took place in the home (1.6 and 2.4 times, respectively). A 60-second reduction in response time increased the likelihood of survival by 20%. Finally, an increase of $50 000 in the valuation per unit of the home address increased the patient's chance of survival by 60%.

Discussion

One of the principal variables studied in this paper was obtained in a novel manner[14]: we used patients' addresses to obtain a measure of socioeconomic status through the use of tax assessment rolls, which are considered public information. Although that approach is not the focus of this paper, a few comments are appropriate. The method required substantial effort to implement in the current King County assessment office environment. Public access is provided through on-line terminals and the data must be entered and the results recorded by hand. For large numbers of cases this could be accomplished by a simple computer program that would enter the addresses from a computer file and allow the search to run in a batch process. Although in principle this approach is entirely feasible, it would require cooperation from the tax assessment office. Depending on the source of the addresses, misspellings of street names can be common. Thorough familiarity with the city street map can resolve many but certainly not all of these problems. Certain types of outliers may exist that can distort the usefulness of the data if not properly accounted for. For example, a very expensive property may be being used almost as a slum dwelling while the owner awaits demolition permits. Despite these difficulties, the technique provided us with individualized socioeconomic information that was highly correlated with census tract data but was more informative in that it provided relationships that were not observable with census tract data.

Whether the opportunity to use this methodology will arise naturally in many situations is unclear. However, since we undertook this effort, at least one group of investigators has expressed an interest in the method. Those investigators are using a computerized mailing list to target households with residents aged 50 or older. These households are being sent a variety of materials whose purpose is to educate people to reduce the time from onset of chest pain to access of the emergency system. Because it is likely that the success of the materials may be dependent on the recipients' socioeconomic status, a simple and inexpensive measure of socioeconomic status would be useful for the investigators' analysis efforts.

TABLE 2—Relationship of Survival and Covariate Levels

	n	% Surviving	Univariate *P*
Age, y			0.01
<60	81	40.7	
60–69	127	30.7	
70–79	113	31.9	
80+	35	17.1	
Time to first unit's arrival, min			0.05
≤3	23	47.8	
3–4	77	39.0	
4–5	97	29.9	
5–6	67	26.9	
>6	71	28.2	
Time to defibrillator unit's arrival, min			0.007
<3	20	45.0	
3–4	67	38.8	
4–5	83	33.7	
5–6	64	32.8	
>6	96	22.9	
Assessed value per unit, $ in thousands			0.01
≤50	60	28.3	
50–75	89	25.8	
75–100	49	30.6	
>100	55	38.2	
CPR attempted by bystander			0.18
Yes	173	36.4	
No	153	29.4	
Gender			0.42
Male	279	33.3	
Female	76	27.6	
Race			0.16
White	294	33.7	
Other	49	22.4	
Event witnessed			0.0005
Yes	265	37.4	
No	48	10.4	
Activity at collapse			0.22
None	165	28.5	
Low	96	38.5	
Moderate or higher	62	35.5	
Location of collapse			0.03
In home	214	28.5	
Outside home	15	33.3	
Away from home	103	43.7	
Chronic comorbidity index			0.008
≤.25	101	41.6	
.25–.35	45	35.6	
.35–.45	53	35.8	
.45–.55	47	27.7	
>.55	64	20.3	

Note. CPR = cardiopulmonary resuscitation.

Socioeconomic status, occupational stress, and social support have been reported to be associated with the incidence of coronary heart disease and with survival after recovery from an index event such as myocardial infarction.[16] However, to our knowledge an association of these factors with survival after an acute potentially fatal event has not been reported. Factors associated with survival (through hospital dis-

TABLE 3—Results of Multivariate Logistic Analysis for 183 Patients with Complete Data

Variable	Relative Benefit	95% CI	P
Event witnessed	5.0	1.4, 18	0.014
Age (10-y decrement)[a]	1.5	1.1, 2.1	0.018
Chronic comorbidity index (two-history decrement)	1.4	1.0, 1.8	0.037
Location			0.015
At home, outdoors (vs in home)	1.6	1.1, 2.4	
Away from residence (vs in home)	2.4	1.1, 5.7	
Time to arrival of first defibrillation unit (1-min decrement)	1.2	1.1, 1.5	0.016
Assessed value per unit ($50 000 increment)	1.6	1.1, 2.4	0.020

[a]The youngest patient included in the logistic analysis was 30 years old.

