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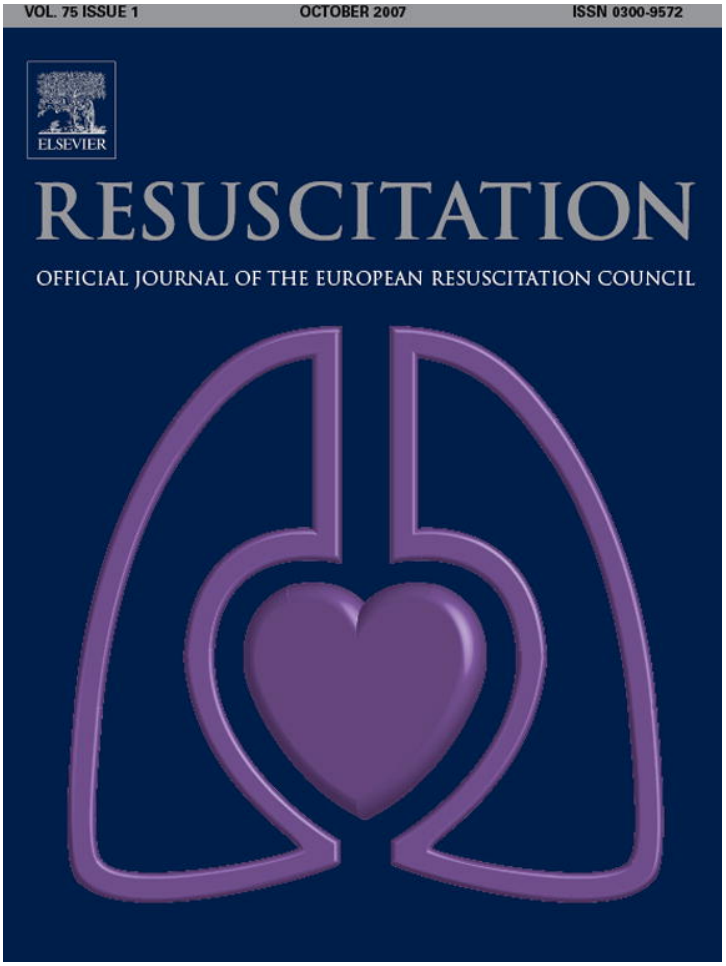

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CLINICAL PAPER

The Save Hearts in Arizona Registry and Education (SHARE) program: Who is performing CPR and where are they doing it?☆

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Cardiac arrest;
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Summary
Background: Bystander cardiopulmonary resuscitation (CPR) decreases mortality from out-of-hospital cardiac arrest significantly. Accordingly, layperson CPR is an integral component in the chain of survival for out-of-hospital cardiac arrest victims. The near statewide incidence and location of layperson CPR is unknown.
Objective: To determine true incidence and location of layperson CPR in the State of Arizona.
Methods: The Save Hearts in Arizona Registry and Education (SHARE) program reviewed EMS first care reports submitted voluntarily by 30 municipal fire departments responsible for approximately 67% of Arizona's population. In addition to standard Utstein style data, information regarding the performance of bystander CPR, the vocation and medical training of the bystander and the location of the arrest were documented.
Results: The total number of out-of-hospital adult arrests of presumed cardiac etiology reported statewide was 1097. Cardiac arrests occurred in private residences in 67%, extended care or medical facilities in 18%, and public locations in 15%. Bystander CPR was performed in 37% of all arrests, 24% of residential arrests, 76% of extended care or medical facility arrests, and 52% of public arrests. Bystander CPR provided an odds ratio of 2.2 for survival [95% CI 1.2—4.1]. Excluding cardiac arrests which occurred in the presence of bystanders with formal CPR training as part of their job description, layperson CPR was performed in 218 of 857 (25%) of cases.
Conclusions: The near statewide incidence of layperson CPR is extremely low. This low rate of bystander CPR is likely to contribute to the low overall survival rates from cardiac arrest. Public health officials should re-evaluate current models of public education on CPR.
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Introduction

Sudden cardiac arrest has been well established as a leading cause of death in the United States.[1,2] Estimates of the actual number of deaths annually from out-of-hospital cardiac arrest (OHCA) vary[3,4] but the number could be as high as 450,000.[1,5] Since Pantridge and Geddes advanced the concept of providing prehospital ACLS care,[6] emergency medical service (EMS) systems worldwide have introduced the use of defibrillators, advanced airway techniques, and ACLS medications. Despite these efforts, survival rates from OHCA remain low.[7—9]

