Roger C. Bone, MD, *Section Editor*

Distinct Criteria for Termination of Resuscitation in the Out-of-Hospital Setting

Marni J. Bonnin, MD; Paul E. Pepe, MD; Kay T. Kimball, PhD; Peter S. Clark, Jr, EMT

Objective.—To identify distinct criteria for appropriate on-scene termination of resuscitation efforts for out-of-hospital cardiac arrest when on-scene interventions fail to restore spontaneous circulation.

Design.—For 18 months, all out-of-hospital cardiac arrests were evaluated prospectively for survival to hospital discharge and for all established survival predictors including age, gender, presenting cardiac rhythm, whether it was a witnessed event, performance of basic cardiopulmonary resuscitation by bystanders, and interval to paramedic arrival and return of spontaneous circulation (ROSC).

Setting.—A large municipality with a single, centralized emergency medical services program.

Patients.—All normothermic adults treated for out-of-hospital, unmonitored, primary cardiac arrest.

Interventions.—Standard advanced cardiac life support provided at the scene by paramedics.

Main Outcome Measures.—The number and circumstances of patients achieving survival to hospital discharge following failure to achieve on-scene ROSC.

Results.—Of 1461 consecutive primary cardiac arrests, 139 were monitored (paramedic witnessed), including 59 that occurred en route to the hospital. Of the 1322 unmonitored patients, 370 achieved ROSC at the scene. Only six (0.6%) of the 952 who did not achieve ROSC at the scene survived, and all six were readily identifiable as having persistent ventricular fibrillation. Excluding those patients with persistent ventricular fibrillation, all survivors achieved ROSC within 25 minutes after paramedic arrival.

Conclusions.—Excluding patients with persistent ventricular fibrillation, resuscitative efforts can be terminated at the scene when normothermic adults with unmonitored, out-of-hospital, primary cardiac arrest do not regain spontaneous circulation within 25 minutes following standard advanced cardiac life support. These criteria should now be validated in several large centers with high survival rates.

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SINCE the late 1960s, it has been demonstrated that most cases of "sudden death" in our communities are the result of potentially reversible ventricular fibrillation (VF).[1-5] However, most cardiac arrests occur in the home and other out-of-hospital settings.[2-5] As a result, during the past 20 years, elaborate systems of emergency prehospital care have been established worldwide to provide improved resuscitative efforts for the millions of annual victims of out-of-hospital sudden death.[2-6] Furthermore, to ensure the best possibility of survival, it has been standard practice in most paramedic systems to continue resuscitation efforts until the patient has been attended and evaluated directly by an emergency department (ED) physician. Therefore, although risks are associated with rapid emergency transport by ambulance,[7] in most communities, cardiac arrest victims who are not revived at the scene are still urgently transported to an ED for further resuscitative efforts. In turn, any decisions to terminate efforts and to make a pronouncement of death are usually carried out directly by the ED physician.

See also pp 1433 and 1471.

Recently, however, it has been promulgated that certain persons who have experienced out-of-hospital cardiac arrest should be pronounced dead at the scene.[8-11] Several studies have indicated that only patients regaining spontaneous pulses in the prehospital setting eventually survive to successful hospital discharge.[8,12-18] Still, those studies have been limited, particularly for sample size, inclusion criteria, and low survival rates in the emergency medical services (EMS) systems being studied. In addition, to our knowledge, none of the studies has established clear, practical criteria for delineating when patients have no further potential for survival (and therefore could be pronounced dead at the scene). In most of these reports, outcomes were followed up in only those patients arriving at the ED without pulses. However, in some of these series, patients classified as survivors had regained spontaneous pulses en route to the hospital. Such patients

From the City of Houston (Tex) Center for Resuscitation and Emergency Medical Services (Drs Bonnin and Pepe and Mr Clark), and the Department of Medicine, Baylor College of Medicine, Houston, Tex (Drs Bonnin, Pepe, and Kimball).

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Reprint requests to The City of Houston Center for Resuscitation and Emergency Medical Services, 410 Bagby, Suite 300, Houston, TX 77002 (Dr Pepe).

may have been inappropriately pronounced dead at the scene if efforts had been terminated prematurely because of a continued absence of pulses during on-scene efforts.

Therefore, the purpose of this investigation was to prospectively determine which patients, if any, survive to hospital discharge following failure to achieve on-scene restoration of spontaneous circulation (ROSC). Using these data, we hoped to establish the circumstances and applicable criteria under which patients can be declared dead at the scene and in turn can have their resuscitation efforts appropriately terminated.

