

# PREHOSPITAL CARDIAC ARREST IN A PARAMEDIC FIRST-RESPONDER SYSTEM USING THE UTSTEIN STYLE

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## ABSTRACT

**Objectives.** To describe the characteristics of patients found to have cardiac arrest and to evaluate the characteristics predictive of survival after cardiac arrest in a paramedic first-responder model. **Methods.** All patients who suffered out-of-hospital cardiac arrest in the city of Reading, Ohio, from January 1998 to December 2003 were recorded in the Utstein style. The number and incidence rate of witnessed arrests, initial rhythms, rate of bystander cardiopulmonary resuscitation (CPR), and 30-day mortality rate were retrospectively collected. Demographics, time to hospital, and response times were evaluated as predictors of survival. **Results.** Of those patients initially found to be in cardiac arrest, 14.3% were discharged alive. Witnessed arrests were more likely to result in live discharge of the patient. Whether bystander CPR was performed was not found to affect survival, nor was initial rhythm, although no patients initially found in asystole were discharged alive. No demographic characteristics or response times were predictive of survival. **Conclusion.** The rates of survival in this paramedic first-response system are favorable compared with basic emergency medical technician first-response systems. Further study using direct comparison methodology is warranted to confirm these findings. **Key words:** cardiac arrest; emergency medical services; out-of-hospital; paramedic; Utstein template.

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Following the development of the Utstein guidelines for reporting of data for out-of-hospital cardiac arrests<sup>1</sup> and the subsequent 2004 revisions of these guidelines,<sup>2</sup> there has been a plethora of studies from Scandinavian nations,<sup>3-12</sup> followed in suit by their European counterparts.<sup>13-18</sup> Japanese<sup>19-22</sup> and other Asian emergency medical services (EMS) systems<sup>23,24</sup> have also used this style to report their findings. The results vary based on how the data have been reported<sup>25</sup>; and comparison has been difficult between the different popu-

lations, in particular with regard to the initial presenting rhythm.<sup>26</sup> Within the United States, studies have looked at rates of survival in both urban and rural settings.<sup>27,28</sup> While one study has completed a combined analysis of rural and suburban systems over a two-year period,<sup>29</sup> ours is the first to consider a strictly suburban, paramedic first-responder EMS system. We report the characteristics of cardiac arrests and identify predictors of survival within this system.

## METHODS

### Design

This was an observational cohort study, approved by the institutional review board of our institution.

### Materials

Data were extracted from the EMS database maintained by Reading, Ohio. Data pertaining to all out-of-hospital cardiac arrests that were considered for resuscitation by this EMS system between January 1998 and December 2003 were included.

### Demographics

The city of Reading has 11,292 residents and performs approximately 1,200 runs per year. According to 2000 U.S. Census data, the city population is 93.69% white and 3.20% African American. The per-capita income for the city is \$23,527, with 7.3% of the population below the poverty line.

### EMS System

The first responder to an EMS call consists of two paramedics who travel in a vehicle equipped with advanced life support (ALS) equipment but no patient transport capabilities. After the paramedic (EMT-P) crew assess the patient, they determine whether transport to a hospital is required and, if so, by what level of care. If transport is deemed necessary, an ambulance, driven by two emergency medical technician-basic (EMT-B) care providers, is requested. Patient acuity is then used to determine the combination of EMS personnel (either EMT-B/EMT-B, EMT-P/EMT-P, or EMT-P/EMT-B) used to transport the patient.

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## Data Collection

Data were initially collected by EMS personnel on a standardized run sheet, then entered into an electronic database (Firehouse Software, Des Moines, IA) upon returning to base. All data were collected in accordance with the Utstein guidelines that were current at that time.<sup>1</sup> For the purposes of this study, the Social Security Administration Death Master File Online Service ([www.ssdmf.com](http://www.ssdmf.com)) was searched for 30-day mortality rates of survivors. Hospitals were contacted directly by the authors of this study to determine survival of patients after arrival to the hospital. This involved determining whether they died in the emergency department (ED), died in the intensive care unit (ICU), or were discharged alive.

