

# Traumatic Cardiac Arrest: Who Are the Survivors?

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**Study objective:** Survival from traumatic cardiac arrest is poor, and some consider resuscitation of this patient group futile. This study identified survival rates and characteristics of the survivors in a physician-led out-of-hospital trauma service. The results are discussed in relation to recent resuscitation guidelines.

**Methods:** A 10-year retrospective database review was conducted to identify trauma patients receiving out-of-hospital cardiopulmonary resuscitation. The primary outcome measure was survival to hospital discharge.

**Results:** Nine hundred nine patients had out-of-hospital cardiopulmonary resuscitation. Sixty-eight (7.5% [95% confidence interval 5.8% to 9.2%]) patients survived to hospital discharge. Six patients had isolated head injuries and 6 had cervical spine trauma. Eight underwent on-scene thoracotomy for penetrating chest trauma. Six patients recovered after decompression of tension pneumothorax. Thirty patients sustained asphyxial or hypoxic insults. Eleven patients appeared to have had "medical" cardiac arrests that occurred before and was usually the cause of their trauma. One patient survived hypovolemic cardiac arrest. Thirteen survivors breached recently published guidelines.

**Conclusion:** The survival rates described are poor but comparable with (or better than) published survival rates for out-of-hospital cardiac arrest of any cause. Patients who arrest after hypoxic insults and those who undergo out-of-hospital thoracotomy after penetrating trauma have a higher chance of survival. Patients with hypovolemia as the primary cause of arrest rarely survive. Adherence to recently published guidelines may result in withholding resuscitation in a small number of patients who have a chance of survival. [Ann Emerg Med. 2006;48:240-244.]

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## INTRODUCTION

### Background

Survival rates of 0% to 3.7% have been reported for victims of traumatic cardiac arrest.<sup>1-4</sup> Resuscitation of this patient group is therefore considered by many to be futile and an inappropriate use of resources.<sup>1,2,4</sup> The National Association of EMS Physicians and the American College of Surgeons Committee on Trauma produced guidelines in 2003 about withholding or termination of resuscitation in out-of-hospital traumatic cardiopulmonary arrest.<sup>5</sup> Since the publication of these guidelines, 2 articles have described improved survival rates,<sup>6,7</sup> and 1 has described possible breaches of the guidelines.<sup>6</sup>

### Importance

It is important for providers of emergency care to know the true survival rate of patients in traumatic cardiac arrest and to be aware of patient subgroups associated with particularly good or bad outcomes. It is also important to know whether published guidelines are reliable.

### Goals of This Investigation

The aim of this study was to establish long-term survival rates for patients with out-of-hospital traumatic cardiac arrest who were attended to by a physician-led trauma service. The characteristics of patients who survived to be discharged from hospital were evaluated. The records of surviving patients were

### Editor's Capsule Summary

#### *What is already known on this topic*

Guidelines exist for determining which victims of traumatic cardiac arrest are candidates for resuscitation.

#### *What question this study addressed*

This retrospective study describes a cohort of traumatic cardiac patients treated by a helicopter team that included an experienced physician. The authors examine whether there were survivors of out-of-hospital traumatic arrest whose resuscitation would not have been attempted had current recommendations been followed.

#### *What this study adds to our knowledge*

Only 7.5% of the 909 patients in traumatic cardiac arrest survived to hospital discharge. Thirteen (19%) of the 68 survivors would not have been resuscitated had current guidelines been followed. Unfortunately, this study did not address quality-of-life issues or neurologic status of survivors.

#### *How this might change clinical practice*

This study demonstrates that strict adherence to the guidelines by physicians in the field might result in a few potentially salvageable patients being denied lifesaving measures. Results in paramedic-based systems would be expected to be less successful.

examined and checked against each of the criteria in the National Association of EMS Physicians/American College of Surgeons Committee on Trauma guidelines.

## MATERIALS AND METHODS

### Study Design

A retrospective trauma database review was conducted to identify all patients who had out-of-hospital cardiopulmonary resuscitation (CPR) between July 1994 and June 2004. Data were evaluated for patients transferred directly from the accident scene; interhospital transfers were excluded. This service is occasionally dispatched to medical cardiac arrests in special circumstances (eg, where access is difficult). These patients were also excluded. Patients who were confirmed dead on the scene and not transported to the hospital were included. Patients who had had cardiac arrest as a result of burns, hanging, traumatic asphyxia, electrocution, and drowning were also included. The primary outcome measure was survival to hospital discharge.

The helicopter emergency medical service (EMS) in which the study was conducted is a long-established out-of-hospital trauma service consisting of a physician and flight paramedic. Physicians have at least 5 years of postgraduate experience and come mainly from emergency medicine and anesthesiology. The service operates from an urban teaching hospital in the United Kingdom. Dispatch criteria target patients with severe trauma.

