Impact of Community-Wide Police Car Deployment of Automated External Defibrillators on Survival From Out-of-Hospital Cardiac Arrest

Robert J. Myerburg, MD; Jeffrey Fenster, MD; Mauricio Velez, MD; Donald Rosenberg, MD; Shenghan Lai, PhD; Paul Kurlansky, MD; Starbuck Newton, MS; Melenda Knox, AO, M-D PD; Agustin Castellanos, MD

Background**—**Disappointing survival rates from out-of-hospital cardiac arrests encourage strategies for faster defibrillation, such as use of automated external defibrillators (AEDs) by nonconventional responders.

Methods and Results**—**AEDs were provided to all Miami-Dade County, Florida, police. AED-equipped police (P-AED) and conventional emergency medical rescue (EMS) responders are simultaneously deployed to possible cardiac arrests. Times from 9-1-1 contact to the scene were compared for P-AED and concurrently deployed EMS, and both were compared with historical EMS experience. Survival with P-AED was compared with outcomes when EMS was the sole responder. Among 420 paired dispatches of P-AED and EMS, the mean±SD P-AED time from 9-1-1 call to arrival at the scene was 6.16±4.27 minutes, compared with 7.56±3.60 minutes for EMS ($P<0.001$). Police arrived first to 56% of the calls. The time to first responder arrival among P-AED and EMS was 4.88±2.88 minutes ($P<0.001$), compared with a historical response time of 7.64±3.66 minutes when EMS was the sole responder. A 17.2% survival rate was observed for victims with ventricular fibrillation or pulseless ventricular tachycardia (VT/VF), compared with 9.0% for standard EMS before P-AED implementation ($P=0.047$). However, VT/VF benefit was diluted by the observation that 61% of the initial rhythms were nonshockable, reducing the absolute survival benefit among the total study population to 1.6% (P-AED, 7.6%; EMS, 6.0%).

Conclusions**—**P-AED establishes a layer of responders that generate improved response times and survival from VT/VF. There was no benefit for victims with nonshockable rhythms. **(*Circulation*. 2002;106:1058-1064.)**

Key Words: defibrillation ■ tachycardia ■ resuscitation ■ death, sudden ■ heart arrest

Out-of-hospital sudden cardiac arrests account for 50% of cardiovascular deaths.[1,2] The first reports of impact of community-based emergency rescue systems (EMS) on its uniform fatality demonstrated survival rates of 14%[3] and 11%.[4] Subsequent refinements to response systems,[5,6] early defibrillation strategies,[7] and public education on bystander CPR[8] subsequently resulted in improved outcomes.[9,10] Survival outcomes peaked in the range of 30% for those in ventricular fibrillation and pulseless ventricular tachycardia (VT/VF) at initial contact. However, subsequent data from large metropolitan areas with heavy traffic congestion and vertical development led to disappointments, with overall survival rates as low as 1% to 2%,[11,12] while rural areas also suffered poor outcomes attributable to geographic factors.[13] In Miami-Dade County, Florida, the survival rate for victims found in VT/VF after witnessed-onset cardiac arrest had fallen to 9% in 1996, compared with 23% for both witnessed and unwitnessed onsets in the late 1970s.[14]

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New response strategies intended to reduce time to defibrillation have rekindled optimism. These approaches largely use strategically placed "smart" automated external defibrillators (AEDs),[15,16] designed to identify VT/VF and prompt the user when to deliver a shock. In 1999, Metropolitan Miami-Dade County, Florida, deployed AEDs to all of its police officers. We are reporting data on response times and survival rates compared with outcomes from Metropolitan Miami-Dade County's Fire Department–based EMS immediately before starting the police-AED program.

Methods

Between February 1 and July 1, 1999, AEDs (PhysioControl, LIFEPAK 500) were deployed to all Miami-Dade County, Florida, police officers. The start-up process included a 4-hour training session that included hands-on instruction on the use of AEDs. The

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From the Division of Cardiology, University of Miami School of Medicine (R.J.M., J.F., D.R., A.C.); Metropolitan Dade County Public Health Trust and Jackson Memorial Hospital (M.V.); Metropolitan Miami-Dade County Police Department (M.K.); and Miami Heart Research Institute (P.K., S.N.), Miami, Fla; and the School of Public Health, Johns Hopkins University (S.L.), Baltimore, Md.