## Analysis

Descriptive analysis used frequencies and percentages to report counts, and means and standard deviations (SDs) to report continuous data. Logistic regression with univariable analysis was used to determine the influence of demographic characteristics and EMS run characteristics on death.

## RESULTS

### Overall

In a population of 11,292, there were 87 (0.8%) out-of-hospital cardiac arrests considered for resuscitation over a five-year period (154/100,000 inhabitants/year). Figure 1 summarizes the results according to Utstein guidelines. Of the 87 cardiac arrests, 84 (96.6%) were of cardiac etiology. Arrests of cardiac etiology were witnessed by bystanders in 38 cases (45.2%). Cardiac rhythm was found to be ventricular fibrillation for 15

patients (17.9%), asystole for 15 (17.9%), and some other rhythm for 54 (64.2%). Other rhythms included pulseless electrical activity, bradyarrhythmias, and tachyarrhythmias (including ventricular tachycardia). The mean age of patients with arrests of cardiac etiology was 65.3 years (SD 17.4 years). Forty-four (52.4%) were male, and 75 (89.3%) were white.

## Survival

In our population, survival to disposition from the ED was 31% (26 of 84 patients were known to survive, 95% confidence interval [CI] 22%–41%). Survival to discharge was 14% ( $n = 12$ , 95% CI 8%–23%). Survival to 30 days was 7% ( $n = 6$ , 95% CI 3%–15%).

Figure 2 shows the witnessed events stratified by initial rhythm. Eleven patients (28.9%) had bystander cardiopulmonary resuscitation (CPR) performed. Six (54.5%) of those on whom CPR was performed had return of spontaneous circulation, compared with return of spontaneous circulation in 15 (55.6%) of those for whom CPR was not performed. No patient who did not have return of spontaneous circulation in the field survived beyond ED resuscitation efforts. Of the seven patients discharged from the hospital, two had an initial rhythm of ventricular fibrillation, while the remaining five had other initial rhythms. Both patients admitted to the ICU after an initial rhythm of ventricular fibrillation were discharged and alive at 30 days. Of those admitted to the ICU with other initial rhythms, three (21.4%) were alive at 30 days.

Figure 3 shows the unwitnessed events stratified by initial rhythm. Fourteen patients (30%) had bystander CPR performed. Three (21.4%) of those on whom CPR was performed had return of spontaneous circulation, compared with return of spontaneous circulation in six (18.8%) of those for whom CPR was not performed.

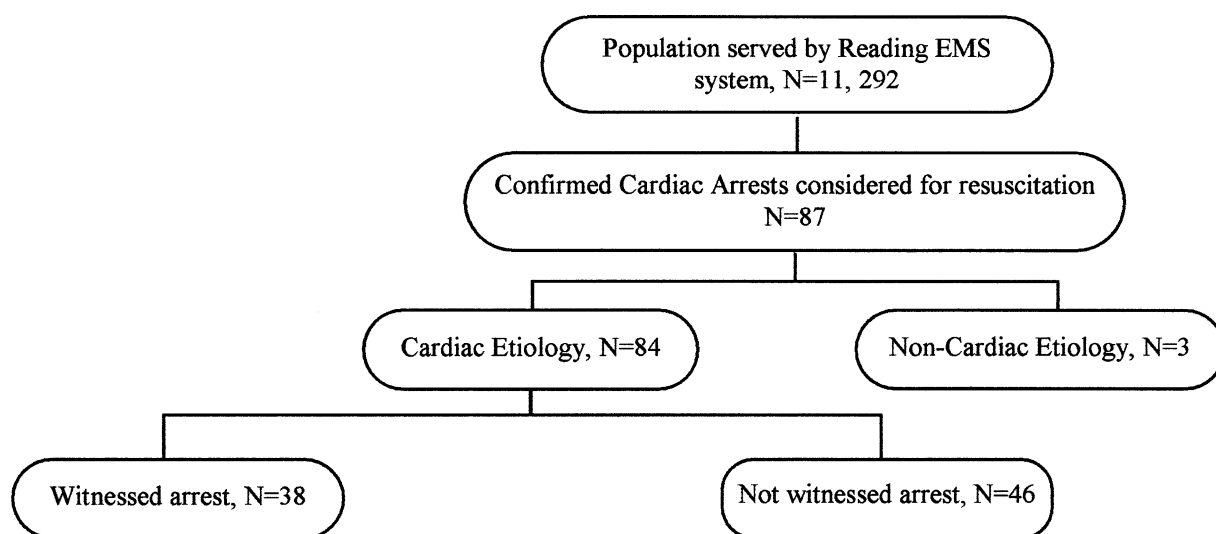


FIGURE 1. Distribution of witnessed and unwitnessed cardiac arrests. EMS = emergency medical services.

