Emergency surgery in patients in extremis from blunt torso injury: heroic surgery or futile care?

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Background: Trauma strikes unexpectedly, frequently in the young and fit. When trauma victims arrive in the emergency room all possible steps, including surgery, are often undertaken in an attempt to achieve a successful outcome. However, for patients presenting in extremis, with cardiac arrest or exsanguinating blunt chest injury, the results of resuscitation and emergency surgery are extremely poor.

Patients and setting: Eight patients in extremis with a mean injury severity score of 36, presented to the resuscitation room of Queens Medical Centre during 2001. On arrival all were in extremis or cardiac arrest after significant blunt injury to the torso, and during resuscitation had a brief loss of cardiac output. They underwent emergency surgery to control haemorrhage and correct injuries in an attempt to preserve life. Seven patients died within hours of their initial presentation either in theatre or the intensive care unit and one patient survived.

Conclusions: Futility care in the management of severely injured patients is a controversial concept although the literature defines four concepts of futility within surgery. At present, while there remains even the remotest possibility of survival, there remains a strong incentive to act and reports of isolated survivors from studies of trauma patients in extremis or cardiac arrest continue to emerge. This may be seen as justification for either an aggressive surgical approach or an indication that surgery is futile. In an emerging culture of guidelines regarding effectiveness of treatment, is this an area in which such guidelines can or should be applied?

Case A
A 32 year old male motorcyclist involved in a high speed crash who was intubated by a paramedic. On arrival in the resuscitation room he was in pulseless electrical activity (PEA). Spontaneous cardiac output returned with cardiopulmonary resuscitation (CPR) and after a pericardiocentesis yielding frank blood. A median sternotomy was undertaken in theatre and a ventricular injury repaired, followed by laparotomy at which a grade IV/V liver laceration was packed. Resuscitation was abandoned after further deterioration.

Case B
A 37 year old male motorcyclist involved in a high speed crash found unconscious at scene and rapidly transferred to the emergency department, where he was intubated, bilateral chest drains sited with the left draining 900 ml of blood immediately, and fluid resuscitation started. An obvious wound in the left posterior triangle of the neck with significant venous bleeding was temporarily controlled with a Foley catheter and he was transferred to theatre for a left neck exploration.

Case C
A 19 year old man who suffered a fall from height. Although on scene he was breathing spontaneously with a Glasgow coma score (GCS) of 8 and a palpable carotid pulse, on arrival in the resuscitation room he deteriorated into PEA. He was intubated and CPR started with bilateral needle thoracocentesis, chest drainage, and a fluid challenge to which he responded. Clinical examination revealed an unstable pelvic fracture and FAST (focused assessment with sonography for trauma) ultrasound detected free intra-abdominal fluid. In theatre a pelvic fixator was placed and the abdomen packed for a grade IV liver laceration. He continued to deteriorate and died in theatre.

Case D
A 37 year old male motorcyclist involved in a high speed crash found unconscious at scene and rapidly transferred to the emergency department, where he was intubated, bilateral chest drains sited with the left draining 900 ml of blood immediately, and fluid resuscitation started. An obvious wound in the left posterior triangle of the neck with significant venous bleeding was temporarily controlled with a Foley catheter and he was transferred to theatre for a left neck exploration.

Abbreviations: ERT, emergency room thoracotomy; PEA, pulseless electrical activity; GCS, Glasgow coma score; CPR, cardiopulmonary resuscitation
thoracotomy with trapdoor extension for ongoing blood loss. The external jugular vein had been avulsed and the left lung lacerated. He was transferred to the adult intensive care unit (AICU) but deteriorated and died shortly afterwards.

Case D
A 19 year old male pedestrian who was struck by a bus. He was unconscious on scene and intubated by a paramedic. In the resuscitation room fluid resuscitation was continued and bilateral chest drains placed. There was a brief loss of cardiac output and FAST detected free fluid in the abdomen. He was taken immediately to theatre and underwent laparotomy for a splenic rupture and thoracotomy for pulmonary contusions and lung lacerations. He deteriorated and died later in the AICU.

