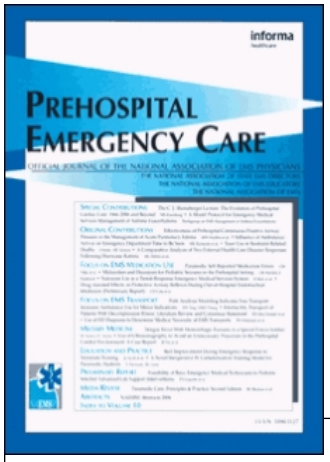

Prehospital Emergency Care
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713698281

Establishing Arizona's Statewide Cardiac Arrest Reporting and Educational Network

Bentley J. Bobrow [ab]; Tyler F. Vadeboncoeur [c]; Lani Clark [b]; Vatsal Chikani [b]
[a] Department of Emergency Medicine, Mayo Clinic Arizona, Phoenix, Arizona
[b] Arizona Department of Health Services, Bureau of Emergency Medical Services & Trauma System, Phoenix, Arizona
[c] Department of Emergency Medicine, Mayo Clinic Jacksonville, Jacksonville, Florida

Online Publication Date: 01 July 2008

To cite this Article: Bobrow, Bentley J., Vadeboncoeur, Tyler F., Clark, Lani and Chikani, Vatsal (2008) 'Establishing Arizona's Statewide Cardiac Arrest Reporting and Educational Network', Prehospital Emergency Care, 12:3, 381 — 387

To link to this article: DOI: 10.1080/10903120802100670
URL: http://dx.doi.org/10.1080/10903120802100670

ESTABLISHING ARIZONA'S STATEWIDE CARDIAC ARREST REPORTING AND EDUCATIONAL NETWORK

Bentley J. Bobrow, MD, Tyler F. Vadeboncoeur, MD, Lani Clark, BS, Vatsal Chikani, MPH

ABSTRACT

Background. Only a few large cities have published their out-of-hospital cardiac arrest (OHCA) survival statistics using the Utstein style reporting method. To date, to the best of our knowledge there has been no published OHCA survival data for a state. **Objective.** To describe the process, benefits, and challenges of establishing a statewide OHCA database and educational network. **Methods.** Arizona's Bureau of Emergency Medical Services and Trauma System initiated a statewide, prospective, observational cohort review of all OHCA victims on whom resuscitation was attempted in the field. Emergency medical services (EMS) first care reports, voluntarily submitted by 35 departments in Arizona, were analyzed. We chronicled the development of our data-collection process along with how we obtained patient outcomes and delivered feedback to field providers. Entry data included time intervals and nodal events conforming to the Utstein style template. **Results.** In data collected between January 1, 2005, and April 1, 2006, there were 1,484 OHCAs reported, of which 1,104 were of presumed cardiac etiology occurring prior to EMS arrival. The OHCA incidence was approximately 0.44 per 1,000 population per year. In our database, bystander CPR provided an odds ratio of 3.0 for survival (95% confidence interval 1.3, 6.7). Outcomes for 1,076 patients were obtained. Thirty-seven (3.4%) of the 1,076 cardiac arrest victims survived to hospital discharge. Twenty-seven (8.6%) of the 331 ventricular fibrillation cardiac arrest victims survived to hospital discharge. **Conclusion.** It is feasible for a public health agency to implement a voluntary, statewide data-collection system and educational network to determine and improve survival from OHCA. **Key words:** CPR; cardiac arrest; Utstein style reporting; EMS systems.

PREHOSPITAL EMERGENCY CARE 2008;12:381–387

INTRODUCTION

Cardiovascular disease is a leading cause of death in the United States.[1] The annual incidence of sudden cardiac arrest in North America is approximately 0.55 per 1,000 population,[2,3] and out-of-hospital cardiac arrest (OHCA) claims an estimated 250,000 lives each year.[1,4] Despite advances in emergency medical systems and resuscitation science, OHCA continues to be a major cause of death and remains a significant public health problem.