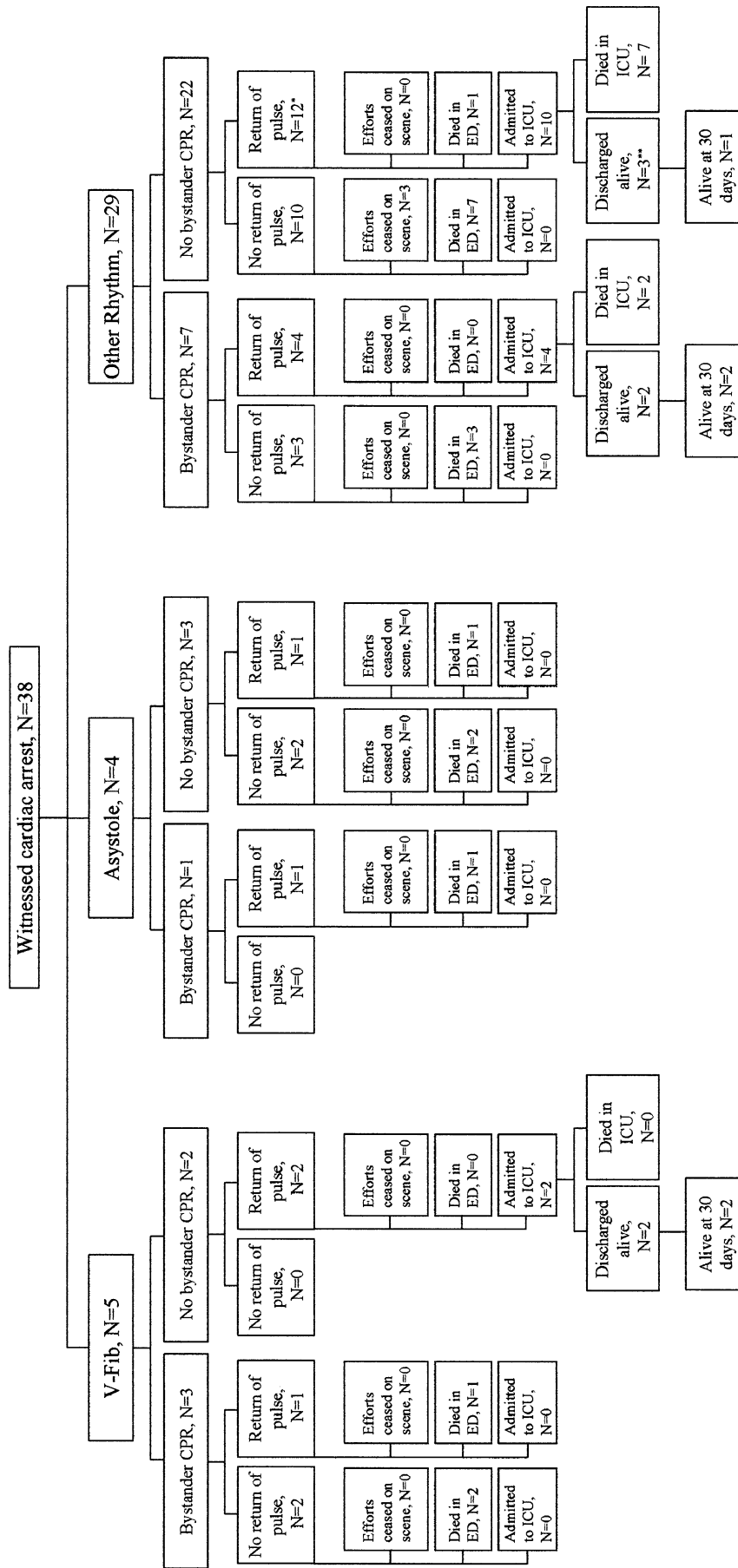


FIGURE 2. Outcomes for patients with a witnessed cardiac arrest. \*Indicates one patient lost to follow-up. V-Fib = ventricular fibrillation; CPR = cardiopulmonary resuscitation; Ed = emergency department; ICU = intensive care unit.