Case E
A 41 year old male driver involved in a motor vehicle crash. He had vital signs on scene, but rapidly deteriorated in the emergency department and was intubated, bilateral chest drains placed, and fluid resuscitation started. An unstable pelvic injury was detected. After a brief loss of cardiac output he was transferred to theatre for external pelvic fixation and laparotomy for a ruptured spleen and grade III liver lacerations. He deteriorated into a PEA arrest from which resuscitation was unsuccessful.

Case F
A 24 year old male driver involved in a high speed road traffic accident. The driver was conscious at scene with a systolic blood pressure of 150 mm Hg and heart rate of 100. Rapid abdominal distension and complete cardiovascular collapse shortly after admission led to immediate transfer to theatre for laparotomy and packing of a grade IV liver laceration. He continued to deteriorate and died in theatre.

Case G
A 35 year old male driver involved in a road traffic accident. Initially trapped in the vehicle, he was treated on scene by the hospital flying squad and bilateral tension pneumothoraces decompressed. On arrival in the emergency department he had bled significantly into the chest drains and deteriorated into a PEA arrest. Percardiocentesis and CPR were performed with return of cardiac output on three occasions. Bilateral thoracotomy was undertaken in the resuscitation room, but despite these efforts he deteriorated further and died in the emergency department.

Case H
A 72 year old woman involved in a motor vehicle crash. Initial respiratory distress was relieved by treating a tension pneumothorax and insertion of a chest drain. However, further respiratory difficulties led to a PEA arrest, which responded to CPR. Computed tomography showed right sided lung contusions, a pleural effusion and suggested rupture of the left hemidiaphragm. At laparotomy a bleeding unsalvageable spleen was removed. She made a slow but steady improvement, was weaned from the ventilator at 10 days and was discharged home with no neurological impairment.

Table 1 shows physiological data from the patients’ arrival in resuscitation and table 2 shows a summary of injuries. Seven patients died within hours of their initial presentation. TRISS methodology, using the parameters from initial presentation, suggests there were three potentially avoidable deaths.

DISCUSSION
These cases represent the complexity of decision making in trauma resuscitation, where comparatively little information is known about the patient and the true extent of their injuries at the time when urgent management decisions need to be made. They raise a number of important clinical and ethical issues in the management of the trauma patient in extremis.

Modern trauma systems are based on the concept of the “golden hour” although there is scarce available data to support this theory. In our patients the prehospital times were comparatively short and ranged from 25 minutes to 75 minutes (for one entrapped patient). The report Better Care for the Severely Injured6 recommends that a trauma team led by an emergency consultant should receive all severely injured patients and this was the case in all but one of our patients. The decision to proceed to theatre was taken by a senior surgical specialist registrar (SpR) or consultant and in all cases the operative procedures were performed by the SpR and a consultant surgeon within 40 minutes of the patient’s arrival at the hospital. This early senior physician response is similar to most large urban centres in the USA and there seems little that could be done to the “system” to improve on these results.

Current resuscitation guidelines from the American Heart Association7 for blunt traumatic cardiac arrest advocate urgent surgical exploration and most American trauma surgeons would undertake emergency room thoracotomy (ERT) for blunt trauma if there had been signs of life in the emergency department and cardiac arrest for less than five minutes.8 However, survival from out of hospital cardiac arrest has been shown to be negligible. Battistella et al9 reviewed 604 victims of traumatic prehospital cardiac arrest (304 blunt). There were only four blunt trauma survivors (1.3%) and 12 (4%) from penetrating injury. They concluded that prehospital trauma victims who are pulseless with asystole or agonal (heart rate less than 40 beats per minute) cardiac electrical activity should be pronounced dead at the scene. Shimazu reviewed the outcome of 267 patients in cardiopulmonary arrest on arrival at hospital, of whom 217 had sustained blunt trauma. Half underwent emergency thoracotomy. Overall five patients survived (2.3%) but only two patients recovered to be functional, the others sustained permanent neurological damage.10 Fulton also analysed survival after traumatic cardiac arrest in a group of 245 trauma patients, 146 from blunt trauma, with only four blunt trauma survivors (2.7%).11 Despite these results the author concluded that patients with traumatic cardiac arrest should receive treatment.