Correspondence to Robert J. Myerburg, MD, University of Miami School of Medicine, PO Box 016960, Miami, FL 33101, E-mail rmyerbur@med.miami.edu

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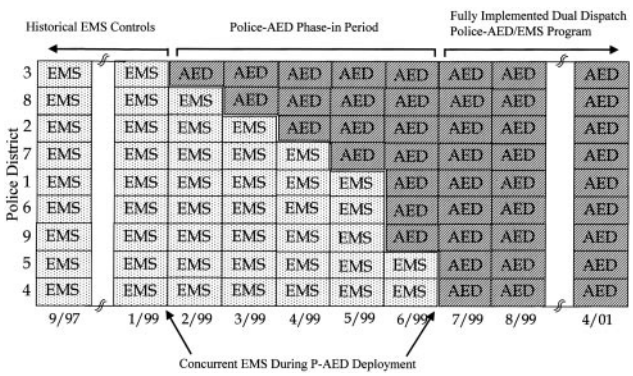

Figure 1. Implementation of the police-AED system in metropolitan Miami-Dade County. AEDs were deployed in the 9 county police districts between February 1 and July 1, 1999, with a decreasing number of police districts served only by EMS as more districts implemented police-AED service. The dual-dispatch police-AED and standard EMS program data are based on experience from February 1, 1999, through April 30, 2001 (see text), with the data from each district included from the month its AEDs were deployed.

education strategy used a "train-the-trainer" system, in which selected officers were trained as educators and participated in the training of others. Training and deployment were carried out sequentially in the 9 Miami-Dade County police districts (Figure 1); 1900 officers were trained during the 5-month implementation period. The cumulative area of Miami-Dade County, excluding incorporated municipalities having independent law enforcement agencies, is 1792 square miles, divided into 9 geographic districts ranging from 15 to 722 square miles (median, 37 square miles) and population densities of 261 to 6647 inhabitants per square mile (median, 635). The mean AED deployment density initially was 0.94 devices per square mile. The total population was 1 181 612 (2000 census), with a mean population density of 660 per square mile.

9-1-1 Communications System

The Metropolitan Miami-Dade County 9-1-1 emergency communications system was modified to meet the requirements of the police-AED (P-AED) dual-dispatch program. Before implementation, 9-1-1 calls coming into central emergency telecommunications were deployed to EMS if they were medical emergencies and to police for conventional police matters. With implementation of the P-AED program, selected codes for medical emergencies were simultaneously relayed to both police and EMS, and the service-specific telecommunication consoles dispatched the appropriate vehicles.

Response Strategies

Simultaneous dispatch of AED-equipped police and standard EMS is a strategy intended to achieve device availability, diagnosis, and defibrillation as quickly as possible when VT/VF is observed by the first service vehicle arriving at the scene (defined as "first responder" for this study). If the EMS vehicle arrives first, police are diverted. If police arrive first, they carry out defibrillation or CPR, according to the initial rhythm diagnosed and subsequent responses, continuing until EMS arrives. Once EMS is at the scene, police are relieved of additional responsibility. Police responsibilities are limited to basic life support and defibrillation, whereas EMS personnel have the added responsibility of providing advanced life support, if needed. In all cases, EMS transports the victim to the nearest appropriate hospital.

A case series with historical controls was the study design used to evaluate the effect on response times and survival. The time from 9-1-1 call to arrival at the scene was compared for P-AED runs and simultaneously dispatched EMS runs in the dual-dispatch system. Both were compared with historical EMS control response times. After AEDs were deployed in a given police district, the subsequent data were included in the dual-dispatch statistics (Figure 1). The historical control comparison is based on EMS response-time data and survival outcomes from September 1, 1997, until P-AED deployment was completed on or before July 1, 1999. Between February 1 and July 1, 1999, each district was counted among the historical controls until its officers received AEDs (Figure 1).

Inclusion Criteria, Data Acquisition, and Analysis

Inclusion in this analysis required documentation of a witnessed or unwitnessed loss of consciousness, not anticipated by prior clinical or hemodynamic status, in the absence of trauma or other exogenous influences as a definable precipitating event. In contrast, a broader range of deployment codes triggered police dispatches. These included witnessed and unwitnessed unexpected loss of consciousness, symptoms of impending loss of consciousness, or other cardiac events and several codes indicating a possible or existing medical emergency. Because initial experience yielded a large number of dispatches that were inappropriate for the intent of the P-AED program, codes that yield no cardiac arrests are evaluated for discontinuation from the dispatch list. This process continues on an ongoing basis.

Special police forms were developed for the program, and the data from these forms were validated and supplemented by information from standard EMS forms generated during the simultaneous EMS runs. All data were entered into a dedicated computer database. The available information provides time intervals measured from 9-1-1 call to police dispatch, arrival at scene, arrival at patient's side, deployment of the AED, defibrillation, and arrival at hospital emergency departments. Demographic data, as well as information on the scene of cardiac arrest, were also recorded. Survival outcomes were acquired from receiving hospitals and families; survival to hospital discharge was the primary end point in the analysis.