Patients are transferred by air or ground to the nearest appropriate hospital. Only interventions judged to be essential are carried out on scene. The mean scene time for the survivors in this group of patients was 29.2 minutes, and mean transfer time was 8.5 minutes.

The medical team usually arrives shortly after ground ambulance crews, sometimes at the same time and rarely first. When a ground ambulance crew arrives first, a basic life support or advanced life support protocol is followed, depending on the level of ambulance service provider (there are 2: technician and paramedic). When the helicopter EMS medical team arrives, they work with the ground crew to achieve the following:

1. oxygenation/definitive airway
2. formal bilateral chest decompression
3. intravenous access/fluid bolus
4. advanced cardiac life support
5. termination of resuscitation if no response in 20 minutes

When "medical" cardiac arrest is a possibility, immediate defibrillation is considered. If local criteria for on-scene thoracotomy are met,<sup>8</sup> it is also commenced without delay.

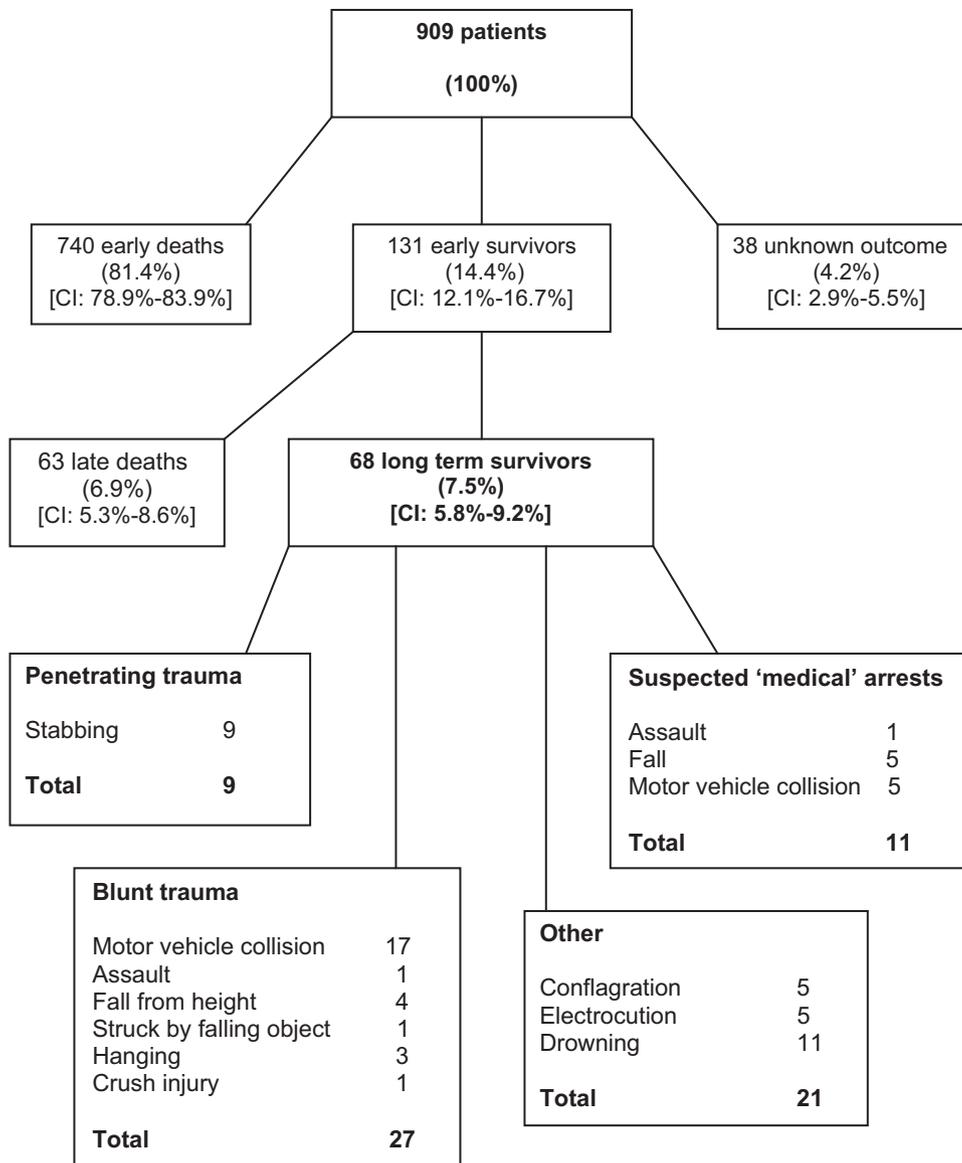
## RESULTS

In the 10-year study period, a total of 12,086 trauma patients were attended to by the service. Nine hundred nine patients required out-of-hospital CPR. Seven hundred forty patients (81.4% [95% confidence interval (CI) 78.9% to 83.9%]) died in the out-of-hospital phase or in the emergency department (ED). One hundred thirty-one patients (14.4% [95% CI 12.1% to 16.7%]) survived to discharge from the ED, and of these, 68 patients (7.5% [95% CI 5.8% to 9.2%]) survived to hospital discharge. The outcome could not be determined for 38 patients (4.2% [95% CI 2.9% to 5.5%]) who were triaged to other hospitals (Figure). Using medical notes and database information, we attempted to determine the main cause of the cardiac arrest for the blunt trauma survivors. Six patients had cervical spine injuries, 6 had isolated head injuries, 6 had tension pneumothorax, and 9 had traumatic asphyxia.

Eight of the survivors of penetrating trauma had cardiac tamponade at out-of-hospital thoracotomy. Hypovolemia was considered to be the cause of cardiac arrest in the one other survivor sustaining penetrating injury. One survivor underwent an on-scene thoracotomy after blunt chest trauma.

Thirteen patients (36%) of 36 who were in cardiac arrest as a direct consequence of blunt or penetrating trauma breach the National Association of EMS Physicians/American College of Surgeons Committee on Trauma guidelines.<sup>5</sup> The breaches were related to the following sections of the guidelines:

- Resuscitation efforts may be withheld in any *blunt* trauma patient who, according to out-of-hospital personnel's thorough primary patient assessment, is found apneic, pulseless, and without organized ECG activity on the arrival of EMS at the scene (5 patients breached).