Studies have shown higher survival rates in the approximately 40% of victims of OHCA who show ventricular fibrillation (VF) as their initial rhythm.[10—14] It is postulated that a much higher percentage of victims are in VF immediately after their collapse, but that the rhythm degenerates to pulseless electrical activity (PEA) or asystole prior to the first rhythm analysis.[15] Ventricular fibrillation frequently converts to a perfusing rhythm if defibrillation is performed within the first 4—5 min. Due to a myriad of issues it is often impossible for EMS providers to perform defibrillation within this brief time window. For every minute without CPR, survival from witnessed OHCA decreases by 7—10%.[16] The survival rate from OHCA decreases more gradually with delays in defibrillation in the presence CPR.[16,17] This makes bystander CPR of critical importance to the ''chain of survival''. It has been shown by numerous investigators that CPR significantly improves survival from witnessed OHCA at varying times to defibrillation.[16—20]

While bystander CPR has been established to decrease mortality from OHCA and is one of the links in the ''chain of survival'', the statewide incidence and location in the current era is unknown.[12,13,19,21] This article reports the current incidence and location of bystander CPR using Utsein-style reporting for the state of Arizona during a 14-month period ending in April 2006.

Material and methods

The state of Arizona encompasses 113,635 square miles with a resident population of 5,939,292, yielding 45.2 persons per square mile. An estimated 13% of Arizona residents are over the age of 65.[22] Arizona has 10,063 EMT-Basics, 141 certified EMT-Intermediates and 3898 EMT-Paramedics. There are a total of 167 fire departments, 84 municipal and 83 rural, in the state. The total number of registered ground ambulances in the state is 742 along

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with 92 registered air ambulances. EMS system response varies greatly across the state between the urban and rural EMS systems. Dispatch is conducted differently throughout the state depending on local protocols and resources. The state Bureau of EMS establishes the scope of practice, education, training, certification and vehicle inspection guidelines, but four regional EMS organizations and individual EMS agencies set specific prehospital protocols.

The Save Hearts in Arizona Registration and Education (SHARE) program was established in November 2004, as part of the State of Arizona Public Health Program. Standard data points to be used on each cardiac arrest case were identified based on an expanded version of the Utstein template. The data collection period for this report started on 1 November 2004 and ended on 9 April 2006. The data points collected included: time and location of arrest, witnessed arrest, bystander CPR, who performed CPR and the quality of CPR as gauged by paramedics, initial cardiac rhythm, use of AED prior to EMS arrival, return of spontaneous circulation, condition upon EMS arrival at the hospital, neurological and functional status for patients with hospital discharge and intended 1-year quality of life survey. Each participating fire department and ambulance agency forwarded copies of their completed patient care reports voluntarily to the full time SHARE Program Research and Quality Improvement Director. All data elements were extracted manually case by case by the same individual and entered into a HIPAA compliant password protected Microsoft ACCESS database on a continuous basis. The database resides on the University of Arizona Sarver Heart Center master server.

We reviewed all cases from the aforementioned time period and extracted the location of the arrest and who was performing bystander CPR. The locations were categorized into three groups as follows: public, medical or extended care facility, or private residence (Table 1).

Those performing bystander CPR were categorized as lay bystander or trained bystander. Employee of location/unknown medical training, spouse, family other than spouse, friend/neighbor, and stranger were considered lay bystanders. Medically trained caretaker, law enforcement, medical personnel, and off-duty medical were considered to have CPR as part of their job description and were classified as trained bystanders.

Outcome data was obtained through the Arizona Department of Health Services Office of Vital Statistics in order to determine the odds ratio for survival in the presence of bystander CPR. When no death confirmation was obtained, a formal letter was sent to patients to determine ultimate outcome and request permission for medical record review and/or a telephone interview.

All statistics were computed using Stata/SE software (version 9.2, StataCorp LP, College Station, TX). The association between dichotomous variables was evaluated using Fisher's exact test. Logistic regression was used to model survival to hospital discharge adjusting for additional covariates. The final multivariate logistic model was achieved using a backwards elimination technique for variable selection.

This study was submitted to the University of Arizona Investigational Review Board for approval. Permission to contact cardiac arrest survivors was also obtained through the Arizona Department of Health Services Human Subjects Board.

Table 1 Classification of locations of OHCA

Public	Private residence	Extended care or medical facility
Airport/aircraft	Apartment	Adult care home/assisted living facility
Church	Mobile home	Dialysis center
Golf course	Single family residence	Hospice/long-term care hospital
Gym/health club/fitness center		Nursing home
Hotel/motel		Medical/dental office/clinic
In a car/on the road/parking lot		
Indoor recreation/entertainment venue		
Jail		
Open field		
Park/outdoor recreation		
Place of patient's employment		
Public street/sidewalk/bus stop/alley		
Restaurant/bar		
School		
Store/mall		

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Table 2 Comparison of who performed CPR by location

