IMMEDIATE HOSPITAL CARE OF THE INJURED

D. CAMPBELL

In the severely injured the greater number of hospital deaths occur within the first few hours following admission, at least one-third within 6 h and more than one-half within 24 h (Hoffman, 1976). Appropriate intensive management at this time is of vital importance and will largely depend on the immediate availability of adequate numbers of staff skilled in the techniques of resuscitation and experienced in the difficult matter of diagnosis in cases of multiple injuries, and recognition of priorities in emergency treatment. There is good evidence, also, that a proportion of these early hospital deaths are preventable if the fundamental principles of maintenance of a patent airway and adequate alveolar ventilation, along with control and adequate replacement of blood loss, are adhered to rigorously. Apart from the question of immediate survival, the quality of ultimate recovery may well depend on effective early management of the severely injured. Nowhere is this more obvious than in the treatment of head injuries.

Following admission of the patient to the emergency casualty department, the main lines of management are instituted immediately and in many instances overlap: resuscitation, overall assessment, diagnosis and specific treatment. This necessitates skilled team-work by many individuals but in particular the anaesthetist and the accident surgeon.

RESUSCITATION AND GENERAL ASSESSMENT

Depending on circumstances, the patient may be admitted to hospital having benefited from continuous resuscitation from the scene of the accident. The arguments in favour of mobile resuscitation teams attached to District General Hospitals are well known and the value of such an arrangement is clearly demonstrated where the number of accident victims justifies the organizational difficulties and expense involved (Baskett, Diamond and Cochrane, 1976). Where nothing has yet been done, however, the two immediate steps to be taken are to secure the airway and insert an adequate-bore i.v. cannula as well as a central venous catheter. So far as adequacy of ventilation is concerned, the decision whether to assist respiration will be a matter of judgement based on the nature of the injuries and clinical signs of respiratory difficulty. This decision will be reinforced by arterial blood-gas analysis at the earliest possible time. Establishment of effective ventilation was recognized by John Hunter in 1776 as of crucial importance in resuscitation, but all too often this fact is overlooked in present-day management. A word of warning, however, is necessary about the use of IPPV in the presence of a chest injury. Where pleural drainage has not been carried out, the development of a tension pneumothorax can result and, if unnoticed, prove fatal (fig. 1). Similarly, if a cervical injury is present but undiagnosed, careless positioning

![Fig. 1. Gross tension pneumothorax following resuscitation with marked mediastinal shift to the left.](https://academic.oup.com/bja/article-abstract/49/7/673/301014/9397300104)
of the head for tracheal intubation can result in tetraplegia or death, for example where there is a fracture of the odontoid process or a high, unstable cervical fracture (fig. 2).

FIG. 2. A high and unstable fracture of the cervical spine. Great caution is required at the time of tracheal intubation to avoid damage to the spinal cord.

Not all patients will require a tracheal tube to maintain an adequate airway, but it is probably best to pass a nasogastric tube in every major accident case to empty the stomach initially and protect the airway from subsequent aspiration accidents. This is certainly vital if consciousness is impaired as judged by the initial neurological assessment. The importance of an early and continuing neurological assessment has been stressed by Teasdale (1976) and an observation chart such as he described, using the Glasgow Coma Scale, is strongly recommended in all suspected head injuries.

Hoffman (1976), in his Hunterian Lecture, already referred to, drew attention to the fact that road accident victims in particular still frequently die of haemorrhage, concealed bleeding often being difficult to diagnose in patients with multiple injuries and in the unconscious. The importance of an accurate estimate of the adequacy of the circulating blood volume cannot be over-emphasized and clinical judgement alone is not enough in the gravely ill casualty. The value of central venous pressure measurements during resuscitation is well known, as are its limitations and complications (Kelman, 1971). In addition, it is possible to observe the adequacy or otherwise of renal perfusion by measuring hourly urine flow, so that a catheter should be inserted in the bladder early in treatment, with the exception of cases of urethral rupture where a suprapubic catheter may be required. In this way, early warning is obtained of the development of acute reversible intrinsic renal failure (Robson, 1975). Accurate measurement of arterial pressure is vital and is greatly facilitated by the percutaneous insertion of a suitable arterial cannula, usually in the radial artery. This also permits frequent arterial blood-gas analyses as an important means of assessing the respiratory and metabolic state of the patient. A simple and satisfactory pressure infusion system for this purpose is illustrated in figure 3. This invasive technique is eminently justified in cases of major trauma. The use of an even more elaborate technique for haemodynamic assessment is, however, subject to more debate on account of the measurable additional risk to the patient involved.