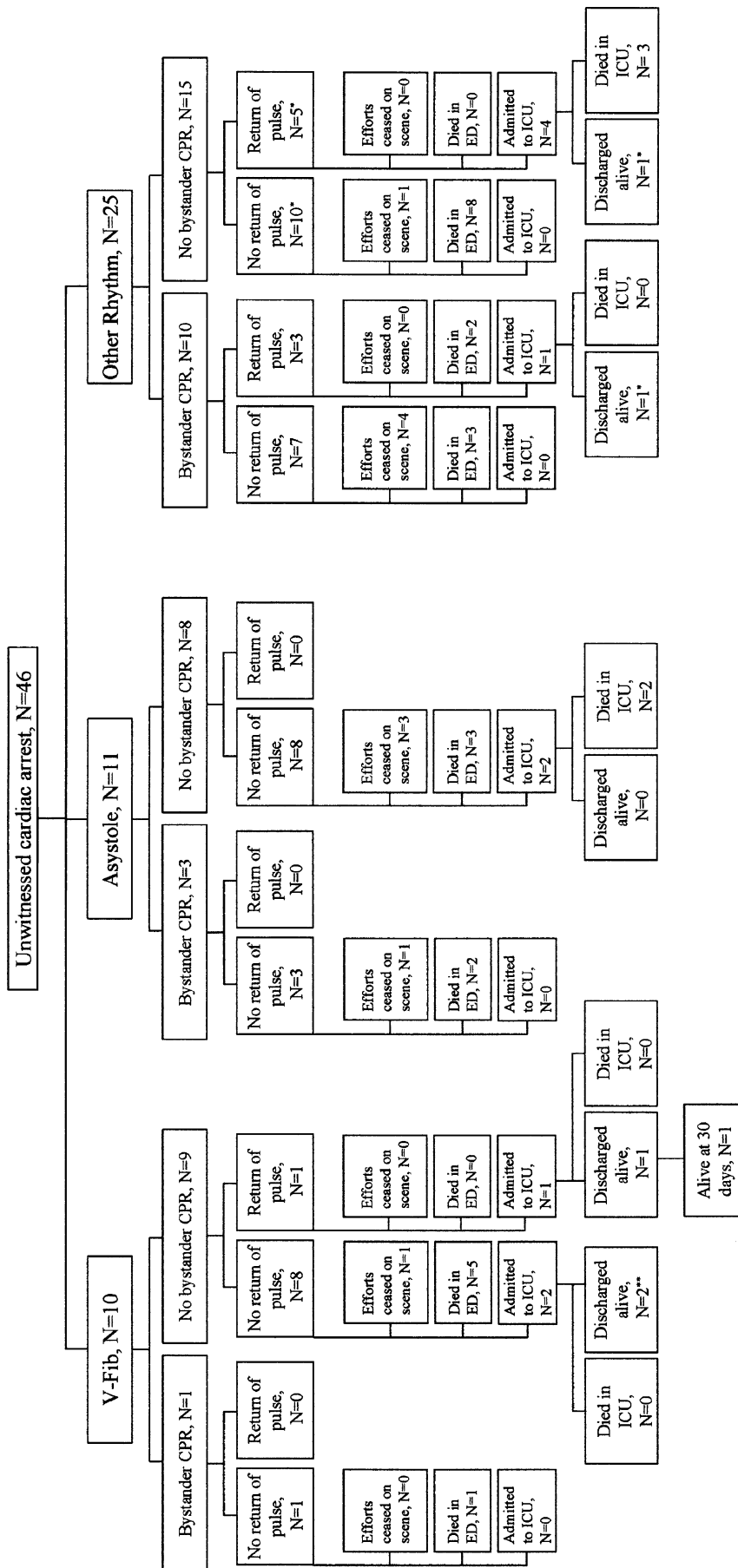


FIGURE 3. Outcomes for patients with an unwitnessed cardiac arrest. \* Indicates one patient lost to follow up. V-Fib = ventricular fibrillation; CPR = cardiopulmonary resuscitation; Ed = emergency department; ICU = intensive care unit.