The results after ERT for trauma are equally disappointing. The technique of resuscitative thoracotomy was first promoted by Schill’s use of open cardiac massage in 1874,12 since then despite fluctuating popularity, an evidence base for rational use of the technique has gradually emerged. Rhee et al13 reviewed 4620 cases of emergency room thoracotomy for trauma from the literature over the past 25 years. The overall survival for penetrating injuries was 8.8% (11.5% with signs of life), however survival was only 1.4% in blunt trauma. The
best results from ERT are consistently in patients with penetrating cardiac injury who present with signs of life. Read et al.\textsuperscript{12} demonstrated a survival of 40%–53% in this subgroup compared with 1.4% when signs of life were absent. Analysis of nine American studies of blunt trauma revealed a salvage rate of only 1%–2%.\textsuperscript{13} These institutions tend to have an aggressive policy of ERT on all comers, which differs markedly to most UK institutions. A small study from the Royal London Hospital of 16 patients, 12 of whom had sustained blunt trauma, failed to produce a survivor.\textsuperscript{14}

Clinical guidelines\textsuperscript{15} for ERT have been developed based on location and mechanism of injury, signs of life at scene, cardiac electrical activity at thoracotomy, and systolic aortic response to thoracic aortic cross clamping. With these criteria only one patient from 150 with blunt injury survived albeit with significant neurological impairment.\textsuperscript{16}

The consensus of evidence is therefore moving towards ERT only for patients after penetrating injury, who may be pulseless, but with myocardial electrical activity and not for victims of blunt trauma.

The ability to intubate the trauma patient on scene without anaesthetic drugs has been evaluated as a prehospital indicator of futility in the UK by Lockey et al.\textsuperscript{17} In a series of 1480 patients there was a single survivor (0.2%) who had sustained a penetrating heart injury. However, the management of the trauma patient is constantly evolving and the development over recent years of new surgical and critical care approaches to the injured patient in extremis may challenge previous survival data. “Damage control”\textsuperscript{18} has been shown to improve survival in the most severely injured patients.\textsuperscript{19} The technique entails the rapid control of bleeding and limitation of contamination followed by restoration of the patient’s physiology through continued resuscitation, correction of temperature, coagulation profile, and reversal of acidosis before definitive surgery is contemplated.

TRISS methodology has become the standard tool to evaluate trauma outcome, however its value in individual patients and subgroup analysis has been questioned.\textsuperscript{20} TRISS analysis of this series of patients suggested that three patients had potentially avoidable deaths. Further review of these patients using trauma performance methodology\textsuperscript{21} did not show errors in their care that would have attributed to their death. The anatomical injury component of scoring systems such as TRISS limits its value in the acute management of trauma patients. Alternative physiological scoring systems that can be calculated rapidly have been developed,\textsuperscript{22} however these are unlikely to be sufficiently robust to help clinical decision making in this patient group. Further work on physiological markers of futility in trauma may be required.

Operative and postoperative futility is becoming increasingly recognised. The term “futile” is both a technical and ethical term. It has long been justified to withhold treatment in such cases. Hippocrates himself suggested we should “refuse to treat those over-mastered by their diseases, realising that in such cases medicine is useless”\textsuperscript{23}.

Four concepts of ethical futility have been defined in the literature: physiological futility, clinical futility, imminent demise futility, and qualitative futility.\textsuperscript{24} These ethical concepts however are not supported by clinical data or trials. The concepts are difficult to transfer into clinical practice even within the cases outlined in this paper. Conventional decision making and risk assessment models such as ASCOT and TRISS are impossible to apply in emergent situations.

In physiological futility\textsuperscript{25} how unlikely must a procedure such as ERT be to produce physiological benefit, before it is futile? With the exception of situations such as prolonged asystole or decapitation, etc, it may not be possible to immediately define futility without the passage of time. Likewise for imminent demise futility\textsuperscript{26} does a survival rate of 1%–3% constitute “reliably expected to die”, or a potential neurological recovery of only 1% represent qualitative futility?\textsuperscript{27}

There is little available practical guidance regarding resuscitative efforts in the traumatised patient. The General Medical Council (GMC) guidelines\textsuperscript{28} suggest that in an emergency a considered judgement should be made about a patient’s best interests when deciding whether to withhold treatment. It is important to realise that such judgements are often not made in isolation, but made by people based upon a wide range of previous experiences, interests, research, religious, and socio-cultural backgrounds. It is important that placing the label “futility” on a patient’s care is not used as an excuse for not involving relatives in difficult discussions about the termination of treatment, or used covertly to ration resources, as both could seriously undermine the trust placed upon the medical community. Each of these concepts is open to debate.

