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In-Hospital Resuscitation Following Unsuccessful Prehospital Advanced Cardiac Life Support: 'Heroic Efforts' Or an Exercise in Futility?

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From our emergency department logbook we identified 281 consecutive patients transported to the Regional Medical Center at Memphis following failed prehospital advanced cardiac life support (ACLS). Medical records were obtained for 240 cases (85.4%). Initial cardiac rhythms in the ED included ventricular fibrillation or pulseless ventricular tachycardia (29%), electromechanical dissociation (18%), and asystole (51%). Thirty-two patients (13.3%) were successfully resuscitated in the ED, but only four (1.7%) survived to hospital discharge. Two patients had good neurologic outcomes; both degenerated to cardiac arrest shortly prior to arrival in the ED. The remaining two survivors were discharged to nursing homes with severe neurologic deficits. Of the 41 cases for whom no medical records could be found, 39 were noted in our logbook to have died in the ED. No record of subsequent hospital admission could be found for the other two. Both are presumed to have died. Failure to respond to prehospital ACLS predicts nonsurvival and may warrant cessation of efforts in the field. Future programs and research efforts in the management of out-of-hospital cardiac arrest should be focused on optimal provision of prehospital care prior to the onset of irreversible deterioration. [Kellermann AL, Staves DR, Hackman BB: In-hospital resuscitation following unsuccessful prehospital advanced cardiac life support: 'Heroic efforts' or an exercise in futility? Ann Emerg Med June 1988;17:589-594.]

INTRODUCTION

Despite two decades of dramatic advances in emergency cardiac care, a majority of victims of out-of-hospital cardiac arrest fail to respond to prehospital efforts at resuscitation.[1-3] In many metropolitan areas, paramedics emergently transport patients who fail to respond to prehospital advanced cardiac life support (ACLS) to the nearest hospital for continued efforts at resuscitation.

A decision to transport a patient in refractory cardiac arrest commits a paramedic crew to hazardous high-speed driving. The emergency department must rapidly mobilize available personnel to continue the attempt of resuscitation. Any patient successfully resuscitated then is admitted to an intensive care unit, often for a stormy hospital course.

Reports have failed to focus on this important subgroup of patients. Information regarding the clinical outcomes of these patients has been scant. No studies have directly examined the personnel and monetary costs associated with decisions to continue resuscitation efforts despite unsuccessful prehospital ACLS. Our study was conducted to examine these issues.

METHODS

The Regional Medical Center at Memphis is a 435-bed, adult, acute care hospital supported, in part, by the government of Shelby County, Tennessee. The hospital and its ED are staffed by residents and faculty of the University of Tennessee, Memphis. The ED at the Regional Medical Center averages 65,000 visits annually and is the point of entry for three-quarters of all nonobstetric admissions.

Emergency medical services (EMS) for the City of Memphis are provided by the Memphis Fire Department (MFD) EMS Bureau. The Bureau operates 14 ambulances staffed by two paramedics each, who are authorized to pro-

