Emergency thoracotomy*

H. R. CHAMPION, P. D. DANNE AND F. FINELLI

Washington Hospital Center, Washington, D.C., USA

SUMMARY

Eighty-nine consecutive trauma patients, who were treated at one institution and received emergency thoracotomy, were studied. Although 76 (85%) of the patients had no vital signs at hospital arrival, 15 (17%) patients survived the emergency thoracotomy to progress to other hospital treatments. Ten patients were ultimately discharged, nine of whom have normal functions. Maintaining a broad set of indications for emergency thoracotomy may increase survival amongst trauma patients for whom the procedure is indicated.

INTRODUCTION

As emergency medical systems mature, with more advanced life support available at the scene, emergency departments receive increasing numbers of severely injured patients *in extremis*. The question is then raised as to how far one should go in resuscitation attempts. In particular, should one perform an emergency thoracotomy for a patient who arrives with minimal or no vital signs after blunt or penetrating injury?

This study evaluates the results of emergency thoracotomy performed in a trauma centre in Washington, D.C., compares these results with those reported in other studies and identifies prognostic factors that may aid in identifying which critical patients might possibly benefit from this procedure.

METHOD

The Washington Hospital Center, Washington, D.C., is an American College of Surgeons Level I Trauma Center. The MedSTAR (Medical Shock Trauma Acute Resuscitation) facility receives and treats critical patients suffering from shock or major

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Correspondence: Mr H. R. Champion, Washington Hospital Center, Washington, D.C., USA

trauma. MedSTAR is separate from the Emergency Department and consists of six emergency bays and a fully-equipped operating room. An ambulance entrance is adjacent to MedSTAR; a helipad is approximately 18 metres from the entrance.

The patient population consisted of 89 trauma patients admitted to MedSTAR during 1981 and 1982 who had suffered major trauma and received emergency thoracotomy (EBT). The only patients studied were those on whom thoracotomy was performed upon admission, or promptly thereafter, in the emergency bay and not in the operating room. At the time of the thoracotomy, no patient had a recordable blood pressure or a palpable pulse, and none were conscious.

Data for the study were obtained retrospectively from ambulance records, MedSTAR resuscitation charts, hospital charts, trauma research records and District of Columbia Medical Examiner's autopsy reports, which were available for all deaths.

Physiologic status at the scene, on arrival and after EBT were characterized by the trauma score (TS) (Champion *et al.*, 1981). A trauma score of 1 (of a possible 16) denoted the worst prognosis. Anatomical severity of injury was determined by calculating an injury severity score (ISS) (Baker *et al.*, 1974) for each patient. The maximum ISS is 75, representing fatal injuries. The ISS was determined from both the physicians' charts, which recorded the description of injury and the autopsy report, when relevant. The coding of two-chamber injuries of the heart by the Abbreviated Injury Scale (AIS) (American Medical Association, 1971), the basis of the ISS, is ill-defined. For this reason, these injuries were given an AIS grade of 6, denoting maximum injury. The two severity scales (TS and ISS) were plotted on a graph to compare outcome against severity (Champion *et al.*, 1983).

Patient outcome was measured as survival (defined as discharge alive from hospital) and response to resuscitation (defined as a palpable brachial or femoral pulse, or a systolic blood pressure of greater than 60 mmHg from spontaneous myocardial activity, with or without inotropic support). Statistical significance was evaluated using Chi-squared analysis and the Student's *t*-test.

RESULTS

The average age was 35.7 years for survivors and 35.3 years for nonsurvivors (range, 14 to 71 years).

Ten (11%) of the 89 patients who underwent emergency thoracotomy survived; nine had a normal level of function at discharge. Five additional patients survived long enough to be transported to the operating room for continuation of surgical therapy, where three died. The remaining two died on the fifth postoperative day from cerebral anoxia associated with their initial arrest.

All patients who survived had some vital signs present when first found at the scene of the incident. Of all vital signs at the scene, the two most significant (in terms of likely patient survival) appear to be the presence of respiratory activity (nine out of ten survivors) or palpable pulse (nine out of ten survivors). Only two patients showed any improvement in their vital signs during transport, and both survived.

Seventy-six (85%) patients arrived with no recordable vital signs (pulse, blood

pressure or respiratory activity) or pupillary activity. Eighty patients had Trauma Scores of 1 (i.e. probability of survival = 0); of these three (4%) survived.

Of the 13 patients with some vital signs on arrival, seven (54%) survived. Vital signs included palpable carotid pulse but no recordable blood pressure; one patient only had pupillary activity.

Sixty (67%) patients arrived in asystole. Of these, three patients (5%) survived. There were no survivors among the 15 patients who presented in coarse ventricular fibrillation.

Eighty patients suffered thoracic trauma with hypovolaemic arrest, profound shock or tamponade; six patients had massive intraperitoneal blood loss. Three patients had what transpired to be lethal direct blunt central nervous system injury.

Of the blunt trauma victims, 16 were motor vehicle accidents, eight were falls, four were pedestrians hit by vehicles and one was crushed. There were no survivors of blunt trauma. Of the 60 patients with penetrating wounds, 54 (90%) had significant primary thoracic injury and six had abdominal injury. The only person to survive a gunshot wound (GSW) had suffered a chest wound with transection of the pulmonary artery, fifth thoracic vertebra and the spinal cord, and a GSW to the right femoral vein.

Of the nine survivors of stab wounds, six had thoracic injuries only, two had combined thoracic and abdominal injuries, and one had an abdominal stab wound as the only injury.