The resuscitative process and emergency surgery associated with the initial care of critically injured patients also entails risks to healthcare providers themselves. Compliance with universal barrier precautions is recognised to be poor in trauma resuscitation\textsuperscript{29} when the need for urgent intervention is greatest. In addition, the trauma population may be at higher risk than the general population of carrying blood borne infections and HIV.\textsuperscript{30} Procedures such as ERT that are associated with the rapid use of surgical instruments and exposure to patient’s blood in less than ideal circumstances must be undertaken with caution. Surgery in the face of accepted futility would needlessly put healthcare providers at increased risk.

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**Table 2** Surgical intervention, injuries, and outcome

<table>
<thead>
<tr>
<th>Case</th>
<th>Surgery</th>
<th>Main injuries</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Median sternotomy, laparotomy</td>
<td>Subarachnoid haemorrhage, grade IV liver laceration, lung contusions</td>
<td>Died</td>
</tr>
<tr>
<td>B</td>
<td>Laparotomy</td>
<td>Grade IV liver laceration, pelvic fracture, aortic dissection</td>
<td>Died</td>
</tr>
<tr>
<td>C</td>
<td>Left thoracotomy + trapdoor</td>
<td>Avulsion of external jugular vein, lung laceration, small subdural haematoma</td>
<td>Died</td>
</tr>
<tr>
<td>D</td>
<td>Ex fix, laparotomy, thoracotomy</td>
<td>Lung laceration and contusion, pelvic fracture, splenic rupture</td>
<td>Died</td>
</tr>
<tr>
<td>E</td>
<td>Ex fix, laparotomy</td>
<td>Cardiac contusion, grade III liver laceration, subarachnoid haemorrhage, multiple fractures</td>
<td>Died</td>
</tr>
<tr>
<td>F</td>
<td>Laparotomy</td>
<td>Grade IV liver laceration</td>
<td>Died</td>
</tr>
<tr>
<td>G</td>
<td>Bilateral thoracotomy</td>
<td>Bilateral lung laceration, cardiac tamponade</td>
<td>Died</td>
</tr>
<tr>
<td>H</td>
<td>Laparotomy</td>
<td>Diaphragmatic rupture, and splenic rupture</td>
<td>Survived</td>
</tr>
</tbody>
</table>
CONCLUSION

The concept of futility in the management of severely injured patients remains controversial and there is no consensus on the treatment of these patients. Published results may be viewed as justification either for an aggressive surgical approach or an indication that intervention is futile. Despite the comparatively poor outcome described in much of the literature, surgeons and physicians involved in the acute care of these patients frequently disregard existing data in an attempt to save life. Few guidelines are available and those that are may be contradictory. While seven patients in our series died from their injuries, one elderly woman survived against all expectations. Review of the current literature suggests that resuscitative and surgical interventions were unlikely to be successful in her case.

The management of the severely injured patient requires a multi-disciplinary team. For strategies such as damage control and aggressive surgical resuscitation to be effective, all the specialists involved must agree with both the justification and aims of treatment or the attempts will be doomed to failure. Equally, in certain circumstances, all must agree that treatment would be futile.

It would be inappropriate to define from this small series the patient group where resuscitation and surgical intervention would be accepted as being futile. We continue to have difficulty deciding on the most appropriate management of these patients and whether surgical intervention is heroic or futile. We feel that there is a need to develop indicators of futility, backed up by large scale studies. Like many other areas of medicine it is a subject that may attract Clinical Guidelines at a national level, but this may raise many areas of medicine it is a subject that may attract Clinical Guidelines at a national level, but this may raise many issues.

REFERENCES