	Total	Public	Private residence	Extended care or medical facility
Arrests	1097	160	737	200
CPR	410	83	175	152
Lay CPR	227 (55%)	71 (86%)	147 (84%)	9 (6%)
Trained CPR	183 (45%)	12 (14%)	28 (16%)	143 (94%)

Results

Nine of 15 counties participated accounting for approximately 67% of Arizona's population. The total number of OHCA reported statewide from 1 November 2004 to 9 April 2006 was 1296 of which 1097 were adult arrests of presumed cardiac etiology occurring before EMS arrival. Arrests occurred in private residences in 737 cases (67%), extended care or medical facilities in 200 cases (18%), and public locations in 160 cases (15%). Bystander CPR was performed in 410 cases or 37% of all arrests. It was performed in 175 (24%) residential arrests, 152 (76%) extended care or medical facility arrests, and 83 (52%) public area arrests (Table 2). Multivariate analysis revealed a significant increase in survival to hospital discharge for patients whose arrest was witnessed (OR: 9.1, 95% CI: 3.8—21.6) as well as among those who received bystander CPR (OR: 2.2, 95% CI: 1.2—4.1).

Bystanders performing CPR had formal training in CPR as part of their job description in 143/152 (94%) of extended care or medical facility arrests, 28/175 (16%) residential arrests, and 12/83 (14%) of public area arrests. Layperson CPR was performed in 227/1097 (21%) cases (Table 2). After excluding arrests that occurred at extended care or medical facilities in addition to those residential and public area arrests, which were known to be treated by providers with formal CPR training as part of their job description, layperson CPR was performed in 218/857 (25%) cases. Layperson CPR was performed by family members in 123/227 (54%) arrests, friends/neighbors in 56/227 (25%) arrests, and strangers in 48/227 (21%) arrests. Strangers included employees of public establishments. Of the 71 public arrests in which layperson CPR was initiated 40 (56%) were by strangers, 24 (34%) were by friends/neighbors, and 7 (10%) were by family members. Of the 147 residential arrests in which layperson CPR was initiated 115 (78%) were by family members, 32 (22%) were by friends/neighbors and 0 were by strangers (Table 3).

Discussion

Recent data suggests that the incidence of OHCA in the United States could be as high as 450,000[1] and the survival rate in the vast majority of locations is found to be considerably less than 5%.[8,9,12,21] While factors such as patient age, patient co-morbid conditions, and whether the event was witnessed cannot be altered, there appear to be modifiable variables which affect survival.

In 1993, Larsen et al. performed a multivariate linear regression which demonstrated that the survival from OHCA would be 67% if CPR, defibrillation, and Advanced Cardiac Life Support (ACLS) were available immediately upon collapse.[16] In 1997, Valenzuela et al. established a linear regression survival model demonstrating that delays to CPR and defibrillation are both critically important to patient survival.[17]

Numerous studies have shown that survival from OHCA is highest in patients with an initial rhythm of ventricular fibrillation.[10—14] Cummins et al.[23] and Holmberg et al.[18] have shown that CPR maintains ventricular fibrillation in OHCA victims. In 1999, Steill et al. demonstrated an odds ratio for survival of 2.98 in patients who received bystander CPR and that survival is doubled if CPR is initiated by fire or police first-responders.[10] Additionally, in 1995, Swor et al. showed an improved rate of hospital discharge with bystander CPR.[19,23—30]

Table 3 Who is performing layperson CPR by location

	Total (227)	Public (71)	Private residence (147)
Family	123 (54%)	7 (10%)	115 (78%)
Friends/neighbors	56 (25%)	24 (34%)	32 (22%)
Stranger	48 (21%)	40 (56%)	0 (0%)

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Weisfeldt and Becker proposed a three-phase time-sensitive model of CPR in which the electrical phase persists for approximately 4 min, the circulatory phase lasts from 4 to 10 min after the collapse, and the metabolic phase is thereafter.[31] During the electrical phase, immediate defibrillation is highly successful.[32–39] Animal models and clinical studies have shown, however, that CPR prior to defibrillation improves outcomes during the circulatory phase.[40–43] While prehospital defibrillation within the first 4 min after collapse does occasionally occur, it is uncommon. An ideal situation is when EMS providers arrive in the circulatory phase of a patient's arrest and a bystander has already ''primed the myocardium'' with CPR so that the EMS provider can perform immediate defibrillation. This scenario is that most likely to be associated with an improved chance of success.