PATIENTS AND METHODS

Patient Population

The study involved a 1.5-year evaluation of all adult out-of-hospital cardiac arrest patients (age ≥18 years) treated within the city limits of Houston, Tex. As part of a comprehensive registry, those patients with cardiac arrests that were clearly associated with trauma, aberration in body temperature, a primary respiratory etiology, or drug overdose were inclusively evaluated per routine. However, these categories were excluded from this specific analysis in that our study objective was an examination of primary cardiac arrest (recognizing that this designation still remains a diagnosis of exclusion).[2]

To comply with evolving recommendations, patients with monitored (paramedic-witnessed) cardiac arrests were evaluated separately (many of these cardiac arrests occur en route to the hospital and they may bode a different prognosis).[2,19,20] Therefore, the target population to be analyzed in this study was the group with unmonitored cardiac arrests. By far, this group constitutes the majority (85% to 90%) of primary cardiac arrests.[3,19,20]

Clinical Setting and Procedures

By ordinance, the City of Houston Fire Department is the sole initial responder and provider of EMS within the city limits of Houston. At the time of the study, two-member advanced life-support (ALS) units were staffed minimally with one paramedic firefighter and either another paramedic or a basic emergency medical technician firefighter. The ALS crews were assisted at every cardiac arrest scene by a four-member firefighter first-responder team, and an EMS supervisor (an experienced Houston Fire Department paramedic officer).[21] First-responder firefighters were trained in basic cardiopulmonary resuscitation (CPR) and bag-valve–mask ventilation.[21] Cardiac arrest management was provided according to a routine protocol that followed standard American Heart Association guidelines for advanced cardiac life support (ACLS).[5] The ACLS provided included cardiac rhythm interpretation, endotracheal intubation and ventilation (15 mL/kg tidal volume) with 100% oxygen, peripheral intravenous (IV) access (including external jugular cannulation), and drug administration, but no central venous access or intracardiac injections.[5,22] All of the paramedics, emergency medical technicians, first-responders, and base-station physicians operated under the training and singular direction of the physician director of the Houston EMS system (P.E.P.). Except for those patients who regained spontaneous circulation at an earlier interval, all patients received continued efforts at the scene for at least a half hour and were then taken to the hospital for continued efforts. All cardiac arrests also received comprehensive, retrospective, individual chart reviews as well as collective data analyses.[2]

The Houston EMS covers an amoeboid 600-square-mile territory (spread over 1000 square miles) and serves a base population of about 1 700 000 established residents with daytime populations estimated to exceed 3 million.[23] In priority calls, the average response time is approximately 5 minutes for first-responder crews and 10 minutes for ALS providers (paramedics) when measuring the interval from the first telephone ring at the 911 dispatch center until arrival at the scene.[2,19,24,25] Although less than 2% of these initial paramedic responses involve cardiac arrests, these calls are given priority and are dispatched within a minute of the first telephone ring.[2,25] First responders are sent simultaneously with ALS units in essentially all (99%) of the cardiac arrest cases. While they are en route to the scene, "prearrival" instructions, including those for basic CPR, are provided to bystanders over the telephone by the dispatchers.[25]

Definitions of Study Variables

Prospectively defined, standardized data were collected routinely for each cardiac arrest patient at the time of their cardiac arrest (list to follow). These data were entered into a computerized database immediately after arrival at the hospital. Within 24 hours, the data were retrieved and collated into the comprehensive cardiac arrest registry of the Houston EMS system. Each individual patient's record analysis included (but was not limited to) age, gender, presence and type of witnesses (eg, family, friend, bystander, police officer, firefighter, physician, nurse, or other), initiator(s) of basic CPR (same as witness list), achievement of or failure to achieve ROSC at the scene, ALS (paramedic) unit response interval (measured from the first ring at the 911 center), presenting electrocardiographic (ECG) rhythm at the scene and the rhythm recorded at the time of hospital arrival and, in applicable cases, the elapsed time to ROSC following the arrival of the first ALS provider.[2,19] Also measured were on-scene intervals (measured from paramedic arrival at the patient's street location until subsequent ambulance departure from the scene) and hospital transport intervals (departure from scene until arrival at the ED). The performance of bystander CPR refers to cases where someone at the scene performed basic CPR techniques prior to the arrival of members of the formal emergency response crews activated by the 911 system.