There are a wide range of reported survival rates from OHCA.[2,5,6] The largest cities in the United States report overall survival from OHCA to be 1% to 2%.[7–9] Other systems have reported survival rates from 2% to 26% depending on the population base, emergency medical services (EMS) design, availability of automated external defibrillators (AEDs), and rates of bystander cardiopulmonary resuscitation (CPR).[10]

While cardiac arrest survival is widely accepted as a benchmark of EMS performance and a gauge for the effectiveness of an EMS system, the vast majority of communities in the United States do not routinely collect or report their data in a standardized Utstein style format.[11] Prior to our program, to the best of our knowledge no state had published such data. For any state attempting to improve survival from OHCA, establishing baseline data and a cardiac arrest network is fundamental.

In this article we describe the implementation of the Save Hearts in Arizona Registry & Education (SHARE) program and report the baseline OHCA survival rates. We discuss major scientific and public health benefits of such a program.

MATERIALS AND METHODS

Study Setting and Population

The State of Arizona encompasses 113,635 square miles and 15 separate counties. According to the 2003 census, Arizona had a population of 5.5 million, yielding 48.4 persons per square mile. There were 2.8 million (51%) females and 2.7 million (49%) males. The median age was 33.9 years. Twenty-eight percent of the population was under 18 years and 13% was over 65 years. The median income of households in Arizona was $40,762.[12] For people reporting one race alone, 78% were white, 5% were American Indian or Alaska Native, 3% were black or African

Received May 22, 2007, from Mayo Clinic Arizona, Department of Emergency Medicine (BJB), Phoenix, Arizona; Mayo Clinic Jacksonville, Department of Emergency Medicine (TFV), Jacksonville, Florida; and Arizona Department of Health Services, Bureau of Emergency Medical Services & Trauma System (BJB, LC, VC), Phoenix, Arizona. Revision received October 5, 2007; accepted for publication October 26, 2007.

Presented at the American Heart Association Resuscitation Science Symposium, Chicago, Illinois, November 2006.

Address correspondence and reprint requests to: Bentley J. Bobrow, MD, Mayo Clinic College of Medicine, Mayo Clinic Hospital, 5777 East Mayo Boulevard, Phoenix, AZ 85054. e-mail: bobrow.bentley@mayo.edu

doi: 10.1080/10903120802100670

American, 2% were Asian, less than 0.5% were Native Hawaiian or Pacific Islander, and 11% described themselves as another race.[12] Twenty-eight percent reported their ethnicity as Hispanic.

The Arizona Department of Health Services (ADHS) Bureau of Emergency Medical Services and Trauma System (BEMSTS) establishes the scope of practice, education, training, certification, and vehicle inspection guidelines for the EMS organizations in the state. The BEMSTS regulates 10,063 emergency medical technician (EMT)-Basics, 141 certified EMT-Intermediates, and 3,898 EMT-Paramedics. There are four EMS regions that determine local prehospital protocols. A total of 167 public, private, and volunteer fire departments in Arizona are overseen by 101 EMS medical directors. Eighty-four departments are municipal and 83 are rural. There are a total of 742 registered ground ambulances in the state, along with 92 registered air ambulances. EMS response rates vary greatly among municipal and rural systems. Dispatch is conducted differently throughout the state depending on local protocols and resources. There are 107 hospitals in the Arizona Hospital Association, with 64 of these receiving patients by ambulance.

Study Design

This was a prospective, observational cohort review of OHCA in which resuscitation was initiated in the field and then reported to the SHARE program between January 1, 2005, and April 1, 2006. A standard data-collection tool and database were developed and study variables were defined for each incident of cardiac arrest. Entry criteria, time intervals, and nodal events conform to the Utstein style template.

Implementation

Support for this statewide data-collection program was obtained from the ADHS after it designated OHCA as a public health problem. The program was then presented as a voluntary initiative to Arizona's EMS leaders through the statewide EMS Council. The ADHS BEMSTS highlighted the benefits of participation, such as receiving outcome data for quality improvement and resource justification. In order to facilitate participation, our data-collection system purposefully did not require additional EMS personnel and it allowed for individual system choice when it came to the method of data submission. All potential participants were assured that the submitted data and outcomes would be kept confidential.