Swan and colleagues (1970) described a flow-directed catheter for the measurement of right heart and pulmonary wedge pressures, enabling assessment to be made of left heart function in various disease states. This technique can be invaluable in the early management of severe major trauma where great precision is often required to guide blood replacement and drug therapy, particularly in the presence of a failing heart (fig. 4). Serious complications can occur, however, and its use will probably remain restricted to a carefully selected group of patients in the care of those experienced with the technique (Colvin, Saege and Lewis, 1975; McNabb, Green and Parker, 1975).

As a further aid to cardiovascular assessment the continuous recording of a Lead II e.c.g. can be helpful although, while it gives warning of dangerous dysrhythmias and ischaemia of the myocardium, it is well to remember that this picture of electrical activity tells little of the adequacy of "pump" performance.

One of the simpler measurements often overlooked is that of body temperature. Severely injured patients may already be hypothermic on admission as a result of exposure, or may shortly become so following the massive infusion of cold blood or fluids i.v. during resuscitation. Even when a blood-warming coil is
Fig. 3. A simple arrangement for intra-arterial pressure monitoring. (1) 20-gauge, 32-mm Teflon cannula. The wings permit stitching to the skin for security (Quik cath, Travenol Labs, Ltd). (2) Sampling tap for arterial blood-gas analysis. (3) Lightweight arterial pressure transducer with disposable dome (S & W, AE-840). (4) Valve with filter to permit continuous flushing of the system (Intraflo, CFS-O3F, Sorenson Research Co.). (5) Pressure infusion line delivering heparinized normal saline to the system.

Fig. 4. Pulmonary arterial and pulmonary wedge pressure tracings from a male patient (age 20 yr) who suffered from over-infusion of i.v. fluids following severe trauma. 11.30 a.m. Pulmonary arterial pressure 60 mm Hg, mean left atrial pressure 21 mm Hg. Following administration of ouabaine and frusemide i.v. (●) there was a steady cardiovascular improvement. 8 a.m. Pulmonary arterial pressure now 40 mm Hg and mean left atrial pressure 10 mm Hg.

Where the patient is not unconscious, relief of pain is an important matter to bear in mind during resuscitation. Simple immobilization of fractured long bones with air-splints or plaster "back-slabs" can improve the situation, and the use of regional blocks with local analgesics can provide considerable relief, especially where there are multiple rib fractures (Moore, 1975). Also, the full potential of nitrous oxide-oxygen mixtures (Entonox) has probably not been exploited in these situations and such a mixture can be used during IPPV (Parbrook, 1968). None of these methods interferes with the assessment of head injuries or diagnosis of intra-abdominal injury to the same extent as does the use of narcotic analgesic drugs parenterally.

While there is no substitute for careful aseptic technique, the risk of bacterial contamination where there has been massive tissue damage is high, and there is possibly a good case for early use of antibiotics analogous to their short-term prophylactic use in certain types of surgery (Stokes et al., 1974;
THYMOXAMINE INFUSION

**Fig. 5.** This temperature chart demonstrates the value of the simultaneous measurement of core (mid-oesophageal) and peripheral (skin of big toe) temperatures. Following resuscitation and infusion of the alpha-blocking drug thymoxamine, the skin temperature increases to approximate that of the body core as peripheral perfusion improves.

Griffiths et al., 1976). Many of these patients will have intra-abdominal injuries with possible soiling of the peritoneal cavity. These patients are certainly liable to develop endotoxic shock later during treatment. If it is decided to employ antibiotics in this way, the best choice at present would appear to be gentamicin with lincomycin. Most casualty departments have a routine so far as tetanus prophylaxis is concerned, the previously immunized patient needing only a booster dose of toxoid, while the non-immune receive an antibiotic with antitetanus globulin and subsequent active immunization (Andrews, 1976).

The importance of early and adequate restoration of circulating blood volume and oxygen delivery to the tissues has been alluded to earlier. The choice of crystalloid fluids, plasma substitutes and blood will be dictated by circumstance and availability and is a very vital matter. This subject is dealt with in detail by Doenicke and colleagues, elsewhere in this issue (p. 681) but it should be borne in mind that immediate surgery to control haemorrhage may be an urgent matter, even when the patient is not fully “resuscitated”.

In this way, while resuscitation and general supportive measures are being carried out without delay, steps are taken to enable essential measurements to be made immediately and subsequently provide the all important continuous monitoring of the patient’s vital functions and control of therapy.

**DIAGNOSIS AND SPECIFIC TREATMENT**

Early and accurate diagnosis of the extent of the patient’s injuries is an essential prerequisite to appropriate and adequate treatment, and this must be undertaken in parallel with the initial resuscitation manoeuvres. Surgery may be required immediately where a life-threatening situation exists, for example intracranial bleeding or a ruptured spleen, or may be delayed and elective. The crux of good management of these patients is to distinguish between these two situations, and requires all the experience and cooperative effort of the members of the accident team. A number of situations continually recur which provide difficulties in diagnosis and treatment and the anaesthetist should be aware of them.