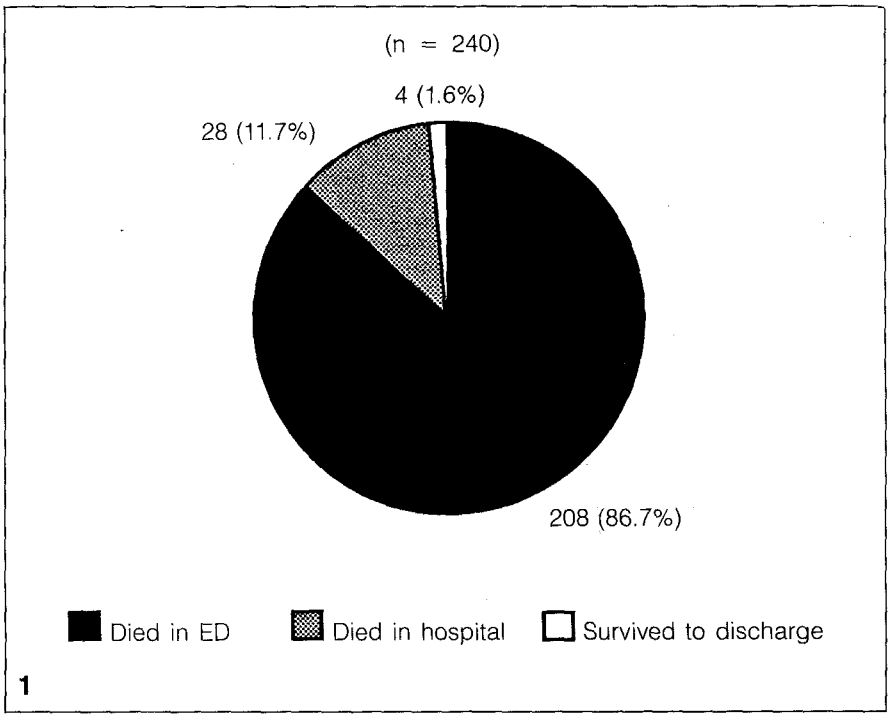

FIGURE 1. *Outcome of refractory prehospital cardiac arrest.*

vide ACLS under the medical control of on-line physicians. All units carry defibrillators. Since 1979, all units also have been equipped with automatic, oxygen-powered cardiopulmonary resuscitators. Paramedics are authorized to perform endotracheal intubation and administer a wide range of cardiac drugs. MFD paramedic response times for emergency runs average five minutes from call to arrival on scene.

During the study interval, all MFD paramedic units followed the 1980 to 1986 guidelines for cardiac resuscitation developed by the American Heart Association.[4] In cases involving ventricular fibrillation or pulseless ventricular tachycardia, paramedics were authorized to deliver up to three defibrillatory shocks prior to establishing contact with an on-line physician. Additional resuscitative measures included immediate endotracheal intubation, hyperventilation with oxygen, establishment of peripheral venous access, and administration of IV epinephrine, lidocaine, and/or atropine as indicated.

According to MFD statistics, on-scene time in cases involving unsuccessful prehospital resuscitation averages approximately 22 minutes.[5] Unfortunately, comprehensive records of each prehospital cardiac resuscitation were not kept during the study interval. Therefore, case-specific data regarding individual cardiac arrest circumstances and details regarding each prehospital resuscitation attempt were unavailable. During the study interval, all MFD cardiac arrest patients who failed to respond to prehospital ACLS received continuous mechanical CPR during emergency transportation to the nearest hospital.

We retrospectively identified, through our ED logbook, all adult patients transported to the Regional Medical Center at Memphis by ambulance following nontraumatic, out-of-hospital cardiac arrest who arrived without a palpable pulse or blood pressure between November 11, 1983, and January 6, 1986. A total of 219 cases were identified. In addition, we prospectively identified 62 cases between January 7 and December 15, 1986. Patients who arrived by automobile and patients who sustained a cardiac arrest only after arrival in the ED were excluded. Painstaking file searches through medical records yielded 240 of 281 charts (85.4%).

All available records were reviewed by one of the authors to identify the presenting cardiac rhythm in the ED, total time of the ED resuscitation effort, major ED management, and ED outcome. We defined a "successful" resuscitation as reestablishment of a pulse and blood pressure sufficient to sustain life and permit admission of the patient to an ICU. For patients resuscitated in the ED and admitted to the hospital, we noted length of hospital stay, hospital outcome, and disposition. Functional status at discharge was determined using implicit criteria (ie, good recovery, able to return home without significant deficits; moderate disability, able to return home but requiring assistance with some aspects of daily life; severe disability, dependent on others for daily support).

Estimates of ED personnel use were calculated using documented durations of ED resuscitation and conservative estimates of the total number of personnel involved. ED charges for cardiac resuscitation are the same regardless of the duration of the resuscitation attempt or the total number of personnel involved. ICU and ward bed charges were calculated based on documented lengths of stay and standard hospital room charges. Medications, supplies, and professional fees were not included. All charges are expressed in 1986 dollars.

RESULTS

Absence of a pulse was confirmed on arrival to the ED in all 240 cases in which documentation was available. Two hundred eight of 240 patients (87%) were intubated successfully prior to arrival; the remainder were being ventilated by esophageal obturator airway or bag-valve-mask. Endotracheal intubation was completed in all cases within two minutes following arrival in the ED.