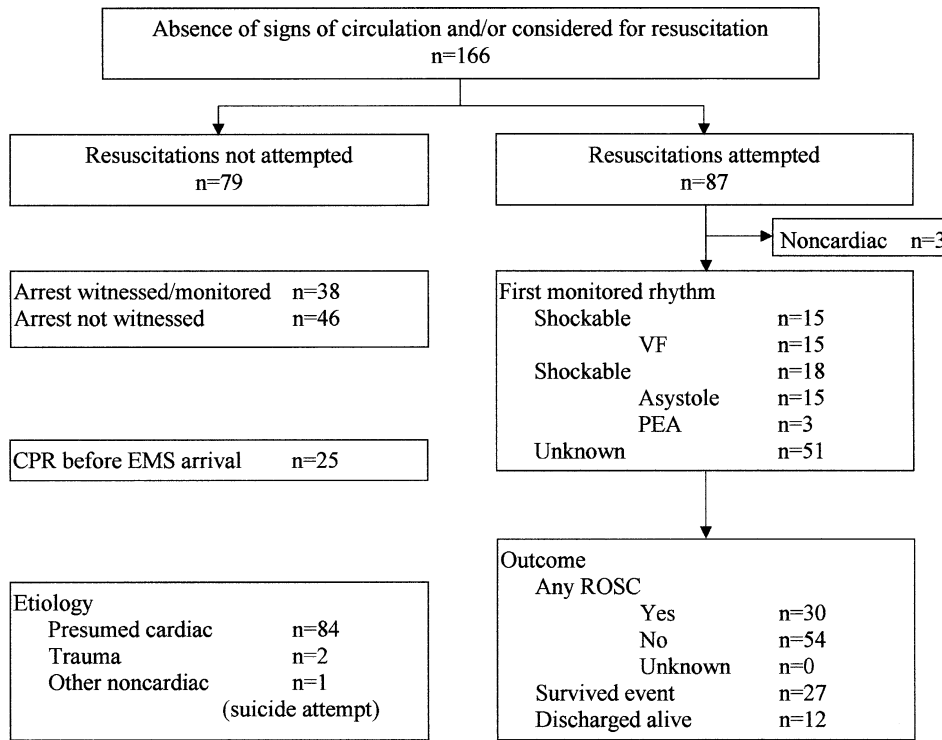


FIGURE 4. Core data elements reported according to the revised Utstein criteria. VF = ventricular fibrillation; PEA = pulseless electrical activity; CPR = cardiopulmonary resuscitation; EMS = emergency medical services; ROSC = return of spontaneous circulation.

Two (5.4%) patients who did not have return of spontaneous circulation in the field were discharged alive from the hospital; neither was alive at 30 days. Of those discharged from the hospital, three (60%) had an initial rhythm of ventricular fibrillation, while four had other rhythms.

Figure 4 shows the presentation of the data based on the revised Utstein guidelines.<sup>2</sup> In 79 (47.6%) of the instances in which an absence of vital signs was found, no attempt at resuscitation was made.

### Demographic Predictors

Based on univariable logistic regression analysis to predict probability of death at ED disposition, age, gender, and race were not significant predictors (Table 1). Other

characteristics of the event that were also not predictive included initial rhythm and whether a bystander had performed CPR. If the event had been witnessed, the probability of death tended to decrease, although the effect was only marginally statistically significant.

### Response Times

Using the univariable logistic regression analysis (Table 1), response time to scene, time in transit, total call time, and time from scene to hospital arrival were not significant predictors of survival.

