Health-Related Quality of Life Is Better for Cardiac Arrest Survivors Who Received Citizen Cardiopulmonary Resuscitation

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Background—This study evaluated the prehospital factors associated with better health-related quality of life for survivors of out-of-hospital cardiac arrest.

Methods and Results—This prospective, 20-community, cohort study involved consecutive, adult out-of-hospital cardiac arrest patients who survived to 1 year. Patients were contacted by telephone and evaluated for the Health Utilities Index Mark III (HUI3), which describes health as a utility score on a scale from 0 (dead) to 1.0 (perfect health). The 8091 cardiac arrest patients had overall survival rates of 5.2% to hospital discharge and 4.0% to 1 year. We successfully contacted and evaluated 268 of 316 (84.8%) of known 1-year survivors. The median HUI3 score was 0.80 (interquartile range, 0.50 to 0.97), which compares well with age-adjusted values for the general population (0.83). Logistic regression identified 2 factors independently associated with very good quality of life (HUI3 ≥0.90) and their odds ratios (95% CIs), as follows: age 80 years or older, 0.3 (0.1 to 0.84), and citizen-initiated cardiopulmonary resuscitation (CPR), 2.0 (1.2 to 3.4) (Hosmer-Lemeshow goodness-of-fit statistic, 0.74).

Conclusions—This study is the largest ever conducted for out-of-hospital cardiac arrest survivors, clearly shows that these patients have good quality of life, and is the first to demonstrate that citizen-initiated CPR is strongly and independently associated with better quality of life. These results emphasize the importance of optimizing community citizen CPR readiness. Given the low rate of citizen-initiated CPR in many communities, we believe that local and national initiatives should vigorously promote the practice of bystander CPR. (Circulation. 2003;108:1939-1944.)

Key Words: heart arrest survival cardiopulmonary resuscitation

Out-of-hospital cardiac arrest is a very common problem, with >300 000 cases occurring each year in the United States. Overall, survival to hospital discharge remains poor, with survival rates for all rhythms combined ranging from 1% to 20%. Variation in survival rates among communities can be attributed to differences in the chain of survival concept, as described by the American Heart Association. It is generally believed that the best survival can only be achieved if all 4 of the following links have been optimized: (1) rapid access, (2) early cardiopulmonary resuscitation, (3) early defibrillation, and (4) early advanced cardiac life support. The relative importance or effectiveness of each of the 4 links has not been clearly demonstrated. To address this issue, we have been conducting the Ontario Prehospital Advanced Life Support Study (OPALS), which is the largest prehospital study yet conducted. This multicenter and multiphase study evaluates the impact of rapid defibrillation and advanced life support (ALS) programs on survival and morbidity in 10 000 cardiac arrest, 6000 major trauma, 8000 respiratory distress, and 13 000 chest pain patients over an 8-year period.

We have previously shown that out-of-hospital cardiac arrest survival is significantly improved by 3 modifiable factors, namely citizen cardiopulmonary resuscitation (CPR), fire and police CPR, and response with an automated defibrillator in 8 minutes or less. Nevertheless, many have adopted a fatalistic view regarding the outcomes of these patients with out-of-hospital cardiac arrest. There is a widely perceived impression that the quality of life and functional status of the survivors is poor. Consequently, there are concerns that aggressive community-wide approaches to improving the chain of survival may be futile.

Health-related quality of life refers to the physical, psychological, and social domains of health and is influenced by a person’s experiences, beliefs, expectations, and percep-
Several investigators have recently evaluated the outcomes or quality of life of survivors of out-of-hospital cardiac arrest. We have previously found that most patients who survive to hospital discharge have quite good quality of life and functional status. Little is known, however, about the factors that may correlate with or lead to better functional status for these cardiac arrest survivors. The current study was designed to evaluate theprehospital factors associated with better health-related quality of life for survivors of out-of-hospital cardiac arrest.

Methods

Design
We have previously described the methodology for the cardiac arrest portion of the OPALS study. The OPALS study incorporates a 3-phase before and after controlled clinical trial design. The quality-of-life substudy described in this paper represents a prospective cohort study involving all out-of-hospital adult cardiac arrest patients enrolled in phases II (basic life support with defibrillation [BLS-D]) and III (ALS) of the OPALS study.