To achieve accurate and comparable time points for the multiple timed elements of the responses, the internal clocks in the AEDs and the clocks in the emergency communications center, telecommunication consoles, and computer-assisted dispatch (CAD) systems all are synchronized to atomic clock time. When a 9-1-1 call is received, the CAD system assigns a time stamp automatically, and the time of dispatch of both police and EMS vehicles are linked to that standard. The time of arrival at the scene must be called in by both police and EMS and logged into the CAD, generating a time stamp also linked to the 9-1-1 incoming call standard. However, the time from arrival at scene to arrival at patient's side is not uniformly called in to the CAD operator and therefore not linked to atomic clock time. The atomic clock-linked AEDs provide standardized time references for power-up and shocks. Because of this, the primary definition of response time, for the purpose of comparing police AED and EMS, was based on the interval from 9-1-1 call to arrival at scene, because these time points are linked to a uniform standard. Finally, time of onset of cardiac arrests to 9-1-1 call was estimated on the police forms, but they were approximations provided by witnesses, not uniformly available, and not linked to the atomic clock standard.

Statistical Analysis

Student's t test was used to compare response time between the different groups. All probability values reported are 2-sided. Comparisons of survival rates and of proportions of responders arriving at the scene of a cardiac arrest in a specific time were carried out by χ^2 analyses.

Results

Between February 1, 1999, and April 30, 2001, the metropolitan Miami-Dade County emergency communications center received 2 243 732 calls to 9-1-1, among which 56 321 (2.5%) triggered dual police-AED and EMS dispatches to possible or definite medical emergencies and 82 124 (3.7%) were nonmedical police emergencies. Police medical calls, therefore, averaged 2086 per month (70 per day county-wide

TABLE 1. Demographics of Cardiac Arrest Victims

	CONTROL EMS (September 1997 to July 1999)	POLICE-AED/EMS (February 1999 to April 2001)
No.	318	420
Age, y	69.5±15.1	67.8±16.3
Sex, male/female (% male)	186/132 (59)	257/163 (61)
Ethnicity		
White	109 (34.3)	113 (26.9)
African American	74 (23.3)	71 (16.9)
African Carribean	3 (0.9)	4 (1.0)
Hispanic	124 (39.0)	219 (52.1)
Other	8 (2.5)	13 (3.1)

Values are n (%) or mean±SD. Control EMS indicates conventional fire-rescue system before implementation of police-AED program; Police-AED/EMS, dual-dispatch police and EMS system.

or 8 per district). Based on the number of shifts and cars, this accounts for 1.1 dispatches per AED per month.

Among the police medical emergency runs, 420 (0.75%) were true cardiac arrests. In comparison, during the historical control period from September 1, 1997, until district-specific implementation of the P-AEDs, the standard EMS system deployed 318 sole responders to actual cardiac arrests (Figure 1). Police arrived first to 237 of the 420 dual dispatches to true cardiac arrests (56%). EMS arrived before police in 138 instances (33%), and police and EMS arrived simultaneously in 45 (11%).

The mean age of the 420 cardiac arrest victims responded to in the police-AED program was 67.8±16.3 years (mean±SD), and 257 (61%) were males. Among the 318 historical EMS controls, the mean age was 69.5±15.1 years, and 186 of the 318 (59%) were males (P=NS for age and sex) (Table 1). The initial rhythm recorded at the scene of cardiac arrest (see Figure 2 and Table 2) was a shockable rhythm, VT/VF, in 163 (39%) of the police-AED responses and 122 (38%) of the standard EMS responses.

Response Times

P-AED times from 9-1-1 call to arrival at the scene of cardiac arrest and from call to patient's side were shorter than concurrent EMS response times. Among the 420 dual dispatches to cardiac arrests, the mean±SD police response time to arrival at the scene was 6.16±4.27 minutes (median, 6). During the same period, the mean police response time to the scene of nonmedical police emergencies was 4.15±1.40 minutes ($P<0.0001$) (Figure 2).

The response time to the scene by simultaneously dispatched EMS vehicles after implementation of the police-AED program was 7.56±3.60 minutes (median, 7 minutes; $P<0.001$ compared with police) (Table 2). Because EMS arrived first in 33% of the paired police-AED/EMS runs, the arrival time of the first service at the scene was analyzed separately (Table 2). This analysis demonstrated an arrival time of the first responder of 4.88±2.88 minutes (median, 5 minutes; $P<0.001$ compared with EMS controls) (Figure 2). The historical control response time for standard EMS before implementation of the police-AED program (including the proportional of the 5-month phase-in period) was available for 315 of the 318 runs (99%). The response time was 7.64±3.66 minutes (median, 7 minutes), not different from the actual EMS response time of 7.56±3.60 minutes during the paired observation period after police AED deployment.