Presenting cardiac rhythms in the ED included ventricular fibrillation or pulseless ventricular tachycardia in 69 cases (29%), electromechanical dissociation (EMD) in 43 (18%), asystole in 122 (51%), and other rhythms in six (2.5%). Following arrival, resuscitation efforts followed 1980 to 1986 ACLS guidelines.[4] Transthoracic or transvenous pacing was attempted in 30 cases (13%); successful capture was noted in 19 (8%), but pulses were established in only three (1%). Pericardiocentesis was attempted in 19 (8%) cases, but transient clinical benefit was noted in only one.

In the ED, physicians were able to successfully reestablish a pulse and blood pressure in 32 of 240 cases (13.3%). Patients found to be in ven-

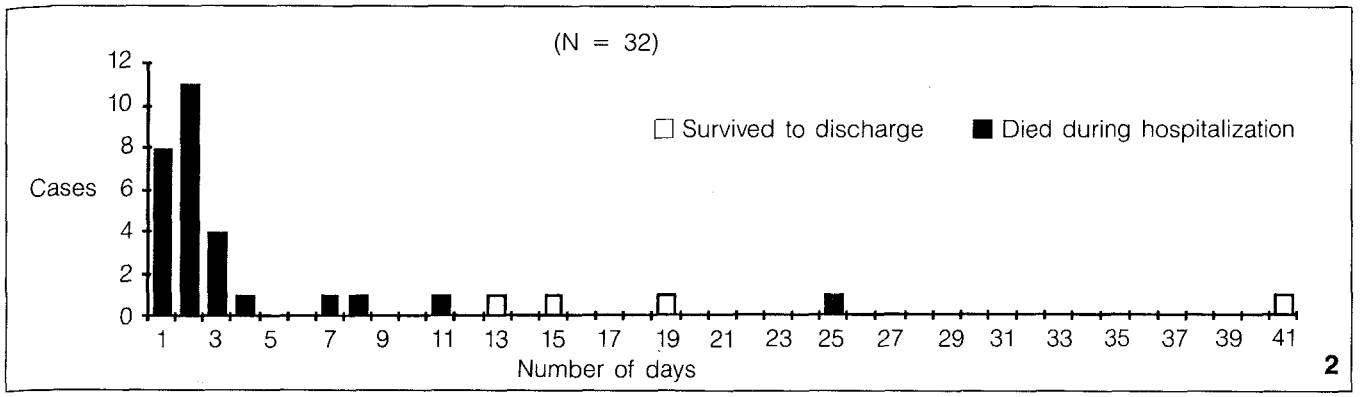

FIGURE 2. *Outcome of refractory prehospital cardiac arrest — length of hospital stay.*

TABLE 1. *ED and hospital room charges following refractory prehospital cardiac arrest*

	(N = 281)	
ED	$284/case × 281 cases	= $ 79,804
ICU	$554/day × 119 days	= $ 65,926
Ward	$212/day × 70 days	= $ 14,840
	Total	$160,570

Charges expressed in 1986 dollars; excludes charges for drugs, laboratory, supplies, and professional fees.

tricular fibrillation or pulseless ventricular tachycardia on arrival to the ED were resuscitated more often than patients found in other rhythms (22% vs 9.9%; chi-square $P < .02$). All patients successfully resuscitated were admitted to an ICU.

Only four patients (1.6%) survived to hospital discharge (Figure 1). Despite more frequent initial resuscitation, patients who presented to the ED with ventricular fibrillation or pulseless ventricular tachycardia were no more likely to survive to hospital discharge (two of 69 [2.9%] vs two of 171 [1.2%]; chi-square $P = .22$). One of these four survivors actually responded to prehospital ACLS with reestablishment of a pulse and blood pressure at the scene but had a second cardiac arrest less than two minutes prior to arrival at the Regional Medical Center. A second patient deteriorated en route from ventricular tachycardia with a pulse and blood pressure to ventricular fibrillation shortly before arrival. Both were resuscitated and subsequently discharged home with good neurologic outcomes.