Thirty-four (61%) of the 56 patients with penetrating thoracic trauma had more than one organ damaged. The most common organs injured were the lung and the heart. In combined abdomino-thoracic trauma, the most common abdominal organ injured was the liver (13 patients).

There was a 40% survival rate for patients with penetrating cardiac injury and a 50% survival rate for patients with penetrating injuries to the intrathoracic great vessels. There were three survivors from asystole, two of whom had stab wounds to the heart. The third patient had suffered several non-cardiac intrathoracic injuries from a GSW. No patient survived a combined wound of great vessel and heart.

Complications that prolonged hospital stay were termed 'serious'. Serious complications developed in half the patients, including one instance of mitral incompetence from a stab wound and four instances of complications relating to intrathoracic infection.

DISCUSSION

Previous research has concluded that EBT is not useful for blunt trauma (Bodai *et al.*, 1983; Deepak *et al.*, 1983; Moore *et al.*, 1979), for patients who have no vital signs at hospital arrival (Moore *et al.*, 1979; Cogbill *et al.*, 1983; Harnar *et al.*, 1981), for patients who have no cardiac electrical activity on arrival (Harnar *et al.*, 1981), or for patients with penetrating injuries to the abdomen (Bodai *et al.*, 1983; Harnar *et al.*, 1981). The cost of EBT has been quoted by some as an additional reason for not pursuing this course of therapy (Deepak *et al.*, 1983; Moore *et al.*, 1979), although other reports have concluded that EBT is 'cost-effective' (Baker *et al.*, 1980).

Based on these studies, the conclusion appears to be that emergency thoracotomy

should be reserved only for those patients with penetrating thoracic trauma who arrive with vital signs. However, there has been no consistency in the patient populations studied: some populations included thoracotomy performed many hours post-admission.

The present study isolated several factors that were significant in patient survival after emergency thoracotomy. All survivors had some vital signs present at the scene of the accident; however, 30% of survivors had *no* vital signs at all at hospital arrival. These patients had faster-than-average transport times to the hospital (*vide infra*). The presence of respiratory activity, or pulse at the scene appear to be the most important vital signs. Pupillary reactivity was absent on arrival in two of the survivors (both of whom were in asystole).

Rapid transport to the hospital may positively affect outcome. There were more survivors in 1982; survivors arrived, on average, 9 minutes faster than the survivors in 1981. There was no transport time difference between the groups of nonsurvivors.

The presence of electrical activity was not an essential prerequisite to survival. This contradicts findings of other studies (Deepak *et al.*, 1983; Cogbill *et al.*, 1983; Hamar *et al.*, 1981). Sixty patients (67%) were asystolic on arrival; three patients (5%) survived.

Quality of treatment may be a significant factor in survival. A hospital where significant numbers of emergency thoracotomies are done has an opportunity to improve both techniques and the coordination of support systems that are required to consistently bring such an exercise to a successful outcome. At the institution studied, the percentage of patients who showed a response to resuscitation increased (from 18% in 1981 to 53% in 1982) as did the survival rate (from 8% in 1981 to 14% in 1982). The patient populations were of comparable type each year in terms of mechanism of injury, distribution of injuries and condition upon presentation.

Certain skills are only learned with repeated practice and experience in emergency resuscitation. These include the technique of internal cardiac massage, especially when combined with volume and pharmacological resuscitation, and the expertise in direction and coordination on all the support elements necessary for a successful resuscitation. Facilities that have a small, specially-focused staff may offer more opportunities to develop these team skills than a busy emergency department with a large staff and often high turnover. Development of such team skills may also be a factor in reducing morbidity. It is for these reasons that a fairly liberal policy regarding initiating massive resuscitation, including thoracotomy, may be worthwhile, but only as part of an organized and structured approach to overall management of the victim of life-threatening injury. Table 1 shows suggested criteria.

CONCLUSION

Emergency thoracotomy can be the first step in the successful resuscitation of a specific patient population *in extremis* from acute injury. This population is dominated by patients with non-ballistic penetrating wounds to the chest. Diffuse, blunt, torsal, trauma-producing exsanguinating injury is rarely successfully managed by emergency thoracotomy.

Successful resuscitation is dependant on much more than the ability to open the chest. Coordinated team skills are also required, as well as the ability to mobilize and

Table 1 Entry and exit criteria for emergency thoracotomy in the emergency department*Criteria for performing thoracotomy*

- Cardiac Arrest or near cardiac arrest, *plus*
Vital signs at accident scene, *plus*
Short prehospital transport time (less than 10 minutes)
- Absence of obvious massive central nervous system injury

Environment

Major trauma bay with ability to rapidly institute volume and pharmacologic resuscitation, and controlled ventilation

Equipment

Thoracotomy tray with Lebsche knife, Finochietto retractors, clamps and cardiac suture material

Support systems

Blood bank, nursing, operating room and thoracic surgeons

Criteria for promptly discontinuing a futile effort

- Irretrievable anatomic injury, e.g. ruptured heart
- Failure to volume resuscitate, e.g. achieve pH 7.0–7.6, within 15 minutes of starting resuscitation
- Failure to sustain spontaneous cardiac rhythm and maintain mean systemic BP ≥ 50 , with or without inotropic support, within 30 minutes

apply significant resources over a brief period. Because a life might be saved and because often nothing can be lost by such a manoeuvre, it is important for an emergency department to be prepared for such an eventuality.

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