The interval to arrival at patients' side added small time increments to the response times, generally of an average

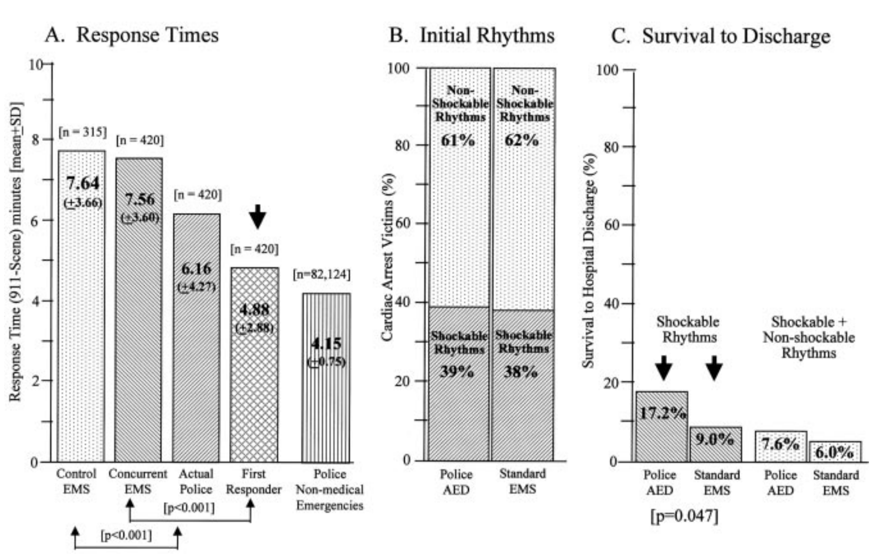

Figure 2. Response times, initial rhythms recorded, and survival to discharge from hospital. A, EMS responses times were similar before and during the dual-dispatch police AED program, whereas there were improved response times by police and combined police/EMS first responders with the AED program. B, Proportion of victims having shockable rhythms at initial contact was similar (and lower than expected) in both the EMS control observations and the police-AED program. Victims found in shockable rhythms at initial contact had a significantly higher survival rate during the police-AED program (17.2%) than during the EMS control period (9.0%), P=0.047.

TABLE 2. Police and Emergency Rescue Responses to Cardiac Arrests

	Before Police AED Program		After Implementation of Police AED Program			
	n (%)	EMS, min, mean±SD	n (%)	Police, min, mean±SD	EMS, min, mean±SD	First Responder, min, mean±SD
Response times: 9-1-1 call to scene of cardiac arrest						
All events	315	7.64±3.66	420	6.16±4.27	7.56±3.60	4.88±2.88
Shockable rhythms	121 (38.4)	7.53±3.33	163 (38.8)	5.85±3.68	7.53±3.82	4.77±2.65
Nonshockable rhythms	194 (61.6)	7.71±3.85	257 (61.2)	6.35±4.61	7.56±3.47	4.94±3.01
Witnessed onset	111 (35.2)	7.71±3.62	209 (49.8)	6.36±4.33	7.94±3.74	5.12±2.99
Nonwitnessed onset	204 (64.8)	7.60±3.69	211 (50.2)	5.96±4.22	7.16±3.44	4.63±2.73
Response times: 9-1-1 call to victim's side						
All events	315	8.13±3.73	420	6.56±4.38	8.06±3.88	5.29±2.97
Shockable rhythms	121 (38.4)	7.97±3.47	163 (38.8)	6.29±3.87	7.92±3.88	5.18±2.80
Nonshockable rhythms	194 (61.6)	8.25±3.90	257 (61.2)	6.75±4.69	8.15±3.90	5.35±3.08
Witnessed onset	111 (35.2)	8.17±3.76	209 (49.8)	6.78±4.39	8.46±4.20	5.52±3.06
Nonwitnessed onset	204 (64.8)	8.12±3.73	211 (50.2)	6.36±4.39	7.66±3.52	5.06±2.88

First responder indicates first service to arrive at scene of cardiac arrest (see text).

duration of 45 seconds or less for all categories of response (see Table 2 for details). There was not a significant difference in response time for victims in shockable versus nonshockable rhythms, nor for witnessed versus nonwitnessed onset, although interpretation of each of these figures is limited by lack of reliable and complete data on the intervals between onset of cardiac arrest and activation of 9-1-1, particularly for the nonwitnessed events.

Analyses of the distribution of response times among police-AED responders, paired EMS responders, and historical EMS responders demonstrate that the proportion of response times <5 minutes from 9-1-1 activation is significantly higher for the police-AED responses than for either of the EMS analyses. Thirty-four percent of the police responses were achieved in <5 minutes, compared with 14% for concurrent EMS ($P<0.001$) and 11% for historical EMS deployments before the police program ($P<0.001$) (Figure 3). Moreover, the first responder time to the scene of cardiac arrest during the police-AED program was <5 minutes in 41% of the runs ($P<0.001$ compared with historical EMS controls). Thus, despite the relatively small difference in mean response time between police and EMS (<2 minutes; see Table 2), the skewed response times suggest that a dual-dispatch police/EMS system offers a response-time advantage to a substantial segment of the individuals at risk (Figure 3).