The remaining two patients failed to respond at any point to prehospital ACLS but were resuscitated successfully in the ED. Both were eventually discharged to nursing homes with severe neurologic deficits following prolonged hospital stays (Figure 2).

Of the 41 patients for whom no record could be found, 39 were noted in our logbook to have died in the ED. In the remaining two cases, no specific ED outcome was recorded. A search of inpatient files and ICU admission logbooks failed to reveal the name of either patient within 24 hours of arrival in the ED. Both are presumed to have died.

Resuscitation attempts were continued in the ED a mean of 33.2 ± 16.6 minutes (range, six to 163 minutes). The responding team usually consisted of a staff physician, a resident, one to two interns, two ED nurses, a ward clerk, and an anesthesiologist or certified nurse anesthetist. Total personnel time spent in resuscitation attempts exceeded 1,100 person-hours.

During our study interval the standard hospital charge associated with an ED resuscitation at the Regional Medical Center was $284, regardless of the duration of the resuscitation or consumption of supplies. The 32 patients successfully resuscitated in the ED spent a total of 119 days in an ICU; 70 days were spent on general medical wards. The 1986 room rate for a day in the ICU was $554; the room charge for a ward bed was $212. Based on these figures, total ED and hospital room charges for the study group exceeded $160,000 (Table 1).

DISCUSSION

Since the pioneering work of Pantridge and Geddes,[6,7] prehospital emergency cardiac care has become established in many major metropolitan centers. Cobb,[8] Nagel,[9] Eisenberg,[10] and others[11] have shown that well-trained paramedics can reliably deliver defibrillatory shocks, start IV lines, perform endotracheal intubation, and successfully resuscitate many victims of out-of-hospital cardiac arrest. In 1980, Eisenberg, Copass, Hallstrom, et al[12] demonstrated the superiority of prehospital ACLS in comparison to basic EMT services.

Of the variables that have been shown to be associated with successful resuscitation following cardiac arrest, the most important one amenable to system intervention is the total duration of time to defibrillation.[2,3] In cases involving delays to defibrillation of more than three to four minutes, early provision of CPR improves the chances for subsequent resuscitation,[3,4,13,14] Most patients who respond to prehospital emergency cardiac care do so early in a resuscitation effort.[15] Few survive resuscitation attempts lasting longer than 30 minutes.[16]

Given these clearly developed principles, it is no surprise that patients who fail to respond to prehospital ACLS rarely survive emergency trans-

portation to the hospital for subsequent efforts at in-hospital resuscitation. Fewer still survive to hospital discharge. While patients in our study arriving in ventricular fibrillation or ventricular tachycardia were more frequently resuscitated in the ED, it appears that the prolonged period of CPR associated with these cases precluded long-term survival with good neurologic function. If the two patients in our series who maintained a spontaneous pulse and blood pressure until two minutes prior to arrival at our hospital are excluded, no patient in our series could be considered to have had a satisfactory outcome.

Several potential limitations to our study deserve comment. All of our patients were adult victims of nontraumatic cardiac arrest. Conclusions based on a series of adult patients may not apply to prolonged resuscitation attempts involving pediatric patients. Likewise, persons sustaining cardiac arrest following penetrating trauma have been shown to benefit from a combination of aggressive prehospital care, rapid transport, and immediate in-hospital surgical management.[17]

Conventional wisdom and several case reports dictate that hypothermic patients warrant determined efforts at resuscitation and adequate rewarming, because an unknown number of victims of severe hypothermia may respond to prolonged resuscitation and survive with good neurologic function.[18-20]

Prior to June 1986, comprehensive data regarding the prehospital management of cardiac arrest were not collected or maintained by the MFD. We are, therefore, unable to comment on the specific circumstances surrounding each cardiac arrest episode or the precise quality of prehospital cardiac care. We believe, however, that any intercommunity differences in the quality of prehospital cardiac care are likely to be reflected in varying rates of prehospital resuscitation, rather than in different rates of subsequent in-hospital resuscitation.