Setting
The OPALS study is being conducted in 20 Ontario urban or suburban communities, which range in population from 16 000 to 750 000 (total, 2.7 million). In phase II, all communities responded to medical emergencies with a 2-tier BLS-D emergency medical service system, with first-responding AED-equipped fire fighters followed by BLS ambulance providers. In phase III, all sites functioned at the ALS level with ALS paramedics trained to perform endotracheal intubation, intravenous therapy, and administration of intravenous drugs. Emergency responders were required to arrive at the scene with a defibrillator within 8 minutes for 90% of cases. All ambulance dispatch information was obtained from a central computerized information system, and all patient encounters were documented with a common ambulance call report.

Population
The study population for the OPALS study includes all patients with out-of-hospital cardiac arrest for whom resuscitation was attempted. Excluded are patients who were younger than 16 years of age, who had trauma, or whose arrests were clearly of noncardiac etiology. Case definitions followed the Utstein style guidelines for reporting cardiac arrest data.

For the present quality-of-life study, we enrolled patients if they survived to at least 1 year after hospital discharge. The OPALS study had full Research Ethics Board approval, and participants in this quality-of-life study gave informed consent.

Outcome Measures
Eligible subjects were contacted by a registered nurse by telephone 12 months after hospital discharge to obtain verbal consent. The spouse or caregiver was interviewed if the patient was unable to complete the interview. The primary outcome measure was health-related quality of life, which was measured using the Health Utilities Index Mark III System (HUI3). This interview instrument takes approximately 10 minutes to complete. The HUI3 consists of 8 attributes of health (vision, hearing, speech, mobility, dexterity, emotion, cognition, and pain) with 5 or 6 levels per attribute (Table 1). For each attribute, no or mild impairment in health has been defined as better than level 3 function (or level 4 function in the cognitive attributes). For each respondent, health status is described as a vector that combines the levels of each attribute. Any missing data were imputed using the Group Mode method at the attribute level with SOLAS 3.0 software. The health status information is then converted into a utility score of health-related quality of life on a scale from perfect health (1.0) to death (0). This utility score is calculated using an algorithm that is adapted from an earlier version of the index. This scoring method was derived from measurement of utilities using the standard gamble in a large sample of the public. The HUI3 was previously shown to be both reliable and valid in other populations. A difference of 0.1 on the scale is considered clinically meaningful, although some authors believe that differences in the overall score of as little as 0.03 may be important.

We compared the median HUI3 score of the study population to the median score of age- and sex-matched samples from the 1996 to 1997 National Population Health Survey of Canada.

The secondary outcome was the Cerebral Performance Category Scale, a simple 5-point measurement of cerebral and functional status. Class 1 indicates good performance and class 5 indicates brain death.

Data Analysis
We compared the characteristics of patients with very good utility scores defined as ≥0.90 with those patients with HUI3 scores of <0.90 with the Student t test or the χ² test as appropriate. We arbitrarily chose 0.90 as the cut point, because we sought to identify correlates of very good quality of life rather than just average quality of life. Forward stepwise logistic regression analyses were conducted to identify factors independently associated with the primary outcome measure, very good HUI3 score. We evaluated the following potential factors: gender, age >80 years, location residential, witnessed by bystander, witnessed by emergency medical service, bystander CPR, first-responder CPR, response with defibrillator <8 minutes, initial rhythm VF/VT or pulseless electrical activity (PEA), defibrillated, and patient able to answer HUI3 interview without a proxy. We estimated odds ratios with 95% CI, and the Hosmer-Lemeshow goodness-of-fit statistic was calculated for the resultant model.

Results
For the period 1995 to 2000, 8091 eligible cardiac arrest patients of all rhythms were treated within the study communities. Of these, 418 (5.2%) patients were discharged from hospital alive and 324 (4.0%) were known to be alive at 1

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year and were considered for HUI3 interviews. Of these, 268 patients could be evaluated and had complete outcome measures (Figure 1).

Table 2 compares the clinical and demographic characteristics of the 268 study cases with those of the non-HUI3 cases and of all patients treated. Of the 1-year survivors, 86% were in the best Cerebral Performance Category Scale class, and there were no cases of class 4 vegetative state or class 5 brain death (Figure 2). The median HUI3 score was 0.80, with an interquartile range of 0.50 to 0.97. Most cases had a score exceeding 0.80, although a few had values <0, representing a state “worse than death” (Figure 3A). Figure 3B shows that the cardiac arrest survivors had a HUI3 score comparable to that (0.83) of age- and sex-matched samples from the general population.