Survival Data

Among 163 victims in VT/VF at first contact, 28 (17.2%) responded to in the P-AED program survived to hospital

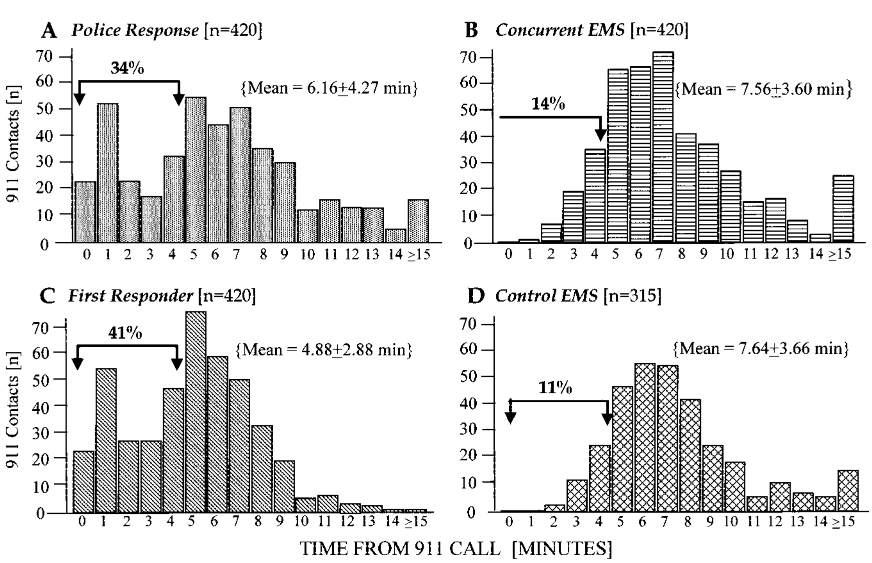

Figure 3. Distributions of response times from 9-1-1 contact to arrival at the scene of cardiac arrest. Data for police response times (A) and concomitant EMS responses in the dual-dispatch program (B) are compared with the first responder arrival time (C) and with the historical control EMS response time (D). Thirty-four percent of the police responders arrived at the scene in <5 minutes, compared with 14% for the paired EMS controls. First responders arrived in <5 minutes in 41% of the runs ($P<0.001$). The vertical axis is absolute numbers of cardiac arrest runs. The horizontal axis is the time from 9-1-1 call to arrival at the scene (minutes). Zero represents an arrival time of 59 seconds or less.

TABLE 3. Survival With Police and Fire-Rescue Responses to Cardiac Arrest

	No. (%)	Nonshockable Rhythms, n (%)	Shockable Rhythms: VT/VF, n (%)	Cumulative Survival, n (%)	VT/VF Survival, n (%)	Odds Ratio for VT/VF (95% CI)	P for VT/VF
All cardiac arrests							
Police AED program	420	257 (61.2)	163 (38.8)	32 (7.62)	28 (17.2)	2.1 (1.0–4.2)	0.047
Standard EMS	318	196 (61.6)	122 (38.4)	19 (5.97)	11 (9.0)	...	...
Witnessed cardiac arrests							
Police AED program	209 (49.8)	113 (54.1)	96 (45.9)	25 (13.6)	23 (24.0)	2.7 (1.0–7.0)	<0.05
Standard EMS	111 (34.9)	54 (48.7)	57 (51.4)	13 (11.7)	6 (10.5)	...	...
Unwitnessed cardiac arrests							
Police AED program	211 (50.2)	144 (68.2)	67 (31.8)	6 (2.84)	5 (7.5)	...	...
Standard EMS	207 (65.1)	142 (68.6)	65 (31.4)	6 (2.90)	5 (7.7)	...	...

discharge, compared with 11 of 122 (9.0%) in the standard EMS program (Figure 2). The odds ratio for survival during the P-AED program was 2.1 (95% CI, 1.0 to 4.2), $P=0.047$ (Table 3). In contrast, and as expected, the survival rate for victims in nonshockable rhythms was very low and was not benefited by the P-AED program. The overall survival for such victims was only 4 among 257 events (1.6%) in the P-AED program and 8 of 196 events (4.1%) in the historical EMS group. Thus, cumulative survival data to hospital discharge revealed a small, statistically insignificant survival benefit for the police-AED program compared with standard EMS (32 police-AED survivors [7.6%] versus 19 standard EMS survivors [6.0%]; OR, 1.3; P=NS).

The survival benefit of the police-AED deployment strategy for victims in VT/VF was slightly higher for those victims with VT/VF in whom the onset was witnessed (Table 3, Figure 4). Witnessed onset yielded a 24.0% (23 of 96) survival rate for P-AED and 10.5% (6 of 57) for standard (historical) EMS and a similar proportional benefit for police-AED compared with standard EMS (OR, 2.7 [95% CI, 1.0 to 7.0]; $P<0.05$) (Table 3).