- Victims of *penetrating* trauma found apneic and pulseless by EMS, according to their patient assessment, should be



**Figure.** Outcome of traumatic cardiac arrest and mechanism of injury for survivors.

rapidly assessed for the presence of other signs of life, such as pupillary reflexes, spontaneous movement, or organized ECG activity. If any of these signs are present, the patient should have resuscitation performed and be transported to the nearest ED or trauma center. If these signs of life are absent, resuscitation efforts may be withheld (1 patient breached).

- Termination of resuscitation efforts should be considered in trauma patients with EMS-witnessed cardiopulmonary arrest and 15 minutes of unsuccessful resuscitation and CPR (7 patients breached).

In addition, 4 blunt trauma survivors were found to be apneic and pulseless on initial assessment, but ECG rhythm was not recorded. It is possible that a number of these patients would also have breached the guidelines.

### LIMITATIONS

The study is retrospective and observational. Follow-up data were unavailable on 4.2% of patients, and a major drawback of this study is the lack of information on the functional outcome of the survivors. Some of the survivors may have survived in a poor neurologic state. Injury Severity Scores were not available on all patients, but the relevance of applying this score to patients who are post-cardiac arrest is questionable.<sup>8</sup> The patients in this study were all attended to by physicians, and the interventions available to them are clearly described. The guidelines do not suggest that they should be applied only in specific types of EMS systems, but they do suggest that they should be individualized for each EMS system. Our results may not be easily extrapolated to systems with different levels of out-of-hospital care providers.

**Table.** Survival by mechanism of injury.\*

Mechanism of Injury	Number	Survivors (%) [95% CI]
Blunt trauma (assault, falls, under train, MVC, struck by falling object, other)	542	18 (3.3) [1.8–4.8]
Asphyxial injury (conflagration, drowning, electrocution, traumatic asphyxia, hanging)	176	30 (17.0) [11.5–22.6]
“Medical”+trauma	39	11 (28.2) [14.1–42.3]
Penetrating trauma	114	9 (7.9) [2.9–12.8]

\*Plus 38 patients who were lost to follow-up.  
MVC, Motor vehicle collision.

## DISCUSSION

Resuscitation of trauma patients in cardiopulmonary arrest remains a controversial topic. A recent comprehensive review of the literature, on which the 2003 guidelines are based, demonstrated survival rates of 0% to 3.7%.<sup>5</sup> All are retrospective database studies, and the proportions of blunt and penetrating trauma vary. Some exclude hanging, drowning, burns, electrocution, or patients for whom resuscitative efforts were terminated on scene; others include them. The definition of cardiac arrest varies; in some studies, periarrest patients are included.