Table 3 compares the characteristics of the 159 patients with HUI3 scores >0.90 with the 109 patients with very good scores, >0.90. Patients with very good HUI3 scores were more likely to be slightly younger (63 versus 65 years) and male (86% versus 79%), to have had bystander CPR (42% versus 28%), and to be well enough to respond to the HUI3 interview themselves.

Stepwise logistic regression analysis demonstrated the odds ratios for those factors independently associated with very good quality of life: 2.0 (95% CI, 1.2 to 3.4) for patients who had undergone citizen CPR and 0.3 (95% CI, 0.1 to 0.8) for patients who were aged 80 years or older (Table 4). The Hosmer-Lemeshow goodness-of-fit statistic for the analysis was 0.74 for 1 degree of freedom. We repeated the analysis using a HUI3 cut point of 0.83 and found essentially the same results.

Discussion

With 8091 patients and 268 1-year survivors, this represents the largest study to formally evaluate the quality of life of out-of-hospital cardiac arrest survivors. We were pleased with the health-related quality of life of those patients alive at 1 year. Most of these patients were in the best Cerebral Performance Category Scale class, and the median HUI3 score was 0.80, which is an excellent result. This score compared quite favorably with that of age- and sex-matched members of the general population. Univariate and multivariate analysis revealed that patients who were aged 80 or older had the poorest quality of life. The single modifiable factor associated with very good quality of life was citizen-initiated CPR. This association between bystander CPR and very good functional outcome in cardiac arrest has not been previously identified. We believe this result strongly reinforces the importance of community CPR promotion programs.

We previously evaluated the quality of life of both in-hospital and out-of-hospital victims of cardiac arrest and provided a simple descriptive evaluation of 86 1-year survivors.15 We found lower overall quality of life with a mean HUI3 score of 0.72, but we primarily evaluated in-hospital cases. Our present study focuses on out-of-hospital patients, is much larger, and uses a more complex, multivariate approach to identifying the independent predictors of good outcome. Previous studies of cardiac arrest quality of life were relatively small and did not attempt to identify the predictors of very good quality of life.11–13 These other studies used a variety of instruments, including the Sickness Impact Profile, the Medical Outcome Short Form 36, and the Functional Status Index.27 Our study is the first to use the HUI3 for an exclusively out-of-hospital cardiac arrest population. A study by Cobbe et al14 demonstrated good neurological status at discharge but did not evaluate quality of life of survivors.

We believe that the HUI3 is an excellent tool to evaluate health-related quality of life. It has previously been shown to be reliable and valid in describing a patient’s health status and health preference.17,22 This instrument is generic and multidimensional, and this allows one to calculate a single summary score reflecting overall health-related quality of life. The responses to this brief questionnaire can be used to calculate a utilities score, which in turn can be incorporated into formal economic evaluations and analyses.28 The Short Form 36 is perhaps better known but does not yield a single summary utilities score and has not been validated as a measure of patient preference. The HUI3 allows one to compare the scores of the study population with other population groups. We believe that the HUI3 has face validity for cardiac arrest survivors because the attributes measured are those that may be affected by patients with neurological or functional impairment.
Our study has several potential limitations. First, it has been suggested that the HUI3 results may differ somewhat from those obtained by the traditional standard gamble, time trade-off, or rating scale. However, differences are to be expected among different approaches and no one method has proven to be superior. Second, the HUI3 may not identify small impairments in quality of life such as subtle changes in memory. Disease-specific measures of quality of life may be more responsive to some changes than a generic scale such as the HUI3. Nevertheless, we are not aware of a disease-specific scale for cardiac arrest.