For this study, patients were defined as having achieved ROSC if they were noted to have a spontaneous palpable pulse rate of 60 beats per minute for at least one 5-minute period or longer. Patients who only transiently regained pulses, even those maintaining them for 3 or 4 minutes, were referred to as having achieved "near ROSC" for internal classification purposes. However, within the context of the study results, they were still classified as not having met the criteria for ROSC.

The paramedics' interpretations of ECG rhythms were used for all prehospital ECG analyses. Patients whose VF or ventricular tachycardia (VT) could not be converted at any time by repeated countershock in the prehospital setting were classified as having "refractory" VF or VT, accordingly. Those patients whose VF or VT could be converted but then experienced continuous refibrillation within 3 minutes after the last conversion were classified as persistent, recurring VF or VT in applicable cases. Definitions for electromechanical dissociation and absence of pulses with an idioventricular rhythm have been previously described.[26] Using current standards (developed subsequently to study completion), these two ECG rhythms would have been categorized together under the umbrella term "pulseless electrical activity."[11]

The primary outcome variable was whether a patient achieved survival to hospital discharge. Patients were secondarily classified as either being (1) pronounced dead in the ED or (2) admitted (in-hospital admission). Although the primary outcome variable was survival to hospital discharge, for EMS sys-

tem quality assurance, all survivors or their family members were also subsequently contacted by telephone to assess neurological status 6 months or more following hospital discharge.[2] Neurological status was considered to be significantly impaired if (1) this was the family's opinion using a simplified cerebral performance category score (score ≤3) or (2) the patient still required residence in a long-term care facility because of neurological difficulties 6 months after hospital discharge.[19]

Statistical Methods

The main goal of this model was to determine how well failure to achieve on-scene ROSC predicts nonsurvival.[27] Specifically, we wanted to prospectively evaluate the specificity of this predictor and the characteristics of any patients who still survived to hospital discharge following failure to achieve ROSC at the scene. An unconditioned logistic regression analysis (Stata Release 3, Computing Resource Center, Santa Monica, Calif, 1992) was used to evaluate the joint prognostic value of several key patient characteristics. Variables used in the regression analysis were age, gender, performance of bystander CPR, presenting ECG, paramedic response interval, and 5-minute ROSC at the scene. A Bonferroni corrected level of .008 (.05 per six variables) was used for interpretation of statistical significance. The odds ratio (OR), expressed as the exponent of the coefficient from the regression equation, and its 99% confidence interval (CI) were calculated for each variable. All tests of significance were two-tailed. Data are reported as mean±SD for continuous variables, or as frequencies and percentages for counts.

RESULTS

Overview

A total of 1461 consecutive adult patients meeting the inclusion criteria for primary cardiac arrest were studied.[2,19] The cardiac arrest was witnessed by a paramedic (monitored arrest) in 139 of these cases, and 59 of these occurred while the patient was en route to the hospital. As a result, during the 1.5-year study, we evaluated 1322 cases of on-scene, unmonitored cardiac arrests. The average age of the 1322 patients was 65±14 years (range, 18 to 103 years), and bystander CPR was performed in 24% of the cases. Of the 1322 study patients, 952 (72%) never achieved 5-minute ROSC at the scene even though all had received standard ACLS procedures.[5] However, six of these 952 who failed to achieve on-scene ROSC still survived to hospital discharge.

Table 1.—Characteristics of 1322 Consecutive, Unmonitored Out-of-Hospital Primary Cardiac Arrest Patients and the Respective Results of Univariate and Logistic Regression Analyses of These Variables

	Nonsurvivors (n=1230)	Survivors (n=92)	Univariate *P*	Joint *P* (OR, 99% CI)*
Age, y	65±15	61±12	.02	.27 (0.9, 0.7-1.2)
Male gender, No. (%)	781 (64)	65 (71)	.18	.65 (1.1, 0.5-2.4)
Bystander CPR† performed, No. (%)	274 (22)	37 (40)	<.001	<.03 (1.9, 0.9-3.8)
Paramedic response interval, min‡	10.2±4.2	8.7±3.3	.002	.08 (0.9, 0.9-1.0)
On-scene interval, min§	28±9.3	26±8.6	...¶	...¶
Transport interval, min	7.9±4.3	8.4±5.1	...¶	...¶
ROSC, No. (%)‖	284 (23)	86 (93)	<.0001	<.0001 (32, 10-99)
Initial rhythm, No. (%)				
Ventricular fibrillation	471 (38)	79 (86)	<.0001	<.0001 (5.2, 2.1-12.3)
Asystole	506 (41)	5 (5)	<.0001	...
Idioventricular	191 (16)	7 (8)	...	...
Electromechanical dissociation	52 (4)	0	...	...
Ventricular tachycardia	6 (<1)	1 (1)	...	...
Other/unknown	4 (<1)	0	...	...