charge) from cardiac arrest include younger age, less antecedent morbidity, greater activity prior to the collapse, witnessing of the event, and bystander-initiated cardiopulmonary resuscitation.[8–12] The latter two factors have an obvious explanation: they are likely to result in earlier treatment. On the other hand, the first three factors might be considered to be indicators of a relatively good state of health and hence associated with a better outcome. Because measures associated with economic status might also be correlated with age, morbidity, activity prior to collapse, witnessing, and bystander-initiated cardiopulmonary resuscitation, it is not surprising that socioeconomic status was univariately correlated with survival after cardiac arrest. However, given that a collapse has occurred, there is no obvious explanation of why socioeconomic status should be associated with survival after adjustments are made for known risk factors. It is possible that higher socioeconomic status might be associated with a number of factors that promote a healthier state, including less smoking and alcohol consumption and more access to health care. However, one might have expected these factors to have been accounted for, either by the fact that an event has occurred or through the covariate adjustment we performed. Many of the variables involved in our analysis have substantial measurement error. However, there is no obvious reason why such measurement errors should incorporate a bias component that would induce a spurious relationship with survival. Thus, a more accurate assessment of these variables' values would probably lead to similar but more significant associations. Although this study was based on a specific a priori hypothesis, that an observed association of race with survival might be a consequence of an association of socioeconomic status with survival, it is possible that our findings are due to chance, and we would encourage an investigator who has a suitable data set to conduct the appropriate confirmatory investigations. If our findings are confirmed, researchers evaluating the effect of interventions on survival in this setting should adjust for socioeconomic status to increase the power of their experiment. □

Acknowledgment

This study was supported in part by grants from the National Center for Health Services Research and the Medic One Emergency Services Foundation.

We thank Kathy Long for her valuable assistance in the preparation of this manuscript.

References

1. Moss AJ and the Multicenter Postinfarction Research Group. Risk stratification and survival after myocardial infarction: the Multicenter Postinfarction Research Group. *N Engl J Med.* 1983;309:331–336.
2. Eisenberg MS, Bergner L, Hallstrom A. Epidemiology of cardiac arrest and resuscitation in a suburban community. *J Am Coll Emerg Physicians.* 1979;8:2–5.
3. Marmot MG, Rose G, Shipley M, Hamilton PJS. Employment grade and coronary heart disease in British civil servants. *J Epidemiol Community Health.* 1978;32:244.
4. Koskenvuo, Kaprio J, Kesaniemi A, Sarna S. Differences in mortality from ischemic heart disease by marital status and social class. *J Chronic Dis.* 1980;33:95.
5. Ruberman W, Weinblatt E, Goldberg JD, Chaudhary BS. Psychosocial influences on mortality after myocardial infarction. *N Engl J Med.* 1984;311:552–559.
6. Otto CM, Tauxe RV, Cobb LA, et al. Ventricular fibrillation causes sudden death in South East Asian immigrants. *Ann Intern Med.* 1984;101:45–47.
7. Moss AM, Schwartz PJ, Crampton RS, et al. The long QT syndrome: a prospective, international study. *Circulation.* 1985;71:17.
8. Hallstrom A, Cobb LA, Swain M, Mensinger K. Predictors of hospital mortality after out-of-hospital cardiopulmonary resuscitation. *Critical Care Med.* 1985;13:927–929.
9. Litwin PE, Eisenberg MS, Hallstrom AP, Cummings RO. The location of collapse and its effect on survival from cardiac arrest. *Ann Emerg Med.* 1987;16:787–791.
10. Eisenberg MS, Bergner L, Hallstrom A. Paramedic programs and out-of-hospital cardiac arrest: I. Factors associated with successful resuscitation. *Am J Public Health.* 1979;69:30–38.
11. Thompson RG, Hallstrom A, Cobb LA. Bystander-initiated cardiopulmonary resuscitation in the management of ventricular fibrillation. *Ann Intern Med.* 1979;90:737–740.
12. Weaver WD, Cobb LA, Dennis D, Roy R, Hallstrom AP, Copass MK. Amplitude of ventricular fibrillation waveform and outcome after cardiac arrest. *Ann Intern Med.* 1985;13:927–929.
13. Cobb LA, Baum RS, Alvarez HA, Shaffer WA. Resuscitation from out-of-hospital ventricular fibrillation: four years follow-up. *Circulation.* 1975;51,52(suppl III):223–228.
14. Boutin P. *Tax assessment data as a measure of socioeconomic status: An analysis of survival following out-of-hospital cardiac arrest.* Seattle, Wash: University of Washington; 1990. Thesis.
15. Egret. Seattle, Wash: Statistics and Epidemiology Corporation; 1985–1991.
16. Task Force I. Environmental risk factors in coronary artery disease. *Circulation.* 1987;76(suppl I):139–144.