Discussion

There are two major observations in this study. First, having police equipped with AEDs, dispatched in parallel with conventional EMS responders in a large metropolitan area, results in improved response time from 9-1-1 call to arrival at the scene of cardiac arrest. Second, the improved response time correlates with an improved outcome among victims having VT/VF on first contact. However, we also observed a disappointingly high proportion of patients in nonshockable rhythms at initial contact.

We used time from 9-1-1 call to arrival at the scene as response time, because the boundaries of this interval are linked to the atomic clock and thus provide valid measures for comparing the responses of the two systems. The data demonstrate a response time advantage to the dual-dispatch system. These measures, however, do not provide a valid estimate of total ischemic time, namely from onset of cardiac arrest to attempted defibrillation. That measure, which is extraordinarily difficult to acquire with accuracy, requires accurate identification of onset of cardiac arrest and of return of spontaneous circulation (or at least attempted defibrillation). The front end of that measure, namely from onset of cardiac arrest to 9-1-1 deployment, is very likely to have a role in generating the unexpectedly high number of nonshockable rhythms. Because that measure will affect both police and EMS, it is not likely to have a differential effect in the two systems. Furthermore, it is a measure that is available only in those studies in which the onset of cardiac arrest was witnessed by medical or paramedical personnel.[17,18] Thus, an estimate of the potential impact of a dual-deployment system on survival cannot be based on our measured response times alone. The ultimate benefit might be greater than we observed if the initial delays could be measured, found to be large, and addressed by new strategies.

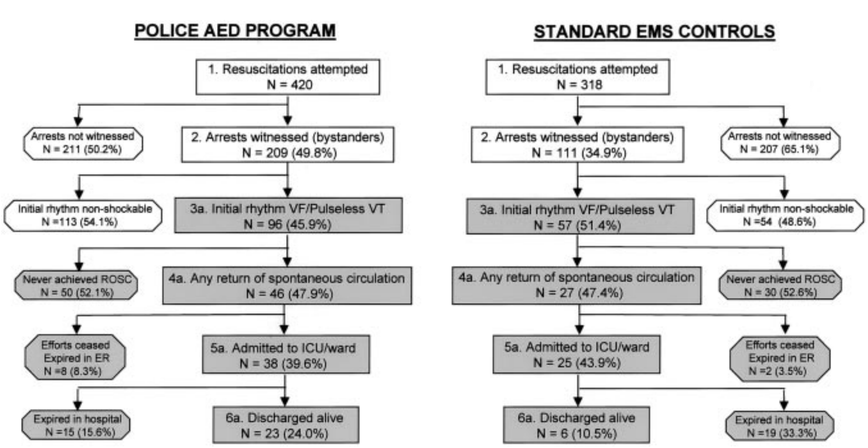

Figure 4. Modified Utstein-style template for witnessed-onset pulseless VT/VF, comparing the experience during the police-AED program to that during the historical control period. The Utstein components are limited to those for which complete data were available for both templates.

The concept of AEDs has existed for nearly 25 years, but strategic deployments and integration into nonconventional community response programs did not begin until recently because of technological factors and limited acceptance.[15,16,19] With recent advances, deployment of AEDs in strategic locations, such as airports,[20] airliners,[20,21] casinos,[22] stadiums, office buildings, and other areas where large numbers of people congregate,[23–25] has begun to demonstrate that an impact on survival is feasible. The concept is now achieving acceptance, and its effectiveness is being measured.

One strategy involves expansion of the concept beyond conventional EMS and ambulances into other emergency vehicle deployments, such as AED-equipped police cars.[26–28] In this strategy, police function as an adjunctive response system for improving response times and outcomes. Although data from one community that pioneered police-AED concepts (Rochester, Minnesota) did not demonstrate a major response time benefit of police over standard responders,[26] the characteristics of that community suggest that problems faced by other areas, such as congestion and vertical development, would not be as great an impediment to responses by conventional systems, as would densely populated areas such as New York and Chicago.[11,12] Despite the fact that police in Rochester achieved a mean response time improvement of $<$1 minute, data from that study did demonstrate that police responders were as effective as conventional responders for defibrillation and survival.[26]

The metropolitan Miami-Dade County police project is the first successful example of uniform deployment of AEDs in police vehicles throughout a major geopolitical entity. A prior study of police response times in a region of the metropolitan area of Amsterdam, The Netherlands, demonstrated a police response time benefit.[27] Data acquired from the larger metropolitan Miami-Dade area, with its geographic dispersion and traffic congestion, also demonstrated a significant benefit of police-related response times. Although the mean police response time was $<$2 minutes shorter than the mean EMS response time, the fact that EMS was the first responder in 33% of the cases improved the effective response time by nearly 3 minutes, compared with EMS alone. This occurred in the time range of important impact with each passing minute,[29] between 4 and 7 minutes. Thus, the layering of police with AEDs as an additional strategy, integrated with an existing EMS system, yielded a net response time benefit that was greater than that apparent from police data alone. The added fact that 41% of the first responses in a large metropolitan area occurred with a response time of $<$5 minutes, compared with only 14% for conventional EMS responders ($P<0.001$), is also encouraging (Figure 2).