Some may consider our poor rate of survival following unsuccessful prehospital ACLS to be specific to the MFD EMS bureau or our study institution. In a subsequent review of the literature, we have identified seven additional studies from six cities or metropolitan counties in which patients failing to respond to prehospital ACLS were transported to the nearest hospital.[9,21-26] Of 1,164 patients, six (0.5%) were noted to survive to hospital discharge (Table 2). Four of these six initially responded to prehospital ACLS but sustained a second cardiac arrest shortly before arrival in the ED. The functional status of these survivors at discharge was not specified.

Based on our data and the results of others, we conclude that failure to respond to prehospital ACLS on the scene with reestablishment of a blood pressure and pulse is highly predictive of death prior to hospital discharge. Combining our results with those noted, only ten of more than 1,440 patients (0.69%) have been reported to have survived to hospital discharge after arriving in cardiac arrest following prehospital ACLS.[9,21-26] Six of these ten survivors actually had a pulse and blood pressure at the time the decision to transport was made. In individual cases, failure to respond to emergency cardiac care may reflect long down times without CPR, delays to defibrillation, long EMS response times, refractory initial arrythmias (eg, asystole), or perhaps other unspecified factors. Regardless of the factor(s) associated with failure to respond in any given case, patients unsuccessfully resuscitated at the scene rarely survive to hospital discharge.

A decision to transport a patient to the hospital following unsuccessful prehospital ACLS is associated with high costs and considerable risks. More than 1,100 hours of skilled ED personnel time were involved in our series, a number approximately equal to one person working 40 hours a week for more than six months. The 32 patients resuscitated in our ED accounted for an additional 189 bed-days of ICU and ward hospitalization. ED and hospital room charges alone exceeded $160,000.

In contrast to the ten survivors of refractory out-of-hospital cardiac arrest identified by our study and literature review, 159 motor vehicle deaths involving ambulances in emergency use were reported to the National Highway Traffic Safety Administration between 1977 and 1985.[27] Many of these deaths involved pedestrians, drivers, or passengers of non-EMS vehicles. The National Association of State EMS directors recently has noted that 25 EMTs and paramedics nationwide died as a result of high-speed ambulance driving between January 1, 1983, and May 31, 1986.[28] One of these deaths involved a MFD paramedic who died in an ambulance accident in 1984.[29] While the annual toll of serious but nonfatal injuries as a result of ambulance-related motor vehicle accidents is undoubtedly higher, the magnitude of this figure is unknown.

A few EMS systems have adopted policies that permit paramedic units to cease efforts in the field in selected cases of refractory out-of-hospital cardiac arrest after consultation with an on-line physician.[23,25] Based on our data, we believe these policies justified. They should be more widely implemented by well-supervised EMS systems offering comprehensive prehospital ACLS.

Both of the patients in our study who survived with good neurologic outcomes and four of the six survivors identified by our literature review had a pulse and blood pressure at the time the decision to transport was made. Initial response to prehospital ACLS appears to select those patients who are likely to benefit from continued emergency cardiac care, because virtually all ultimately successful resuscitations following out-of-hospital cardiac arrest are accomplished at the scene.[15,30] CPR alone rarely sustains cardiac and cerebral function long enough to permit successful transport to an in-hospital resuscitation team.[12]

Despite consistent CPR by automatic resuscitation devices, more than 70% of our patients were in asystole or electromechanical dissociation by the time they arrived in our ED. Given the inevitable deterioration that occurs during prolonged CPR, it appears that little is gained from transporting patients in refractory cardiac arrest to expensive hospital-based technology.

EMS policies that mandate transport to the nearest hospital in cases of refractory out-of-hospital cardiac arrest may actually compromise a patient's chances for survival by encouraging a "load and go" approach rather than determined efforts at prehospital ACLS. Many of the 32 patients resuscitated in the ED during our study might have responded sooner and had better outcomes if efforts had been continued in the field beyond the point that a decision to transport was made. In other than exceptional cases, high-speed transport to the hospital should never be considered an accept-

TABLE 2. *Outcome of patients presenting to the ED in cardiac arrest despite prehospital ACLS*