Third, we made several arbitrary decisions in this study. We chose to evaluate patients at the 1-year mark, and this may have introduced slight selection bias by not including patients who died after discharge but before 1 year. In addition, we arbitrarily defined very good quality of life as that equal to or exceeding a HUI3 score of 0.90. Nevertheless, we believe that this is a pragmatic and reasonable cut point.
and represents a score that would indeed be considered excellent for age- and sex-matched members of the general population. Our goal was to evaluate correlates of very good quality of life, and, hence, we chose not to use the population median value of 0.83. Nevertheless, a secondary analysis using the value 0.83 led to the same results. Furthermore, we were identifying factors associated with very good outcomes and cannot necessarily conclude causation. Fourth, we acknowledge that some patients were lost to follow-up, and we cannot comment on the quality of life of these patients. In addition, we conducted proxy interviews for patients who were too disabled to give their own responses. We believe, however, that this is a strength of the study in that we did not selectively exclude patients who had obviously poor functional status. Finally, this study did not evaluate the impact of ALS interventions on the quality of life of cardiac arrest survivors.

What are the implications of our study for community public health and emergency medical services programs? First, we have identified that patients who survive cardiac arrest generally survive at a very high functional level. Patients who do survive seem to be very grateful and to enjoy a relatively unrestricted life. This should further put to rest the misperception that patients who survive out-of-hospital cardiac arrest are severely disabled.

Second, and more importantly, our findings clearly demonstrate the importance of citizen-initiated bystander CPR. We have previously demonstrated that citizen CPR is an important predictor of survival, with an adjusted odds ratio of 3.7. This study is the first to identify that bystander CPR improves the health-related quality of life of those survivors. We demonstrated that the odds ratio for very good quality of life is 2.0 for patients who receive citizen-initiated bystander CPR. We believe these findings have very important public health implications and that those responsible for community health planning should make citizen CPR training and promotion a major priority. Conversely, the recent emphasis of high-technology solutions for cardiac arrest, such as AEDs, has deflected attention away from bystander CPR, which is

| Table 3. Correlation of Characteristics with Very Good HUI3 Score |
|---------------------------------|--------|--------|--------|
|                                | <0.90 | ≥0.90 | P Value |
| Age, y (SD)                    | 65.4 (11.8) | 63.0 (11.3) | 0.12  |
| Age ≥80 y                      | 18 (11.3) | 4 (3.7) | <0.05 |
| Male gender                    | 125 (78.6) | 94 (68.2) | 0.11  |
| Location residence             | 82 (58.2) | 52 (53.6) | 0.48  |
| Bystander witnessed            | 94 (59.1) | 64 (58.7) | 0.95  |
| EMS witnessed                  | 41 (25.8) | 28 (25.7) | 0.99  |
| Bystander CPR                  | 44 (27.7) | 46 (42.2) | <0.05 |
| First-responder CPR            | 39 (24.5) | 17 (15.6) | 0.08  |
| Response ≤8 min*               | 114 (98.3) | 78 (97.5) | 0.71  |
| Initial rhythm                 | 140 (88.0) | 97 (89.0) | 0.81  |
| VF/VT                          | 5 (3.1) | 2 (1.8) | 0.51  |
| Asystole                       | 13 (8.2) | 10 (9.2) | 0.77  |
| PEA                            | 142 (89.3) | 96 (88.1) | 0.75  |
| Defibrillated                   | 138 (86.8) | 106 (98.2) | <0.01 |

Values in parentheses are percentages unless otherwise indicated. EMS indicates emergency medical service.

*Emergency medical service–witnessed cases excluded.

| Table 4. Results of Logistic Regression Analysis of Factors Contributing to Very Good Quality of Life |
|---------------------------------|--------|--------|--------|
|                                | Estimate | Odds Ratio | 95% CI       |
| Intercept                      | −0.53   | ...     | ...          |
| Age ≥80 y                      | −1.30   | 0.27    | 0.09–0.84    |
| Bystander CPR                  | 0.69    | 2.0     | 1.18–3.37    |

Hosmer-Lemeshow goodness of fit = 0.74.
more widely accessible and very inexpensive. The rate of cardiac arrest victims receiving bystander CPR has been documented to be as low as 14% in many North American communities.8 We also believe that our findings should encourage national agencies to additionally emphasize the very great importance of citizen-initiated bystander CPR.

In conclusion, this represents the largest study yet conducted of out-of-hospital cardiac arrest survivors and clearly demonstrates that most such survivors have good health-related quality of life and functional status. Our findings clearly identify citizen-initiated bystander CPR as a strong and independent predictor of very good functional outcomes for these survivors of cardiac arrest. Given the low rate of citizen-initiated CPR in many communities, we believe that local and national initiatives should vigorously promote the practice of bystander CPR.

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References
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