*Results of logistic regression analysis including joint *P* values, odds ratios (ORs), and 99% confidence intervals (99% CIs) for the six predictors in the model: age, male gender, performance of bystander cardiopulmonary resuscitation, paramedic response interval, ROSC at the scene, and an initial electrocardiographic presentation of ventricular fibrillation.
†CPR indicates cardiopulmonary resuscitation.
‡Interval from first 911 telephone ring until arrival at street location of the patient.
§Interval from paramedic arrival at street location until ambulance departure from the location.
‖Restoration of spontaneous circulation (ROSC) at the scene for at least 5 minutes.
¶Ellipses indicate not tested in logistic regression analyses.

Regression Analysis

Table 1 shows the age, gender, number of patients receiving bystander CPR, prehospital intervals, number of patients achieving ROSC at the scene, and the initial out-of-hospital ECG rhythms for survivors and nonsurvivors. The univariate *P* values shown estimate the individual importance of each of these potential predictors of survival to hospital discharge, whereas the joint *P* values, the ORs, and the CIs estimate the relative importance of each potential predictor when related to the presence of all other variables considered in the logistic regression model. In univariate analysis, the initial rhythms of VF (39% of patients) and asystole (41%) were negatively correlated with each other since they represented large and mutually exclusive categories. Therefore, asystole as the negative predictor variable was omitted from the regression analysis. Other initial rhythms were found at lower frequencies (Table 1); therefore, these predictors were excluded from the regression analysis as well.

From the logistic regression model, the estimated odds of survival for those with ROSC at the scene was 32 (99% CI, 10 to 99) when adjusting for the other criteria. This indicates that a patient who had achieved 5-minute ROSC at the scene had an approximately 32-times greater odds of survival relative to a patient who did not have ROSC, assuming that both patients were similar for initial rhythm, the performance of bystander CPR, paramedic response interval, age, and gender. Likewise, a patient presenting with VF had a fivefold greater odds of survival (99% CI, 2.1 to 12.3) relative to a patient without VF (but similar with respect to the other criteria). Similarly, the estimated odds of survival doubled (99% CI, 0.9 to 3.8; $P<.03$) in patients who had received basic CPR from a bystander; this was not significant at the Bonferroni adjusted level, although it was a significant predictor of survival in the univariate analysis ($P<.001$). Decreases in paramedic response time (in minutes) were also not statistically significant in the regression model (99% CI, 0.9 to 1.0), although they were significant in univariate analysis ($P=.002$). Other characteristics included in this logistic regression analysis that were not significantly associated with survival were age (OR=0.9; 99% CI, 0.7 to 1.2) and gender (OR=1.1; 99% CI, 0.5 to 2.4). As already stated herein, asystole on the presenting ECG had a very strong negative association with survival (<1% chance of hospital discharge). However, in absolute terms, five of the patients presenting with asystole still survived, and only 79 (86%) of the 92 survivors had VF-associated arrest (Table 1). Therefore, even an initial ECG rhythm of asystole was not an absolute predictor of nonsurvival.

Based on the six criteria included in the regression model and using a probability of .5 or greater from the model to classify survivors, 93% of the patients were correctly classified as survivors or nonsurvivors. However, the specificity of the main model to predict nonsurvival was 99.6%.