Studies to date show that, even with the vast efforts aimed at Basic Life Support (BLS) education, bystander CPR is infrequent.[12,13,19,21] Numerous theories have been posed to explain this phenomenon. One is that not enough people are being trained in BLS. It is estimated that the AHA formally trains approximately 4.5 million lay persons each year in the skills of BLS. This is only a small fraction of the over 300 million people in the United States. Several studies have implicated fear of mouth-to-mouth ventilation as the cause of the low incidence of bystander CPR.[44–48] Some authors have asserted that a lack of knowledge retention and/or a fear of harming the patient contribute to the low incidence.[49–52] Recently, Swor et al. showed that even trained bystanders often fail to perform bystander CPR in a real arrest situation.[53]

In this study we used the Arizona Utstein-style database and confirmed the low frequency of bystander CPR on a statewide basis to determine where arrests occur and to determine who is performing the bystander initiated resuscitations. Our study found an overall incidence of bystander CPR of 37%. After removing ''extended care and medical facilities'' the rate is 29%, and when resuscitations performed by trained bystanders are also removed, the rate of true layperson CPR is 25%. Additionally, this study found that 67% of all OHCA occur in the victim's private residence and that only 15% occur in actual public areas. When ''extended care and medical facilities'' are excluded, the percentage of arrests occurring in private residences increases to 82%.

The Arizona numbers are remarkably similar to those reported by Holmberg et al.[18] The Swedish Cardiac Arrest Registry between 1990 and 1995 showed that of 9877 patients, bystander CPR was attempted in 36% of cases (SHARE 37%), that 69% of arrests occurred at home (SHARE 67%) and that 23% of patients at home received bystander CPR (SHARE 24%) versus 53% at other venues (SHARE 52%). The odds ratio for survival with bystander CPR was 2.5 in Sweden and 2.2 in our study. This comparison validates our results, solidifies their implications regarding future directions of BLS education, and provides a baseline from which to evaluate the effectiveness of future education and/or interventions.

In order to increase survival rates from OHCA significantly efforts must be directed at the high percentage of arrests which take place in private residences. While a fear of mouth-to-mouth breathing has been established as a cause of low bystander CPR rates, this might have less relevance in the preponderance of OHCA which occur in private residences. Family members, friends and neighbors, who presumably have a vested interest in the victim's survival and who are less likely to fear communicable disease transmission, are not performing an essential and feasible step to save the life of a family member. Could it be that the major reason for not initiating bystander CPR is either a fear of incorrect CPR performance thereby causing harm to the victim or possibly a stress reaction that does not enable them to perform? In a recent study, Swor et al. found that in bystanders who elected not to perform CPR, 37.5% cited panic as the reason, while 9.1% perceived that they would not perform CPR correctly.[53] Additionally, in 2003, Casper et al. reported that family members were less likely to perform CPR.[54] In this very high stress situation the simplest possible effective intervention would seemingly be the most beneficial.

One of the implications of this study is that alternative methods of doing bystander CPR might well improve its incidence. One alternative method is chest compression only or continuous chest compression (CCC-CPR). The Arizona experience is that CCC-CPR is easier and less costly to teach, it is simpler and less time consuming for dispatchers attempting to prompt bystander providers,[42,55] it avoids the fear of transmission of communicable diseases,[44–48] and it is easier to remember which could potentially diminish the effects of panic and the fear of harming the patient.[56] CCC-CPR has the added benefits of decreasing hands-free time and increasing the number of chest compressions per minute. There is a growing body of animal and clinical data which not only supports CCC-CPR as a viable alternative to chest compressions with mouth-to-mouth ventilation, but shows that it is quite possibly more efficacious.[57–66]

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Limitations

This study is limited by its reliance on voluntary participation and while our data collection encompassed a majority of Arizona's population, there were communities in which data was not collected. Additionally, data was obtained by prehospital providers at the time of their patient encounter so there is no way to verify the description of the person performing CPR. While great measures were taken to categorize bystander CPR providers and locations of arrests accurately, some cases were difficult to discern. For instance, it is possible that some of the family and friends/neighbors were off-duty medical personnel who did not report their training. If this were the case, the percentage of true layperson CPR would have been even lower. Adult care homes and assisted living facilities were categorized as ''extended care and medical facilities'' because 31 of the 32 resuscitations were performed by trained personnel. Finally, while a hotel/motel might represent a victim's primary residence these were categorized as public areas.

Conclusions

It is feasible and vital for public health agencies to document and promote bystander CPR. We conclude that in Arizona, OHCA occurs most frequently in private residences and that bystander CPR more than doubles survival but that it is uncommonly performed. When bystander CPR is performed it is most often by a family member, suggesting that focused CPR training should be provided to family members of high risk individuals. Improved methods of not only performing bystander CPR, but also public education and mass training are necessary to increase survival from OHCA.

Conflict of interest statement

The authors declare no conflicts of interest.

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Our sincere appreciation goes to the EMS Providers across Arizona who dedicate themselves to saving lives every day, often under extreme circumstances. It is our aspiration to ensure that the personal risks they take do the greatest good.

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