The Arizona BEMSTS established the SHARE program as a means to address the public health problem of OHCA. Because OHCA has been identified as a public health issue in Arizona and the goal of the SHARE program is quality improvement, the data collected are exempt from the Health Insurance Portability and Accountability Act (HIPAA). Permission to publish de-identified SHARE program data was obtained from the ADHS Human Subjects Review Committee as well as the University of Arizona Institutional Review Board (IRB).

Data Collection

For this report, the data-collection period began on January 1, 2005, and continued through April 1, 2006. EMS agencies and fire departments were asked to query their patient care report systems for anyone receiving CPR, defibrillation, or epinephrine who had no vital signs upon EMS arrival. Participants then voluntarily forwarded (via e-mail, fax, or regular mail) copies of their completed EMS first care reports to the full-time SHARE Program Research and Quality Improvement (QI) Director. Some EMS systems elected to have an administrative assistant perform this role, whereas other EMS systems used EMTs positioned at their headquarters. While Arizona does not have a standard statewide EMS first care report form, there is a great deal of similarity in the forms used by different systems. To ensure thorough and consistent reporting, documentation training was given at the beginning of the program and is conducted on an ongoing basis.

Data elements included in our enhanced Utstein style database are manually extracted case by case by the SHARE Program Research and QI Director who has 20 years' experience collecting cardiac arrest data. Data are entered into a secure Microsoft Access (Microsoft Corp., Redmond, WA) database on a continual basis. The database is coded with a data dictionary, is password protected, and resides on the secure server at the University of Arizona Sarver Heart Center. To ensure accuracy, data are cross-referenced among first-responding EMS agencies, private transporting ambulance companies, and, when necessary, available hospital information.

The data points collected are survival to hospital discharge stratified according to location of arrest, whether the arrest was witnessed, presence of bystander CPR, identification of CPR performer, mean EMS response times, initial cardiac rhythm, time from 9-1-1 dispatch to first shock, return of spontaneous circulation, and neurologic and functional status for patients with hospital discharge. Arrests are considered "witnessed" if a bystander saw or heard the victim collapse. Initial ventricular rhythms are categorized as shockable (ventricular fibrillation or ventricular tachycardia [VF/VT]) or nonshockable. All time intervals are calculated using the computer-aided dispatch (CAD) system. Collapse-to-shock time is calculated using the EMS-estimated time of collapse and the time the shock was delivered. Dispatch-to-shock time is calculated using the time the first EMS vehicle was dispatched to the time the shock was delivered.

Cases are excluded from the analysis for the following reasons: resuscitation was not initiated, the patient had a do-not-resuscitate order, the etiology of the arrest was known to be noncardiac, or the arrest was witnessed by EMS rescuers at the scene.

The SHARE Program Research and QI Director obtains outcome data from the Arizona Department of Health Services Office of Vital Statistics. When no death confirmation is obtained after three months, survival is verified through the relevant base hospital manager. Follow-up is precluded because of insufficient documentation in less than 1% of the cases. Once survival to discharge is confirmed, a formal letter is sent to patients by the QI Director requesting a telephone interview. Survivors have the option to refuse follow-up contact.

The benefit of this centralized system of data collection, while tedious and time-consuming, is that it grants us the opportunity to screen all data for accuracy and to give feedback to providers regarding their documentation. We believe that ensuring the integrity of prehospital cardiac arrest data is crucial and that this is an important first phase of any large data-collection process.

Statistical Analysis

The data were entered into Microsoft Access for Windows (Microsoft Corp., Redmond, WA) and transported into SPSS 14.0 for Windows (SPSS, Inc., Chicago, IL) for statistical analysis. Continuous variables are presented as mean ± standard deviation. A logistic regression analysis was used to determine the survival association of 1) the witnessed cardiac arrest group compared with the unwitnessed group and 2) patients who received bystander CPR compared with those who did not receive bystander CPR, while adjusting for potential confounders. A base model was adjusted for age, gender, location of arrest, VF, and entire EMS dispatch-to-arrival time interval. The final model included only significant covariates.