Description of the Six Survivors (Without On-Scene ROSC)

As reported herein, six patients survived despite failure to attain on-scene ROSC. Another 35 patients who failed to achieve ROSC at the scene were resuscitated and were admitted to an intensive care unit, but they eventually died prior to hospital discharge. Four of the six survivors came from a subgroup of 28 who achieved ROSC en route to the hospital. All four had refractory or persistent VF. Only two of these patients did well neurologically (cerebral performance category score >3). Likewise, of the remaining 13 patients who did not achieve ROSC until they got to the hospital (<0.1% of all patients), only two eventually survived. Again, both of them were readily distinguished as cases of refractory VF. Both had received bystander-initiated basic CPR and both remained in VF despite continuous defibrillation attempts, even after administration of both 3 mg/kg of lidocaine hydrochloride by IV and 15 mg/kg of bretylium tosylate by IV. Although these patients were eventually discharged, they both had prolonged hospitalizations. One was discharged to a long-term care facility because of residual neurological deficits. The other patient experienced his cardiac arrest in his physician's office and received immediate bystander CPR. He maintained spontaneous eye opening and some motor activity for approximately an hour's duration despite refractory VF and was eventually taken to a nearby specialty hospital where he was rapidly placed on a cardiopulmonary bypass pump. He was neurologically intact by the next day; however, he had persistent severe ventricular dysfunction and renal failure. After a prolonged hospitalization, he eventually received heart and kidney transplants. Nevertheless, he has been judged by family, physicians, and himself to be in good condition more than 3 years after his cardiac arrest.

Therefore, a small percentage of patients can be successfully resuscitated without regaining pulses at the scene. However, they all can be predicted as those with persistent VF/VT. To put this into perspective, only 131 patients (six surviving and 125 nonsurviving) failed to achieve ROSC at the scene and remained in refractory or persistently recurring VF/VT. Therefore, this group in question constituted only 14% of the 952 who did not achieve on-scene ROSC.

ROSC as a Predictor of Survival

As stated herein, with the exception of cases of persistent VF/VT, failure to achieve on-scene ROSC was uniformly predictive of nonsurvival (within the context of this model). Regardless of the presenting rhythm, 23% of the 370 patients who did achieve ROSC (for at least 5 minutes) at the scene were eventually discharged from the hospital. Moreover, 33% (73/219) of those who presented with VF and then achieved ROSC at the scene were successfully discharged, regardless of witness or bystander CPR status. If the VF-associated cardiac arrest was witnessed and if a bystander performed basic CPR, survival rates approached 50% when 5 minutes of ROSC was achieved at the scene.

ROSC Intervals

Although most survivors regained pulses in the first 5 to 10 minutes after paramedic arrival, on-scene ROSC (5 minutes with a pulse rate ≥60 per minute) was generally achieved in all survivors within a 20-minute time frame from the initiation of ACLS. Exceptions were few: (1) two cases of monitored cardiac arrest in which ROSC was achieved (in both cases) at 27 minutes after the onset of cardiac arrest; (2) 15 cases of unmonitored cardiac arrests with persistently recurring/refractory VF/VT in which 5 minutes of ROSC was achieved more than 20 minutes after initiation of ACLS (range, 21 to 39 minutes); and (3) two other cases of unmonitored cardiac arrest without persistent/refractory VF in which 5 minutes of ROSC was not achieved until 22 and 23 minutes after ACLS was first provided. Of further note, transient pulses were first established in both of these cases at 20 and 11 minutes, respectively. However, palpable pulses were then absent for another 2 and 10 minutes, respectively, before finally achieving a stable ROSC. In these two cases, the total cardiac arrest intervals measured between the first 911 telephone ring and 5 minutes of ROSC, were 32 and 27 minutes, respectively (ie, total cardiac arrest intervals of at least half an hour). In six other cases of persistent/refractory VF/VT in which there was subsequent survival to hospital discharge, cardiac arrest intervals (911 to ROSC) exceeded 40 minutes (range, 42 to 51 minutes).

Therefore, with the exception of cases of persistent/refractory VF, no adult survived unmonitored out-of-hospital cardiac arrest if a 5-minute ROSC was not achieved within 25 minutes of the initiation of ACLS (and if there was no pulse rate whatsoever within 20 minutes). These findings were consistent regardless of the paramedic response intervals. When considering paramedic-witnessed (monitored) arrests, a half-hour time limit could also be used.

COMMENT

The emergent transport of patients through traffic for further resuscitative efforts at a hospital must be recognized for the attendant hazards, as well as for the inherent costs, both economic and societal.[5,28,29] Pedestrians or motorists may suddenly become unwitting victims of a vehicular collision during emergency transport,[7] and EMS personnel have increased risk, not only for motor vehicle collisions, but also for communicable disease exposure such as contaminated needlestick injuries during rapid transport.[30] In addition, EMS personnel often work unrestrained in the rear of the ambulance, thus further increasing their chance of injury during transport.