	No. Patients	Survived to Discharge	Comments
Miami[8] 1970-73	102	0	Explicit policy to transport nonresponders. Total includes only patients in refractory ventricular fibrillation following unsuccessful prehospital emergency cardiac care. An unknown percentage of 199 additional patients shocked into asystole or EMD. These are not included in group total.
Brighton, England*[18] 1974-76	≤255*	2	Total number of patients receiving external cardiac message until arrival in ED not stated. Both survivors had a second cardiac arrest en route to hospital following initial resuscitation in the field. Neurologic outcomes not specified.
Miami[19] 1975-78	235	0	No change noted in prior[8] policy of transporting all nonresponders following unsuccessful prehospital ACLS. Assumption made that all were transported to an ED.
Suburban Kansas City[20] 1979	225	0	Explicit policy to transfer all nonresponders. Mechanical resuscitation devices used. Total excludes an additional 29 cases due to trauma.
Sacramento County[21] 1979-81	460†	4	Two of four survivors initially responded to prehospital ACLS but had a second cardiac arrest within three minutes of arrival in the ED. Neurologic outcomes were not specified.
San Francisco[22] 1986	49	0	Half of these patients were randomized to open-chest cardiac massage in the ED.
Milwaukee[23] 1986	93	0	An additional 132 "unsuccessful" resuscitation attempts were terminated in the field following consultation with an on-line physician. Some transported patients pronounced dead on arrival.
Memphis 1984-87	281	4	Two of four survivors sustained a cardiac arrest just prior to hospital arrival; the remaining two had poor neurologic outcomes.
Total	1,445	10‡	

*One hundred one of 356 attempted prehospital resuscitations initially successful. An unknown percentage of remaining 255 patients transported and died in the ED (not included in final denominator total).
†Total approximate, based on the percentage of an overall group of 893 who received ACLS in the field but failed to respond.
‡Six of ten survivors were documented to have a spontaneous pulse prior to transport.

able substitute for skilled and determined attempts at prehospital resuscitation.

Virtually all current ACLS techniques used by in-hospital resuscitation teams can be applied in the field by well-trained paramedics. More invasive ED techniques, such as transthoracic pacing and open-chest cardiac massage, have been shown to be of little or no benefit.[25,31,32] In contrast, prehospital program innovations, such as widespread community training in CPR and EMT defibrillation, have been shown to improve rates of survival following cardiac arrest.[3,33-35]

Despite these compelling statistics, researchers continue to explore increasing expensive hospital-based technology in a determined attempt to improve the currently poor rates of survival following refractory prehospital cardiac arrest.[36] Groups recently have begun to investigate the use of emergency cardiopulmonary bypass for treatment of prolonged cardiopulmonary arrest in dogs.[37,38] Encouraging preliminary results have been reported. Despite the extraordinary costs and dubious benefits such treatment will likely entail, we presume that human trials cannot be far behind.

Virtually all of the progress made to date in the management of out-of-hospital cardiac arrest has come from developments in prehospital emergency cardiac care. In addition, research and training in prehospital emergency cardiac care has improved paramedic and EMT skills for dealing with noncardiac emergencies, yielded insights into improved techniques for in-hospital resuscitation, and has generated a broader base of community support for emergency medical services.[3]

Further progress is being made. Recent innovations such as the development and implementation of automatic defibrillators[39-41] and emergency CPR instruction by telephone[42] appear to be both promising and cost-effective.[15]

CONCLUSION

Based on our analysis of associated costs, risks, and benefits, there ap-

pears to be little justification for policies that encourage rapid transport to the hospital following unsuccessful prehospital ACLS. In the vast majority of cases, failure to reestablish spontaneous cardiac activity at the scene sufficient to generate a pulse after determined prehospital efforts at resuscitation warrants cessation of efforts in the field and pronouncement of death. On the other hand, initial response to treatment followed by recurrent cardiac arrest warrants continued efforts, including transport to the nearest hospital ED.

Given our present understanding of the physiologic limits of prolonged cellular ischemia, we question the wisdom of continued research into costly hospital-based technology for the management of refractory out-of-hospital cardiac arrest. We believe further investments in training, program development, and clinical research should be focused on the optimal provision of prehospital emergency cardiac care, prior to the onset of irreversible deterioration.

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