RESULTS

Data were obtained from 30 EMS systems, representing nine of 15 counties and approximately 67% of Arizona's population (Fig. 1). There were 1,484 arrests, of which 1,104 were of presumed cardiac etiology occurring prior to EMS arrival (Fig. 2). The incidence of OHCA was approximately 0.44 per 1,000 individuals in the population per year. The average age of the victim was 66.5 years (Table 1). There were more males (65.4%), and the majority of OHCA (67.7%) occurred in private residences. There were 472 (42.8%) bystander-witnessed arrests, and 632 (57.2%) arrests were not witnessed. Bystander CPR was performed in 426 (38.6%) of the cases. The median time interval from EMS dispatch to arrival was 5.5 minutes. The initial rhythm was recorded as 1) VF/VT in 30%, 2) asystole in 48%, 3) pulseless electrical activity (PEA) in 22%, and 4) other in 0.5% of the cases.

For the 426 cardiac arrest patients receiving bystander CPR, 171 (40.1%) of the providers had CPR training as part of their job descriptions. When excluding the arrests that took place at extended care or medical facilities, the percentage of bystander CPR providers formally trained in CPR fell to 12.6%. Layperson CPR was performed in 255 of the 1,104 arrests (23.1%).

Eighteen percent of OHCA victims died in the field, 67.4% died in the emergency department, 11.2% died in the hospital, and 3.4% survived to hospital discharge (Table 2). Survival was highest in the group with an initial rhythm of VF/VT (8.6%). The survival rate was 0.4% in cardiac arrest victims with an initial rhythm of asystole and 2.6% in those with an initial rhythm of PEA (Table 2).

The odds ratio of survival for witnessed arrests compared with unwitnessed arrests was 9.3 (95% confidence interval [CI] 2.7, 31.6). The odds ratio of survival for cardiac arrest patients who received bystander CPR compared with cardiac arrest patients who did not receive bystander CPR was 3.0 (95% CI 1.3, 6.7).

DISCUSSION

Out-of-hospital cardiac arrest continues to present both a challenge and an opportunity for public health officials in the United States. OHCA is challenging because of its high prevalence and mortality rate. The opportunity lies in the potential for vastly improving survival rates through an effective EMS system.

Evidence suggests that OHCA survival rates in the United States remain persistently low. A study from King County, Washington, demonstrated no improvement from 1977 through 2001.[13] In 2005, the American Heart Association (AHA) made several modifications to its CPR guidelines, including changing the recommended compression-to-ventilation ratio from 15:2 to 30:2.[1,14] This change was made by expert consensus rather than scientific evidence because of the paucity of available data. One of the objectives of the SHARE program is to establish a baseline OHCA survival rate that will enable us to determine the impact of future interventions. We believe the enormous human and financial impact of OHCA mandates coordinated and concerted effort by EMS, scientific, and public health communities.

Although some U.S. cities have established Utstein style OHCA databases linked to patient outcomes, no state has previously published this type of data.[7–9] An informal survey distributed to all state EMS directors revealed that only Maryland maintained a statewide prehospital cardiac arrest and AED registry linked to patient outcomes. While the National Association of State EMS Directors (NASEMSD) is working with its federal partners at the National Highway Traffic Safety Administration (NHTSA), the Health Resources and Services Administration (HRSA), and the Centers for