Despite disappointing observations in some police-AED programs,[30] our observations support the feasibility and benefit of assigning police officers a role in emergency responses in a large metropolitan area. Methods of implementation and continued problem-solving meetings among police, EMS, and project medical personnel are important to its success. The strategies are complex and must be tailored to circumstances in each community. For example, the curious observation that the mean police response time to nonmedical emergencies was 4.15 ± 1.40 minutes, compared with 6.16 ± 4.27 minutes for the medical calls—a 2.1-minute mean differential—raises additional questions that require clarification. Possible explanations include multiple vehicle responses to certain types of crimes in progress and the relationship between geography of certain police districts versus incidence of cardiac arrest events in those districts. In any case, the time differential offers the possibility for additional improvements in response times as the reasons are clarified and addressed.

The survival data observed for cardiac arrest victims found to be in VT/VF by first responders was better than recent historical outcomes in the same county—17.2% compared with 9.0%—and both were somewhat better for events with witnessed onset. This outcome achieved statistical significance with an odds ratio for survival with the P-AED program of 2.1 ($P=0.047$). However, this subgroup benefit was diluted by the unexpectedly high proportion of cardiac arrest victims found to be in nonshockable rhythms at first contact ($>$60%). Although others have suggested a high proportion of nonshockable rhythms,[17,18,31] including an unexplained trend in this direction in recent years,[17] this unexpected observation compared with prior observations in this community[32] reduced the cumulative benefit to 7.6% survival for the police-AED program versus 6.0% in the standard EMS program, an absolute difference of only 1.6%. These data establish a challenge to identify the reason for the excess of nonshockable rhythms and hopefully improve it. Although the survivors had shorter response times than nonsurvivors, the mean response times for witnessed-onset nonsurvivors with shockable and nonshockable rhythms were not significantly different from one another (Table 3), and the mean response time for those survivors with shockable or nonshockable rhythms were also similar to each other. Although the excess of nonshockable rhythms may be attributable, in part, to delays in activation of the 9-1-1 system, another report providing data on mechanisms of cardiac arrests that occur after the arrival of EMS also showed a higher than expected proportion of nonshockable rhythms.[17]

This likelihood that delays in 9-1-1 activation play at least a partial role in the excess of nonshockable rhythms leads to the notion that any effective strategy must include continuing attention to public education efforts calling for prompt contact of emergency systems. Our data suggesting both response time and survival benefits as a consequence of a P-AED program can have even more meaningful impact if other components encouraging rapid responsiveness, such as public education, public information, and police responder efficiency, are also addressed.

The data reported also highlight a layering effect of added access to early defibrillation. There was an interaction between police with AEDs and EMS in the first responder data (Figure 3), supporting the general goal of rapid accessibility to defibrillation.[6,9,10,15,16] Whatever benefit police-AED strategies add to a community's response systems, even more benefit might be expected to be achieved by other public access deployment strategies. Cumulatively, they prepare the community for cardiac arrest responses from multiple points of attack.[2,15,16]