Even when a traffic mishap is avoided, the care rendered in the back of a rushing ambulance is generally substandard in terms of the efficacy of circulation provided by external cardiac compressions, as well as the ability to perform advanced skills and to properly monitor the patient.[31,32] The act of carefully moving the heavy weight of an adult patient (and the attendant equipment) down stairwells and the angling of stretchers around sharp corners not only pose logistical obstacles that are somewhat foreign to in-hospital care providers, but they also interrupt and preclude the maintenance and proper timing of therapeutic actions. Therefore, those persons suggesting only a "modified" prehospital care approach (eg, "few shocks and hurry to the hospital") as an alternative strategy are probably unfamiliar with the difficulties facing those who attempt to provide care in the out-of-hospital setting.[33] In turn, these persons also would have unrealistic expectations regarding the time that it would still take to get the patient to the hospital.

There are other important issues concerning the transport of patients with ongoing CPR. On hospital arrival, despite the grim outlook for the patient with "CPR in progress," these cases usually become the priority for the ED staff, thus delaying care to other patients in the ED.[29] In addition, although the high cost of prolonged intensive care may not be as great a factor as previously reported[8] for patients who are not responding to prehospital efforts (because most are pronounced dead in the ED), the ED billing costs can still pose a significant burden to many families. In view of the large numbers involved, the toll of continued resuscitation efforts at the hospital on health insurance costs is also substantial, thus affecting society at large. Surveys of five major receiving facilities in our community revealed that the typical charge for use of a resusci-

Table 2.—Previously Reported Survival Rates Following Failed Prehospital Resuscitation (FPR) Attempts (No Pulse on Hospital Arrival) for Out-of-Hospital Primary Cardiac Arrest

Study (Year)	City	Total Study Patients, No.	Total FPR Patients, No.	Survivors After FPR, No.	Comments*
Lewis et al[12] (1990)	St Louis, Mo	243	211	1	Cardiac arrest en route to hospital, survived
Bonnin and Swor[13] (1989)	Michigan	232	181	1	Survivor not intubated in prehospital setting
Kellermann et al[14] (1988)	Memphis, Tenn	...	279	4	Two survivors lost pulse en route; another two with persistent VF survived with neurological deficits
Wolford et al[15] (1988)	Pittsburgh, Pa	59	...	0	All paramedic-witnessed arrests
Jakobsson et al[16] (1987)	Stockholm, Sweden	307	...	0	BLS plus defibrillation only
Geehr et al[17] (1986)	San Francisco, Calif	...	49	0	Half received open-chest heart massage
Warner et al[18] (1985)	Los Angeles, Calif	94	56	0	Only VF cases
Gray et al[8] (1991)	Providence, RI	...	185	0	BLS only in one third of cases

*VF indicates ventricular fibrillation; BLS, basic life support.

tation room, several "rounds" of drugs, and several basic laboratory tests approached $2000 to $3000. Using the criteria noted herein, at $2000 to $3000 per patient, the additional estimated health care system billings/insurance claims for transporting patients to the hospital for continued (but futile) resuscitative efforts would be $1 million to $1.5 million per year in Houston alone. Extrapolated to a national level (based on population and relative incidence of cardiac arrest), this figure approaches $0.5 billion annually. Therefore, if appropriate cases can be reliably identified, there are several sound rationales (including liability, medical futility, and unnecessary use of resources) for recommending on-scene termination of resuscitative efforts.

Collective data from several previous studies, involving almost 1500 combined adult victims of out-of-hospital cardiac arrest, have already indicated dismal survival rates for those adults who fail to arrive at the hospital with pulses (Table 2).[8,12-14,18,29,34] Although most of these studies had limitations, either because they were smaller retrospective reviews in EMS systems with overall low survival rates or because they did not include all consecutive primary cardiac arrest patients, the results are still compatible with the findings of this study. To our knowledge, among all of the prior studies of patients failing prehospital efforts, only six survivors have been reported previously (Table 2). One of these six patients did not receive the full benefit of standard ACLS procedures.[13] Another three of the six already had (or had regained) spontaneous circulation in the prehospital setting, but they had a secondary cardiac arrest just prior to arrival at the ED.[29] Therefore, none of these four patients would have even been considered for possible termination of resuscitation at the scene. This leaves only two previously reported cases (from Memphis, Tenn) as the only known survivors of failed on-scene attempts at prehospital ACLS ever documented in the published literature to date. However, both of these patients subsequently were left with residual neurological deficits requiring institutionalization in long-term care facilities. More important, these two lone survivors of failed on-scene resuscitation also had persistent VF, thus setting themselves off as a small but identifiable subset of patients, a finding identical to the results observed in this study. Therefore, of more than 3000 primary cardiac arrest patients studied, only those with persistent VF have benefited from continued resuscitation efforts in the ED.[34]