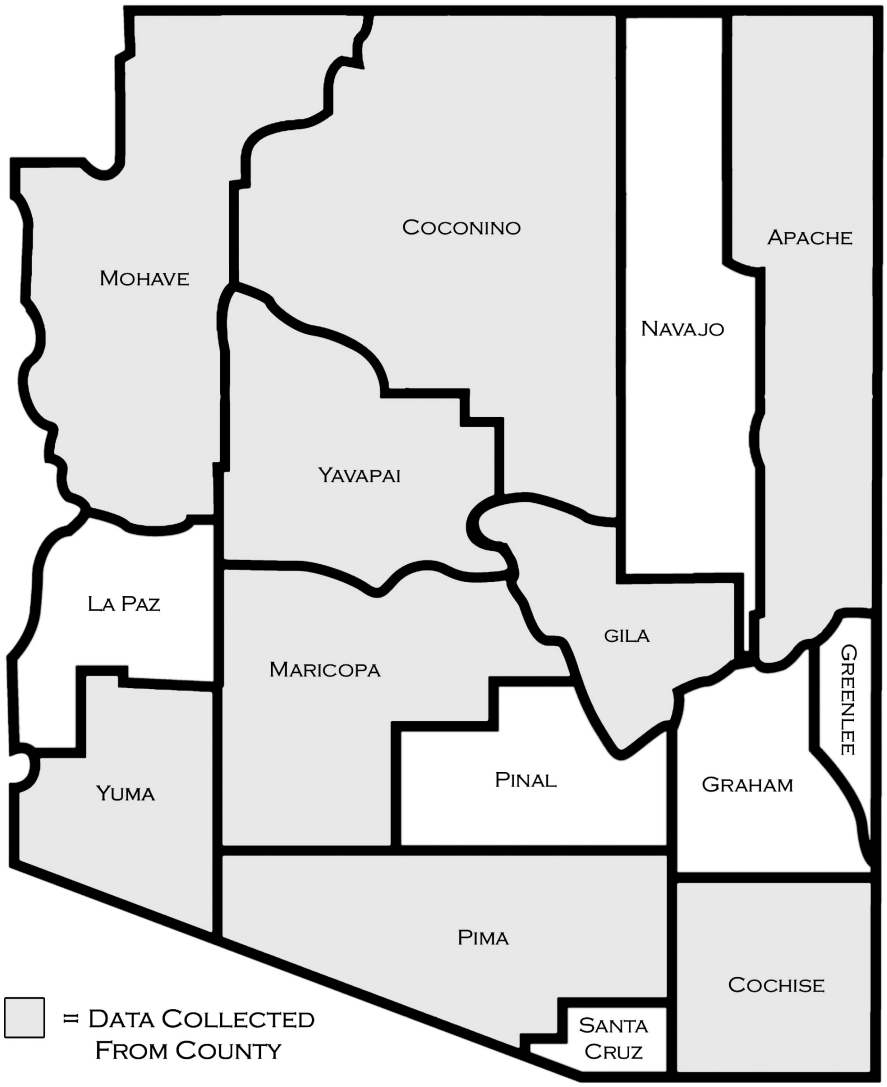

FIGURE 1. Map of the included counties in Arizona.

Disease Control and Prevention (CDC) to develop a national EMS database (the National EMS Information System, or NEMSIS), at present there is no universal process linking disparate EMS databases to allow analysis at local, state, and national levels.

The major objectives of the SHARE program are to establish a reproducible OHCA database using the Utstein style method of data collection and to determine the survival rate for OHCA victims in Arizona. In this initial report we present baseline data during a time period when the state was following the 2000 AHA Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care.[15] Our 3.4% overall survival rate and 8.6% survival rate in victims with initial rhythm of VF/VT are consistent with previously reported survival rates for OHCA in adults.[7–9,16] We did not present the results of every secondary data point collected because they go beyond the scope of this report.

Role of Public Health

EMS systems vary in their ability to collect and examine patient and system data. Our initial discussions with EMS leaders across the state regarding the question of mandatory versus voluntary reporting led us to choose a voluntary data-reporting system. Compliance was achieved through presenting EMS partners with the critical value of this process. We discussed how the quantified data could be used for quality improvement and by organizations in need of supplemental equipment and human resources. We found that providing EMS partners with quarterly reports of their own data and frequent updates in face-to-face meetings maximized participation.

Public health agencies must have a method of accurately measuring the efficacy of OHCA-associated interventions. This is not possible without initially having a coordinated system to continually obtain OHCA data.