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References

1. Myerburg RJ, Castellanos A. Cardiac arrest and sudden cardiac death. In: Braunwald E, Zipes DP, Libby P, eds. *Heart Disease: A Textbook of Cardiovascular Medicine*. 6th ed. Philadelphia, Pa: WB Saunders; 2001: 890–931.
2. Myerburg, Robert J. Sudden cardiac death: exploring the limits of our knowledge. *J Cardiovasc Electrophysiol.* 2001;12:369–381.
3. Liberthson RR, Nagel EL, Hirschman JC, et al. Prehospital ventricular fibrillation: prognosis and follow-up course. *N Engl J Med*. 1974;291: 317–321.
4. Baum RS, Alvarez H, Cobb LA. Survival after resuscitation from out-or-hospital ventricular fibrillation. *Circulation*. 1974;50:1231–1235.
5. Eisenberg MS, Hallstrom A, Bergner L. The ACLS score: predicting survival from out-of-hospital cardiac arrest. *JAMA*. 1981;246:50–52.
6. Weaver WD, Cobb LA, Hallstrom AP. Factors influencing survival after out-of-hospital cardiac arrest. *J Am Coll Cardiol*. 1986;7:752–775.
7. Eisenberg MS, Copass MK, Hallstrom AP, et al. Treatment of out-of-hospital cardiac arrests with rapid defibrillation by emergency medical technicians. *N Engl J Med*. 1980;302:1379–1383.
8. Thompson RG, Hallstrom AP, Cobb LA. Bystander-initiated cardiopulmonary resuscitation in the management of ventricular fibrillation. *Ann Intern Med*. 1979;90:737–740.
9. Cobb LA, Weaver WD, Fahrenbruch CE, et al. Community-based interventions for sudden cardiac death: impact, limitations, and changes. *Circulation*. 1992;85(suppl 1):I-98–I-102.
10. Cummins RO, Ornato JP, Thies WH, et al. Improving survival from sudden cardiac arrest: the chain of survival concept. *Circulation*. 1991; 83:1832–1847.
11. Becker LB, Ostrander MP, Barrett J, et al. Outcome of CPR in a large metropolitan area: where are the survivors? *Ann Emerg Med*. 1991;20: 355–361.
12. Lombardi G, Gallagher J, Gennis P. Outcome of out-of-hospital cardiac arrest in New York City: the pre-hospital arrest survival evaluation study. *JAMA*. 1994;271:678–683.
13. Stults KR, Brown DD, Schug VL, et al. Prehospital defibrillation performed by emergency medical technicians in rural communities. *N Engl J Med*. 1984;310:219–223.
14. Myerburg RJ, Conde CA, Sung RJ, et al. Clinical, electrophysiologic, and hemodynamic profile of patients resuscitated from prehospital cardiac arrest. *Am J Med*. 1980;68:568–576.
15. Nichol G; Hallstrom AP, Kerber R, et al. American Heart Association report on the second public access defibrillation conference, April 17–19, 1997. *Circulation*. 1998;97:1309–1314.
16. Marenco JP, Wang PJ, Link MS, et al. Improving survival from sudden cardiac arrest: the role of the automated external defibrillation. *JAMA*. 2001;285:1193–1200.
17. Herlitz J, Andersson E, Bang A, et al. Experiences from treatment of out-of-hospital cardiac arrest during 17 years in Goteborg. *Eur Heart J*. 2000;21:1251–1258.
18. DeMaio VJ, Stiell IG, Wells GA, et al. Cardiac arrest witnessed by emergency medical services personnel: descriptive epidemiology, prodromal symptoms, and predictors of survival. OPALS study group. *Ann Emerg Med*. 2000;35:138–146.
19. Eisenberg MS, Moore J, Cummins RO, et al. Use of the automatic external defibrillator in homes of survivors of out-of-hospital ventricular fibrillation. *Am J Cardiol*. 1989;63:443–446.
20. O'Rourke MF, Donaldson EE, Geddes JS. An airline cardiac arrest program. *Circulation*. 1997;96:2849–2853.
21. Page RL, Joglar JA, Kowal RC, et al. Use of automated external defibrillators by a US airline. *N Engl J Med*. 2000;343:1210–1216.
22. Valenzuela TD, Roe DJ, Nichol G, et al. Outcomes of rapid defibrillation by security officers after cardiac arrest in casinos. *N Engl J Med*. 2000; 343:1206–1209.
23. Smith SC, Hamburg RS. Automated external defibrillators: time for federal and state advocacy and broader utilization. *Circulation*. 1998;97: 1321–1324.
24. Becker L, Eisenberg M, Fahrenbruch C, et al. Public locations of cardiac arrest: implications for public access defibrillation. *Circulation*. 1998;97: 2106–2109.
25. Robertson RM. Sudden death from cardiac arrest: improving the odds. *N Engl J Med*. 2000;343:1259–1260.
26. White RD, Hankins DG, Bugliosi TF. Seven years' experience with early defibrillation by police and paramedics in an emergency medical services system. *Resuscitation*. 1998;39:145–151.
27. Waalewijn RA, de Vos R, Koster RW. Out-of-hospital cardiac arrests in Amsterdam and its surrounding areas: results from the Amsterdam resuscitation study (ARREST) in "Utstein" style. *Resuscitation*. 1998;38: 157–167.
28. Mosseso VN Jr, Davis EA, Auble TE, et al. Use of automated external defibrillators by police officers for treatment of out-of-hospital cardiac arrest. *Ann Emerg Med*. 1998;32:200–207.
29. Holmberg M, Holmberg S, Herlitz J. The problem of out-of-hospital cardiac-arrest: prevalence of sudden death in Europe today. *Am J Cardiol*. 1999;83:88D–90D.
30. Groh WJ, Newman MM, Beal PE, et al. Limited response to cardiac arrest by police equipped with automated external defibrillators: lack of survival benefit in suburban and rural Indiana. The police as responder automated defibrillation evaluation (PARADE). *Acad Emerg Med*. 2001;8:324–330.
31. Kette F, Sbrojavacca R, Rellini G, et al. Epidemiology and survival rate of out-of-hospital cardiac arrest in north-east Italy: the F.A.C.S. study. Friuli Venezia Giulia Cardiac Arrest Cooperative Study. *Resuscitation*. 1998;36:153–159.
32. Myerburg RJ, Kessler KM, Zaman L, et al. Survivors of prehospital cardiac arrest. *JAMA*. 1982;247:1485–1490.