# Early management of the severely injured patient

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*J R Soc Med* 1998;**91**:26–29 SECTION OF ORTHOPAEDICS, 1 OCTOBER 1996

Intensive care of the severely injured patient should begin at the scene of the accident and continue through to the intensive care unit (ICU). If the initial treatment is of a high standard, some of the morbidity and mortality seen in the ICU can be prevented. Opinions differ on the level of care that should be provided at this stage. In the UK, most patients are seen first by paramedics who then transfer the patient by road ambulance to the nearest hospital. By contrast, in London the Helicopter Emergency Medical Service (HEMS) offers an experienced doctor at the scene to stabilize the patient and decide on the most appropriate hospital. Although the HEMS spends slightly longer at the scene than the ambulance service, it reduces the time to critical intervention, the time to definitive care and the incidence of secondary transfers[1]. The theme of intensive care should run throughout the pre-ICU phase. Early involvement of senior medical staff with trauma experience in diagnosis and treatment reduces long-term complications and prevents lengthy futile attempts at resuscitation. The priorities for immediate care are:

- A secure airway
- Restoration of oxygenation and ventilation
- Resuscitation of the cardiovascular system
- Prevention of secondary injury to the central nervous system
- Achievement of haemostasis
- Maintenance of body temperature
- Preservation of renal function

Continuous early monitoring is fundamental to the treatment of the severely injured patient.

## INTENSIVE CARE

In the first few days some aspects of trauma intensive care differ from general intensive care.

### Volume replacement and haemorrhage control

Initial resuscitation is with crystalloid or colloid solutions, volume being restricted to the minimum necessary to maintain perfusion until bleeding has been stopped. Blood transfusion follows when haematocrit falls below 30%[2,3]. Serious bleeding must be identified and stopped by compression, by surgery or by selective embolization.

Haemodilution, shock and brain injury all predispose to coagulopathies after trauma. Disseminated intravascular coagulation[4] is common and precludes the routine use of antifibrinolytic drugs. Coagulopathies are less likely if the peripheral circulation and blood pH are restored by infusion of warmed fluids and blood and body temperature maintained by external warming[5]. If a coagulopathy does develop, early consultation with a haematologist will not only yield advice but also provide rapid access to blood products[6]. Once bleeding has been controlled the circulation should be restored. Some groups favour supranormal therapeutic goals for cardiac index, oxygen delivery and oxygen consumption[7] but this strategy demands elaborate monitoring.

### Head injuries

In the UK about 6000 patients are admitted to hospital each year with severe head injury[8]. The primary brain damage may be compounded by secondary pathophysiological insults that arise during transportation, resuscitation, surgery and intensive care. The injured brain is highly vulnerable to ischaemic damage, especially from hypotension and hypoxaemia[8,9], and the priorities are airway, ventilation and circulation with timely evacuation of intracranial mass lesions (over a quarter of patients admitted to the Royal London Hospital with severe head injury require evacuation of intracerebral haematoma[10]). Multiple injuries are present in over 50% of patients with severe head injury[8] and patients must be stabilized before diagnostic imaging and neurosurgery. In ICU, treatment is largely directed at maintaining the cerebral perfusion pressure (CPP), calculated as the mean arterial pressure minus intracranial pressure. The CPP should be kept above 70 mm Hg[9,11] by volume replacement and noradrenaline infusion. If possible, intracranial pressure (ICP) should be maintained at less than 20 mm Hg, but CPP is the priority. Oxygenation, ventilation, sedation and volume status should be assessed regularly and pyrexia controlled aggressively. The treatment of persistently raised ICP includes osmotherapy, controlled hyperventilation, heavy sedation with infusion of short-acting hypnotics and

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hypothermia. Transcranial doppler, jugular bulb oxygen saturation monitoring, and cerebral function monitoring may help guide therapy when ICP is raised[11]

## Spinal injuries

There must be a high index of suspicion that a spinal injury has occurred if secondary spinal cord injury is to be prevented. It is common, because of other management priorities, for spinal X-rays to be incomplete or not cleared during the initial assessment and resuscitation. To prevent secondary spinal cord injury, the patient may then need to wear a cervical collar and remain immobile, sometimes for several days. What are the most appropriate investigations to screen for potential cervical spine injuries? Some clinicians argue that the radiological views should include antero-posterior and open-mouth peg views as well as the standard lateral view; poorly visualized or suspicious areas require computerized tomography before radiological clearance can be given[12]. Patients with impaired consciousness, especially those with multiple injuries, should have a full radiographic spinal survey. The awake patient should be examined neurologically. X-rays should be examined promptly by an experienced radiologist, orthopaedic surgeon or neurosurgeon so that, if necessary, the spine can be surgically stabilized at an early stage.

## Treatment of fractures

The treatment of lower limb fractures by traction makes nursing difficult, causes unnecessary pain, increases bleeding at the fracture site and increases the incidence of thromboembolism, pressure sores and fat embolism[13]. Compared with internal fixation, traction carries a higher risk of adult respiratory distress syndrome (ARDS), positive blood cultures, fever and fracture complications[14,15]. Mortality after major fractures has been reduced by internal fixation[16] from 29% to 4.5%. However, early fixation in patients with head injury may have an adverse effect on the head injury[17].

Complex pelvic fractures have a mortality of up to 31%[18]. They may be associated with extensive soft-tissue injuries and can cause uncontrollable bleeding from ruptured pelvic veins. Studies of the epidemiology[18], haemorrhagic pattern[19], and early management[20] of these injuries favour early fixation, preferably in centres with a specialist interest in pelvic surgery. Ideally, all pelvic and long-bone fractures should be fixed externally or internally in the first 24 hours after injury.