### DISCUSSION

The main objective of this study was to evaluate the rates of survival in this paramedic first-response EMS system. While the sample size of our study was small compared with those of other studies, we had a very high overall survival rate (14.3%). Only the hybrid paramedic/physician model<sup>7,9,11,14</sup> used in several European EMS systems had higher overall survival rates, as high as 18.8% to 22.9% depending on the subgroup classifications. This has been supported in a study that showed improved survival in non-asystolic cardiac patients when a physician was present on scene.<sup>30</sup> Without direct comparison of population data, no explicit comparison can be made. However, if further study confirms that the paramedic first-responder system improves outcomes compared with EMT first-responder systems, and shows similar outcomes to those of the

TABLE 1. Univariable Logistic Regression Models

Independent variable	P-value	Odds Ratio*	95% Confidence Interval
Age	0.676	0.994	0.967-1.022
Race (white vs. nonwhite)	0.238	0.274	0.032-2.355
Gender (male vs. female)	0.702	1.200	0.471-3.054
Bystander CPR vs. no CPR	0.125	2.400	0.784-7.351
Witnessed vs. not witnessed	0.052	0.386	0.148-1.007
Time to arrive on scene	0.136	1.288	0.923-1.798
Time on scene	0.368	0.969	0.904-1.038
Time in transit	0.843	0.980	0.803-1.196
Total call time	0.646	0.986	0.926-1.049
Time on scene to arrival at hospital	0.365	0.969	0.906-1.037

\*Odds ratios for mortality are shown.  
CPR = Cardiopulmonary resuscitation.

European paramedic/physician hybrid systems, it may be possible to maximize the cost-effectiveness of improved outcomes using this paramedic model.

Our study is similar to other studies in that no patient with an initial rhythm of asystole survived. Unlike other studies,<sup>18</sup> bystander CPR did not improve the rate of survival. However, whether the arrest was witnessed tended to predict survival. These results add to the literature describing suburban EMS systems and are unique in the paramedic first-response system. Most studies have focused on large cities; we found only one report of a suburban EMS system.<sup>29</sup>

Despite the fact that two individuals who did not have return of spontaneous circulation were discharged alive from the hospital, neither survived to 30 days. Whether the conditions of these individuals warranted transportation to the hospital for further resuscitative efforts is unclear from our data. This patient group should be considered in further studies to determine whether survival beyond 30 days is a possibility when the first responder is unable to resuscitate the patient in the field.

The literature suggests that there still remains some variability in the use of the Utstein style,<sup>29,31,32</sup> and some recommendations for more complete styles have been proposed.<sup>33</sup> Further review of the initial guidelines by an international consortium led to their subsequent revision.<sup>2</sup> The small size and quality of the data have enabled us to present an accurate illustration of patient survival from cardiac arrest in a suburban EMS system using paramedic first responders.

The classification of cardiac arrest into ventricular fibrillation, asystole, and "other" is based on previously published studies classifications.<sup>13,16,23,26,34</sup> This is because, despite identical Advanced Cardiac Life Support guidelines for pulseless ventricular tachycardia and ventricular fibrillation, the survival from ventricular fibrillation has been found to be significantly different.<sup>1</sup> Given the inability to standardize the reporting of ventricular tachycardia from other tachyarrhythmias in this EMS setting, it was included in the "other" classification.

## LIMITATIONS

Limitations to this study include a small sample size, a relatively homogeneous demographic composition, involvement of only one EMS system, and availability of only 30-day mortality rates. There were also two patients who did not survive beyond the ED who had incomplete data on their resuscitation efforts, and six patients whose medical records could not be located; it might be possible to assume that since they were also not located in the death registry, they were 30-day survivors. Given the variability in quality of follow-up, we were not able to determine the neurologic status of survivors at the time of discharge or those alive

at 30 days. Because only three of the cardiac arrests were of noncardiac origin, our demographics may not be generalizable to other populations. Finally, the collection of our data was based on the initial Utstein guidelines.<sup>1</sup> Given the differences found in the revised guidelines,<sup>2</sup> some data points and subsets of these were unavailable for analysis and presentation in the new format.

## CONCLUSIONS

The overall rates of survival in this paramedic first-response system appear to be satisfactory when compared with those of other systems. The only factor found to influence survival was whether the arrest was witnessed. Paramedic first-response systems in suburban areas may represent an alternative to the commonly described EMT first-responder systems.

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