This study demonstrates that in the setting of an urban physician-led system, out-of-hospital resuscitation is associated with a long-term survival rate of 7.5% for patients with cardiac arrest associated with trauma. Attendance of our out-of-hospital team guarantees the presence of a physician and at least 3 rescuers, which may improve outcome. However, 2 other recently published studies show remarkably similar survival rates<sup>6,7</sup> with nonphysician EMS systems. It is unclear why these recent results appear to be better than those published before the guidelines.<sup>5</sup> The futility of resuscitation in traumatic cardiac resuscitation has often been stressed. If our and the other recently published results<sup>6,7</sup> are truly representative of traumatic cardiac arrest outcome, they show that survival in this patient group can be as good as or better than outcome from out-of-hospital cardiac arrest of any cause.<sup>9</sup>

Examination of the characteristics of the survivors revealed that certain subgroups of patients fared better than others. The survival rate of patients whose cardiac arrest was the result of hypoxemia (hanging, drowning, electrocution, conflagration, traumatic asphyxia) had a survival rate of 17% [95% CI 11.5% to 22.6%] (Table). The relatively good outcome in this subgroup is confirmed in another recent study<sup>4</sup> and the National Association of EMS Physicians/American College of Surgeons Committee on Trauma guidelines emphasize that particular attention should be paid to this group. Another group associated with a relatively good outcome includes patients with penetrating trauma who met the local criteria for, and subsequently underwent, out-of-hospital thoracotomy. Eight of the 68 survivors (11.8%) from our series had a thoracotomy

performed on scene, 5 of whom are neurologically normal. Ninety-three thoracotomies were carried out on penetrating trauma victims in the out-of-hospital setting.

We also have other neurologically normal survivors from this procedure outside this series. Several US studies of emergency thoracotomy have demonstrated a 100% mortality rate in patients who had had penetrating trauma and cardiac arrest before reaching the hospital,<sup>5</sup> which is also our experience and provides our rationale for performing thoracotomy on these patients in the out-of-hospital phase. Local indications for this procedure are penetrating injury to the chest or epigastrium, resulting in cardiac arrest, with duration of arrest of less than 10 minutes and the time from arrest to arrival in hospital estimated to be greater than 10 minutes.<sup>10</sup> The National Association of EMS Physicians/American College of Surgeons Committee on Trauma guidelines are not written with this procedure in mind (“. . . thoracotomy is not a procedure that falls under the purview of out-of-hospital care. . .”), and this is a limitation of this study. However, the guidelines also state that “at the scene . . . in the case of penetrating trauma, patients without vital signs or other significant signs of life will not survive even with the most aggressive of therapies.” On-scene thoracotomy is possibly the most aggressive of therapies, but it can clearly produce neurologically normal survivors, which challenges the accuracy of this statement.

Six patients had cardiac arrest after cervical spine injuries. Although we do not have long-term morbidity follow-up on these patients, their notes suggest severe high spinal trauma. It seems likely that some of these patients would have had a primary respiratory arrest as a result of high spinal injury and progressed to cardiac arrest. Resuscitation was successful in 6 patients with isolated head injuries. Unfortunately, we have not established the long-term functional outcome in all of these patients. We are aware of the poor neurologic outcomes that other studies have demonstrated in similar patient groups.<sup>5</sup>

Six patients had a return of cardiac output after decompression of a tension pneumothorax, emphasizing the importance of chest decompression in patients with traumatic cardiac arrest.

Although we do not know how many nonsurvivors died primarily of hemorrhage, it is striking that only 1 survivor fell into this group, perhaps because patients with noncompressible hemorrhage who have cardiac arrest on scene have a very high bleeding rate. The hypovolemic trauma patient is possibly viewed as the “typical” traumatic cardiac arrest by many health care providers, and this study confirms the very poor survival in this group.

The National Association of EMS Physicians/American College of Surgeons Committee on Trauma guidelines undoubtedly correctly identify the majority of nonsurvivors. Unfortunately, there do appear to be some exceptions. Resuscitation might have been withheld or terminated in these patients if the guidelines had been strictly observed. A recent article that described 184 out-of-hospital traumatic cardiac arrests<sup>6</sup> demonstrated breaches in the

same areas. Most of the 14 survivors described in that study breached 1 of the time-related guidelines.

In conclusion, this relatively large study confirms the outcome of traumatic cardiac arrest demonstrated in recent smaller studies. Outcome is still poor but, for reasons that are unclear, better than previously described. Survivors are found in several subgroups (eg, asphyxial injuries, penetrating chest trauma with immediate thoracotomy, neurologic injuries, tension pneumothorax), but cardiac arrest as a result of hypovolemia is virtually always fatal. Recent guidelines published on withholding resuscitation in traumatic cardiac arrest should be applied with caution because survivors who may have breached the guidelines have now been described in 2 studies.

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