**Head injuries**

As an important preliminary step in the management of these patients, it is vital to exclude extracranial causes of coma, particularly in the patient with multiple injuries. Confusion can also arise, leading to a dangerous delay in treatment, where alcohol has recently been consumed. All suspected head injuries should have an immediate x-ray of skull although, in children particularly, brain damage can be present without evidence of skull fracture.

Walpole Lewin, in a recent review of the management of severe head injuries, emphasized the dynamic nature of the condition and demonstrated again the role the “impeccable airway” plays in reduction of mortality. He drew attention to the three major killing factors following severe head injury: intracranial haematoma, cerebral hypoxia and increase in brain bulk (Lewin, 1976). The immense value of the EMI Scanner in the earlier diagnosis of intracranial clots is now fully appreciated and the resulting earlier surgical intervention must lead to a further decrease in mortality and also to an improvement in the quality of survival (Galbraith, Teasdale and Blaicklock, 1976).

Reliance on clinical assessment alone is particularly unwise if the patient is already undergoing controlled ventilation immediately following or before admis-
sion, and it is here that the continuous measurement of intracranial pressure introduced by Lundberg (1960) can be of great value. This may be accomplished by the placement of an intraventricular catheter or by extradural transducer. The advantages and disadvantages of these two techniques have been discussed by McDowall (1976). The main disadvantage in practice is likely to be the unavailability of a neurosurgeon or accident surgeon with experience in this technique and such an invasive technique, of course, has its own complications, such as ventriculitis.

A recent review (Horton, 1976) clearly outlined the important contribution that the anaesthetist can make to the care of head injuries and this is beyond dispute. Nevertheless, the anaesthetist may frequently find it unavoidably necessary to anaesthetize a patient with a less severe head injury for some life-threatening accompanying condition, for example intra-abdominal bleeding, and the possibility of provoking a “second accident” arises as a result of injudicious choice of technique or anaesthetic agent. In these circumstances it is wise to proceed as for a formal neurosurgical procedure, all appropriate precautions being observed during induction, maintenance and recovery phases to avoid prejudicing further the primary cerebral injury (Greenbaum, 1976).

Head injuries are frequently accompanied by severe facio-maxillary trauma and these patients may require all the skill and technical expertise at the anaesthetist’s command to secure an airway at the earliest possible time. The use of the fibreoptic laryngoscope can be of great assistance in achieving tracheal intubation, but the situation may demand an immediate tracheotomy.

**Chest injuries**

The immediate management of severe crushing injuries to the chest has been extensively reviewed over the years and the usefulness of a system of initially grading the patients according to the severity of the respiratory disturbance has been pointed out by workers in Glasgow and Oxford (Lloyd, Smith and O’Connor, 1965; Reid and Baird, 1965; Campbell, 1966). Only the most active management can hope to reduce the high mortality still encountered. In a recent series of 166 patients who suffered major trauma, treated in the Respiratory Intensive Care Unit at Glasgow Royal Infirmary, the overall mortality encountered was 43.4%. Seventy-six cases of major chest trauma were treated in this series with a mortality of 31.5%. About one-third of the chest injuries treated required ventilator therapy for periods up to 2 weeks. Recent work from the United States, however, suggests that over-enthusiasm for ventilator therapy, with a high incidence of tracheotomy, may actually increase morbidity and mortality (Trinkle et al., 1975). These workers suggest that a vigorous regime of fluid restriction, diuretics, steroids and frequent pulmonary toilet, with intercostal nerve blocks for control of pain, reduces the need for mechanical ventilation and is to be preferred in many instances. There is no doubt of the advantages of avoiding tracheotomy where this is possible, and the use of non-reactive plastic tracheal tubes has greatly assisted in this aim. During the resuscitation of chest injuries, in particular where massive blood transfusion is employed, the need to use fine-screen blood filters should be borne in mind (Cullen and Ferrara, 1974). There is good evidence that this can assist materially in the reduction of pulmonary insufficiency following trauma (Reul et al., 1973).