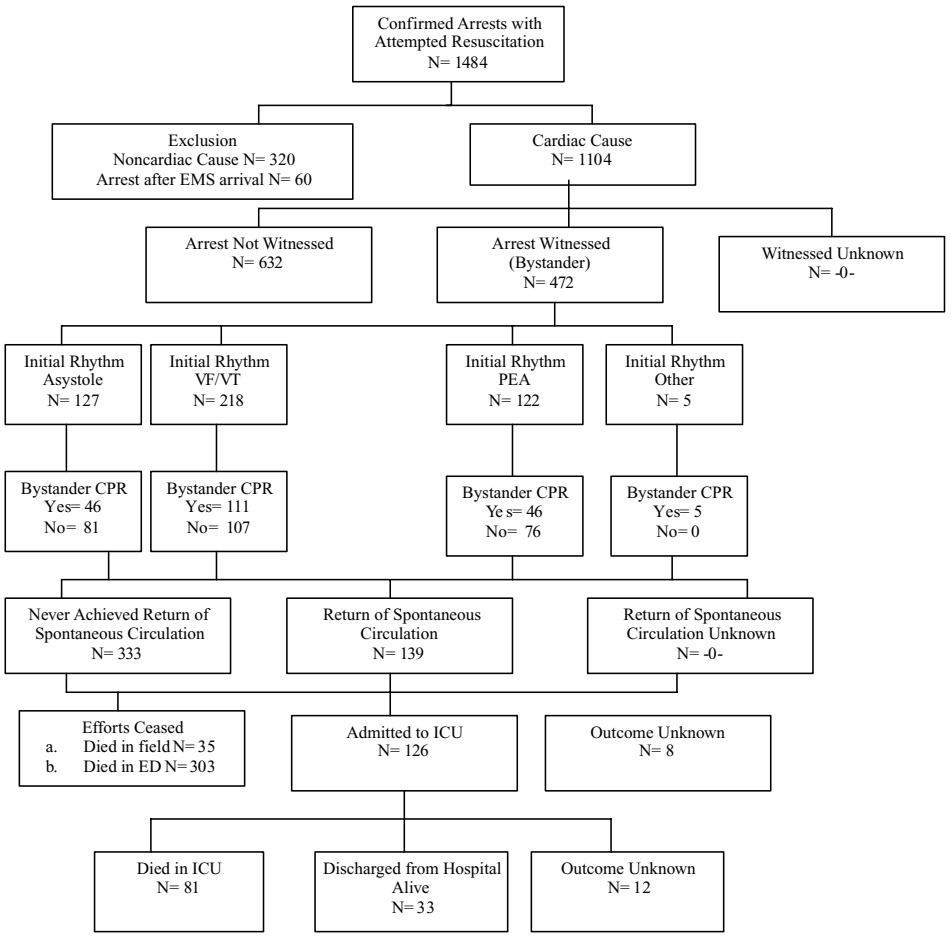

FIGURE 2. Utstein style flow chart. CPR = cardiopulmonary resuscitation; ED = emergency department; EMS = emergency medical services; ICU = intensive care unit; PEA = pulseless electrical activity; VF/VT = ventricular fibrillation/ventricular tachycardia.

The institution of our uniform prehospital cardiac arrest database has led to a cardiac arrest network among EMS agencies in the state where best practices for training, equipment usage, documentation, and data collection can be shared. The database also allows for participation in research consortiums focused on cardiac arrest interventions.

The current model of cardiac arrest treatment is predicated on quaternary prevention focusing efforts on saving the patient who has already suffered an OHCA. With this program, we plan to address risk factors such as hypertension and diabetes, in an attempt to prevent OHCA.

Cost–Effectiveness

Our program has been implemented with minimal cost to the participating EMS agencies. Most individual EMS agencies do not have the infrastructure or resources to continually collect, maintain, and analyze OHCA data in a HIPAA-compliant Utstein style format. Additionally, most individual EMS agencies do not have access to outcome results on which to base their patient care. Having a centralized data-collection system such as the SHARE program gives EMS agencies valuable information they would not have otherwise been able to obtain. This information can then be put to use in improving care—resulting in better OHCA outcomes. Each participating agency receives a quarterly report of its cardiac arrest statistics, feedback on its activity, and access to the most current concepts in resuscitation care through the SHARE website.