## Pain control

Pain may be severe, particularly in partly sedated ventilated patients who cannot communicate. Analgesia can be achieved with a narcotic drug given by intravenous infusion or under patient control. In very severe pain, the necessary high dose infusions may impair respiratory function, consciousness and airway control and require the patient to be intubated and ventilated.

Epidural analgesia with a mixture of narcotic and local anaesthetic agent can be used to control thoracic and lower body pain. An epidural is contraindicated in the presence of a spinal injury, local infection or a coagulation defect and it may mask compartment syndrome in the lower limb.

A non steroidal anti-inflammatory drug can provide excellent background analgesia in soft-tissue and bone injuries, but their effects on renal function and gastric bleeding may preclude their use.

## Renal failure

Acute renal failure (ARF) is an important cause of morbidity and mortality in trauma patients[21] and there are many potential causes. Hypotension and renal hypoperfusion may follow hypovolaemia. Dehydration may occur, particularly in head injuries. Other causes include hypoxia, myoglobinuria, sepsis and nephrotoxic drugs.

Oliguric renal failure is more difficult to manage than polyuric renal failure. Good urine volumes may be preserved by replacing blood loss and providing adequate crystalloid hydration. Oliguria can sometimes be averted by early use of a low-dose frusemide infusion. Frusemide infusions may protect the kidney by decreasing renal oxygen consumption but will only be effective if hydration is adequate[22]. 'Renal dose' dopamine can reverse profound intrarenal vasoconstriction but there is little real evidence for its efficacy in the prevention of ARF. Mannitol, used in large doses to reduce intracranial pressure, may induce ARF by dehydration and reduction of renal medullary oxygenation[22].

## Secondary lung injury

Some patients initially survive major injuries only to die later from ARDS[23]. ARDS is characterized by widespread pulmonary infiltrate on chest X-ray, deteriorating gas exchange and decrease in lung compliance. Its development is unpredictable, but it may follow aspiration of stomach contents, lung contusion, massive blood transfusion, lung infection, generalized sepsis, smoke inhalation and fat embolism[23].

Initial treatment for ARDS is lung ventilation. Controlled diuresis and fluid restriction to reduce pulmonary capillary wedge pressure may improve overall outcome without inducing haemodynamic or renal failure[24]. If lung function continues to deteriorate, further damage from high inspired oxygen concentrations and lung inflation pressures can be limited by permissive hypercapnia,

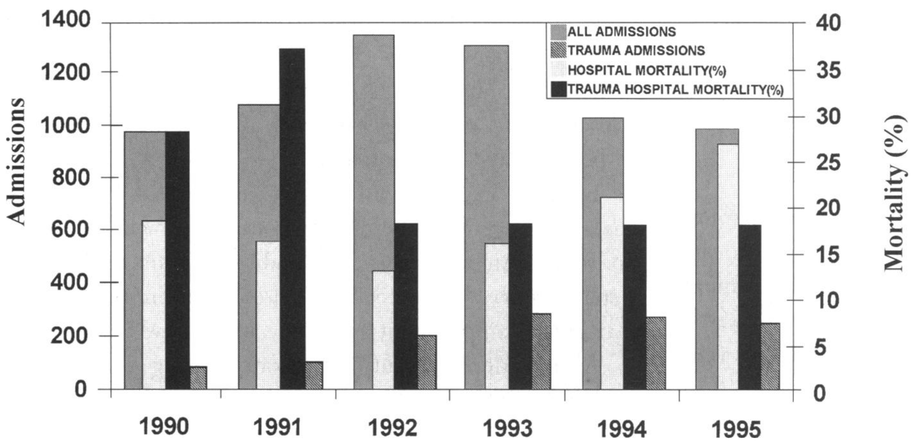


*Figure 1* **Royal London ICU 1990–95: trauma versus all admissions**

acceptance of oxygen saturations of about 90% and the use of reversed inspiratory/expiratory ratio. Gas exchange may be improved by ventilation face down (prone ventilation) and the use of nebulized nitric oxide, a potent pulmonary artery dilator that opens up pulmonary vessels in contact with ventilated alveoli to improve ventilation/perfusion mismatch[25,26].

The use of intravascular respiratory support is controversial. Extracorporeal membrane oxygenation is undoubtedly effective in selected patients but is very expensive, labour intensive and prone to serious complications. It should be used only in an established unit after consideration of the risks and benefits[27].

## OUTCOME STUDIES IN TRAUMA PATIENTS

Treatment of the severely injured is expensive. At the Royal London Hospital in 1995, trauma was responsible for only 25% of ICU admissions but used 49% of bed days. The use of these resources must be justified. The mean age of the first 1000 patients admitted through the helicopter service was 35.8 years and 770 of these left hospital alive. 160 were admitted to ICU and a further 514 to the high-dependency trauma unit with an overall mean stay in these units of nearly 6 days[28]. Figure 1 shows mortality rates for non-trauma and trauma ICU patients from 1990 to 1995. These results resemble those obtained in an American outcome study[29] of 233 severely injured ICU patients, in which hospital mortality was 18.4% and mean age 35.6 years. In that study, 167 patients were alive after 5 years, only 11% were severely disabled or vegetative, 89% were healthy or slightly disabled and 79% were working. In another study[30], 55% of 105 severely injured patients aged over 65 with an injury severity score greater than 16, with an average age of 73, were discharged from hospital. After nearly three years, 48 were still alive, 15% normal, 44% not normal but independent and 30% dependent.

Results such as these suggest that trauma victims, whatever their age, are worth the effort and resources expended on them. A good outcome in severely injured patients depends on providing optimal care. This can only be achieved by treatment of high standard delivered early by experienced senior medical, nursing and support staff.

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