The main points in management are listed in Table I. The secondary factors contributing to the immediate mortality are previous cardiopulmonary disease and accompanying head injury. When the latter situation occurred in the Glasgow series referred to, the mortality increased to 55%. There would seem no doubt that the interaction of the pathophysiological disturbances occurring following cerebral and chest injury greatly influences survival. The hypoxaemia and respiratory/metabolic acidosis resulting from pulmonary damage prejudice recovery from brain injury and this is particularly so where hypovolaemic shock is also a feature of the case. Every effort must therefore be made early in resuscitation to correct these disturbances while remembering that ventilator therapy itself can make the continuing assessment of the head injury more difficult (Teasdale, 1976). Intracranial pressure monitoring already

<table>
<thead>
<tr>
<th>Table I. Priorities in immediate management of chest injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Respiratory</strong></td>
</tr>
<tr>
<td>(1) Establish a clear airway</td>
</tr>
<tr>
<td>(2) Achieve adequate alveolar ventilation and oxygenation</td>
</tr>
<tr>
<td>(3) Relieve pain</td>
</tr>
<tr>
<td>(4) Water-sealed drainage of pleural cavity</td>
</tr>
<tr>
<td><strong>Haemodynamic and metabolic</strong></td>
</tr>
<tr>
<td>(1) Restore an adequate blood volume and organ perfusion</td>
</tr>
<tr>
<td>(2) Correct acid-base imbalance</td>
</tr>
<tr>
<td>(3) Prevent renal failure</td>
</tr>
</tbody>
</table>
referred to may be particularly valuable in the early stages of treatment in this situation.

It must be borne in mind that pulmonary damage is not necessarily the only result of blunt injury to the chest. Direct damage to the heart, varying from rupture of aortic valve cusps to traumatic myocardial infarction (Stewart, 1967) and damage to the great vessels, in particular the aorta, can occur. Keen (1972) showed that the latter injury is not inevitably fatal and emphasized the need for early diagnosis and emergency bypass surgery. Avoidable deaths are caused by a lack of awareness of the condition and lack of appreciation of the radiological evidence of widening of the mediastinum and deviation of the trachea to the right. Keen considers aortography necessary as an urgent diagnostic procedure to confirm and locate the site of aortic rupture and also to avoid unnecessary surgery in patients with more benign causes of mediastinal haematoma.

The early management of severe injuries to the chest remains one of the greatest challenges to the anaesthetist involved in the emergency accident and intensive care area.

Abdominal injuries

The early diagnosis of life-threatening intra-abdominal injuries is often extremely difficult where multiple injuries have been sustained and where the separate clinical pictures overlap and are distorted and disguised. The situation is commonly made more difficult where there has been the need to sedate or curarize a patient to facilitate mechanical assistance to respiration. In a review of the problem, Petty (1973) discussed the indications for and problems encountered in early surgical intervention. He outlined the time scale during which damage to different organs generally becomes manifest, pointing out that so far as immediate management is concerned the first 24 h are dominated by the problems of bleeding and its control and the onset of post-traumatic ileus. Petty summarized the absolute indications for immediate exploration as follows:

1. Shock occurring immediately after successful resuscitation or later in a patient with suspicion of an abdominal injury.
2. The presence of free gas in the abdomen on x-ray.
3. The splenic rupture syndrome—persistent tenderness under the left costal margin, left shoulder pain, fracture of the lower left ribs.
4. Increasing abdominal distension.
5. Gradually increasing abdominal pain, tenderness or rigidity.

As an aid to diagnosis where intraperitoneal haemorrhage is suspected in difficult situations, Tucker, Hurlow and Mahajan (1975) recommend the introduction of a peritoneal dialysis catheter and lavage with warm sterile saline.

In general, it is undoubtedly better to look and see than to wait and see. It is worth emphasizing that liver and pancreatic damage are easily missed and that the tendency now is for aggressive surgical treatment where damage to these organs is suspected (Blumgart and Vajrabukka, 1972). On the other hand, surgical intervention for renal damage is rarely required, although an emergency i.v. pyelogram should be carried out where this injury is suspected. It is the secondary damage to the kidney, consequent upon hypovolaemic shock and massive tissue damage, leading to acute renal failure, which is essential to anticipate and treat actively (Kennedy et al., 1963).

The anaesthetist involved in accident work must be fully acquainted with these problems of diagnosis and prepared to facilitate surgical intervention where it is indicated as necessary for the immediate survival of the patient. It is also important to bear in mind that secondary damage, particularly to brain, liver and kidney, can result from hypoxaemia and diminished perfusion where the initial resuscitation has been delayed or has been inadequate.

CONCLUSION

Nowhere has the anaesthetist a more critical or fundamental role than as part of the hospital accident team dealing with the immediate care of critically injured patients. While the accent must always be on the securing of an impeccable airway and vigorous cardiopulmonary resuscitation, the anaesthetist must also be familiar with the protean signs and symptoms of life-threatening primary damage to the brain, lungs, heart and intra-abdominal organs, and conscious of the need to avoid further secondary damage which, if it does not immediately result in death, may certainly determine the ultimate quality of survival. From the technical point of view, the anaesthetist is especially well suited to supervise the overall monitoring of vital functions necessary from the time of the patient's admission to ultimate recovery from the critical period of injury.

REFERENCES