At present, the cost of this program is that of delivering the first care reports to our Research and QI Director and the cost of our director's time, which is paid for by the state's BEMSTS and the University of Arizona. No grant or research money is required. Our statewide data-collection network was implemented with minimal cost because the effort was distributed among many individuals at different EMS agencies who were committed to its success and who were able to participate during their hours of usual employment.

Limitations

Participation in the SHARE program is voluntary, so we do not have participation from every agency in the

TABLE 1. Demographics of the Victims of Out-of-Hospital Cardiac Arrest

	% (*n*)*
Age, mean (SD)	66.5 years (17.1)
Gender	
Male	65.4 (722)
Female	34.6 (382)
Location of cardiac arrest	
Home	67.7 (747)
Medical facility or extended care	17.1 (189)
Other	15.2 (168)
Witnessed	42.8 (472)
Bystander CPR performed	38.6 (426)
Medical personnel	40.1 (171)
Layman	59.9 (255)
EMS dispatch-to-arrival time interval, mean (SD) (90th percentile)	5.5 (min) (2.9) (9.0)
Initial rhythm	
Ventricular fibrillation/tachycardia	30.0 (331)
Asystole	48.0 (530)
PEA	21.6 (238)
Other	0.5 (5)

*Data are expressed as percentage (number) unless otherwise specified.
CPR = cardiopulmonary resuscitation; EMS = emergency medical services; PEA = pulseless electrical activity; SD = standard deviation.

state, and new participants continually join. This might have resulted in some selection bias, with the more productive agencies being more prepared and willing to provide their reports. Additionally, our method of data collection may not have resulted in the capture of all of the cardiac arrests for each EMS agency. The EMS agencies were asked to query their patient care report systems for anyone receiving CPR, defibrillation, or epinephrine who had no vital signs upon EMS arrival. Some systems had sophisticated electronic record-keeping mechanisms, while others simply had to review each paper report by hand. EMS first care paper reports are a potential source of incomplete data. We attempted to mitigate this issue by carefully reviewing the required data with providers before the start of the program and by ongoing education and notification of deficiencies.

While this was not a randomized, controlled trial of OHCA, an observational approach has been used effectively over the past few decades to advance resuscitation science, and it will probably continue to be the major contributor to future advances in resuscitation.[17]

TABLE 2. Outcomes of the Victims of Out-of-Hospital Cardiac Arrest

	% (n)
Survival to hospital discharge (total)	3.4 (37)
Survival in arrests with initial rhythm as:	
Ventricular fibrillation/tachycardia	8.6 (27)
Asystole	0.4 (2)
PEA	2.6 (6)
Death	
Called in the field, no transport	18.0 (194)
Called in the ED	67.4 (725)
Admitted, death in hospital	11.2 (120)

ED = emergency department; PEA = pulseless electrical activity.

Challenges/Successes/Opportunities

As in any novel voluntary program, the initial challenge was encouraging participation. Participation expanded quickly once departments became aware of the benefits with regard to patient care, quality improvement, and resource justification.

One anticipated hurdle is maintaining momentum for the program and assuring its longevity. We believe this is best addressed by presenting EMS providers with regular performance feedback and useful data for quality improvement.

We continue to build on the success of this program by adding EMS systems and refining the data-collection methodology. We plan on continuing to provide ongoing feedback to participating EMS agencies. Our data will also be used as a baseline in our evaluation of current efforts at mass-bystander continuous chest-compression CPR training. Lastly, we have received IRB approval and are in the process of administering standard quality-of-life surveys to survivors.

[Program Update: As of May 2008, the SHARE program has expanded to include 67 EMS agencies encompassing approximately 80% of Arizona's population. The program has evolved to include public outreach to educate laypersons and public safety officers in continuous chest compression CPR. We are also tracking the technique (chest compression only vs. standard), incidence, and quality of CPR. The latest program addition is an effort focusing on the implementation and monitoring of post-cardiac arrest care and outcomes through a statewide cardiac arrest center consortium.]

Our hope is that this work will facilitate the efforts of other states attempting to create and maintain a statewide cardiac arrest network.