Nevertheless, while these previous studies examined the value of continued ED resuscitation efforts after failed prehospital resuscitation, they did not specifically delineate when a patient could be pronounced dead at the scene with reasonable certainty that there is no longer a chance for survival. In fact, in several of the previous studies, patients did not achieve their ROSC until after leaving the scene (while en route to the hospital). This was the case in our study as well. However, such patients were not necessarily included in previous study results as failed "prehospital" resuscitations because they had pulses on hospital arrival. If efforts are to be terminated at the scene, these patients must still be considered to clearly determine which patients have no further chance of survival.

Therefore, the results of this study not only prospectively confirm in a large group of consecutive cases what has been previously inferred by earlier limited reports, but the results also delineate which patients still have a potential for survival despite failed resuscitation efforts at the scene. Conversely, this study has also allowed us to establish distinct criteria for appropriate termination of resuscitation at the scene (Table 3). The high specificity of this model supports the purpose of this investigation, ie, to establish criteria that can be used to identify nonsurvivors. These explicit criteria for appropriate termination of resuscitative efforts at the scene also validate guidelines previously suggested primarily for cessation of resuscitative interventions in the ED.[35-38] Again, patients with monitored cardiac arrests or those with refractory or persistent VF should be considered exceptions. Also, patients with any continuing neurological activity (eg, spontaneous respiration, eye opening, or motor activity) would also be considered exceptions. Furthermore, this study did not address the pediatric patient for whom, in practice, resuscitation efforts are often carried on for a somewhat longer duration.[39]

Table 3.—Criteria for Termination of Resuscitation Efforts at the Scene Following Unmonitored, Out-of-Hospital, Adult, Primary Cardiac Arrest

1. Adult cardiopulmonary arrest (not associated with trauma, body temperature aberration, respiratory etiology, or drug overdose)
2. Standard advanced cardiac life support[5] for 25 min
3. No restoration of spontaneous circulation (spontaneous pulse rate of >60 beats per min for at least one 5-min period)
4. Absence of persistently recurring or refractory ventricular fibrillation/tachycardia or any continued neurological activity (eg, spontaneous respiration, eye opening, or motor response)

At the time of study design, we chose to define ROSC as being at least 5 minutes of a spontaneous pulses. Since inception and conclusion of this study, consensus guidelines were developed that suggest a more inclusive criterion for ROSC (return of spontaneous pulse rate for any period).[2,19] Another 56 patients who did not have refractory VF and who did not meet our stricter criteria for ROSC did develop some pulses transiently. Nevertheless, none of these "near-ROSC" patients achieved hospital admission, thus supporting the usefulness of the stricter criteria chosen herein for ROSC.[2,19]

Several EMS systems already have allowed for termination of resuscitative efforts at the scene in selected cases of cardiac arrest under on-line physician orders.[9,10,40] In two of these systems, Seattle–King County, Wash, and Milwaukee, Wis, overall resuscitation and long-term survival rates are extremely high, helping to validate the comfort level with

this practice. In those communities, on-scene termination of efforts is an accepted practice and has met with few problems. Other EMS systems have recently validated this same experience.[41,42]

Essentially all patients in this study received full benefit of ACLS interventions in the prehospital setting. Therefore, if IV insertion or endotracheal intubation cannot be accomplished promptly in the prehospital setting, it still could be argued that the patient should be transported rapidly to an ED to provide the patient with the full benefit of these interventions.[13]

Patients management practices used during this study were (and remain) consistent with the most recent published guideline.[11] However, while this study helps to validate the practice (of terminating resuscitations at the scene) as a reasonable and medically acceptable option for EMS systems today, it must also be recognized that these conclusions remain valid only as long as new or unusual treatment advances have not become available. There is no more worrisome a place for self-fulfilling prophecies than in resuscitation practices. Above all, this study underscores the reality that future research and clinical efforts in resuscitation should be directed to the prehospital setting.[43-45] In turn, EMS systems must become more scientifically oriented and if possible, better integrated with our academic institutions.[44]

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