CONCLUSION

It is feasible for a public health agency to implement a voluntary, statewide, prehospital cardiac arrest network that uses Utstein style data reporting for determining OHCA survival. A database such as this will aid EMS and public health agencies in improving the quality of cardiac arrest care and ultimately in increasing survival.

The authors thank Doug Leach of the Arizona Department of Health Services Office of Vital Records, and the EMS managers of Arizona base hospitals for valuable assistance with outcome data. The authors are also indebted to Paula Brazil, MA, (Department of Health Services, Bureau of Emergency Medical Services and Trauma System) for assisting in the preparation of this manuscript. Their sincere appreciation goes to all EMS providers across Arizona who dedicate themselves to saving lives every day, often under extreme circumstances.

References

1. Emergency Cardiac Care Committee and Subcommittees, American Heart Association. 2005 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiac care. Circulation. 2005;112(suppl 24):IV1–203.
2. Rea TD, Eisenberg MS, Simibaldi G, White RD. Incidence of EMS-treated out-of-hospital cardiac arrest in the United States. Resuscitation. 2004;63:17–24.
3. Vaillancourt C, Steill IG. Cardiac arrest care and emergency medical services in Canada. Can J Cardiol. 2004;20:1081–90.
4. Zheng ZJ, Croft JB, Giles WH, Mensah GA. Sudden cardiac arrest in the United States, 1989–1998. Circulation. 2001;104:2158–63.
5. Chugh SS, Jui J, Gunson K, et al. Current burden of sudden cardiac death: multiple source surveillance versus retrospective death certificate-based review in a large US community. J Am Coll Cardiol. 2004;44:1268–75.
6. Cobb LA, Fahrenbruch CE, Olsufka M, Copass MK. Changing incidence of out-of-hospital ventricular fibrillation, 1980–2000. JAMA. 2002;288:3008–13.
7. Eckstein M, Stratton S, Chan L. Cardiac Arrest Resuscitation Evaluation in Los Angeles: CARE-LA. Ann Emerg Med. 2005;45:504–9.
8. Lombardi G, Gallagher EJ, Gennis P. Outcome of out-of-hospital cardiac arrest in New York City: The Pre-Hospital Arrest Survival Evaluation (PHASE) Study. JAMA. 1994;271:678–85.
9. Becker LB, Ostrander LP, Barrett J, Kondos GT. Outcome of CPR in a large metropolitan area—where are the survivors? Ann Emerg Med. 1991;20:355–61.
10. Nichol G, Detsky AS, Stiell IG, et al. Effectiveness of emergency medical services for victims of out-of-hospital cardiac arrest: a meta-analysis. Ann Emerg Med. 1996;27:700–10.
11. Cummins RO, Chamberlain DA, Abramson NS, et al. Recommended guidelines for the uniform reporting of data from out-of-hospital cardiac arrest: the Utstein style. A statement for health professionals from a task force of the American Heart Association, the European Resuscitation Council, the Heart and Stroke Foundation of Canada, and the Australian Resuscitation Council. Circulation. 1991;84:960-75.
12. U.S. Census Bureau. American Community Survey (ACS). Data Tables: Data Profiles 2003. Available at: http://www.census.gov/acs/www/Products/Profiles/Single/2003/ACS/AZ.htm. Accessed March 9, 2007.
13. Rea TD, Eisenberg MS, Becker LJ, Murray JA, Hearne T. Temporal trends in cardiac arrest: a 25-year emergency medical services perspective. Circulation. 2003;107:2780–5.
14. Eisenberg MS. The C.J. Shanaberger Lecture: The evolution of prehospital cardiac care: 1966–2006 and beyond. Prehosp Emerg Care. 2006;10:411–417.
15. American Heart Association in collaboration with International Liaison Committee on Resuscitation. Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2000;102(8 suppl):I1–11.
16. Cummins RO, Ornato JP, Thies WH, Pepe PE. Improving survival from sudden cardiac arrest: the chain of survival concept. Circulation. 1991;83:1832–47.
17. Ornato JP, Peberdy MA. Measuring progress in resuscitation: it's time for a better tool [editorial]. Circulation. 2006;114:2754–6.