Paediatric trauma

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Trauma remains the leading cause of death in children less than 14 yr of age in the UK today. In 1996, more than 2.25 million children attended accident and emergency departments after injury and 439 died.[7 8 31] The absence of a formal trauma system in the UK means that most injured children are taken directly to the nearest hospital, regardless of whether it is a specialist paediatric centre. Consequently, staff in every hospital with an accident and emergency department must be prepared to deal with injured children and their families. Anaesthetists may be asked to participate in the management of injured children at several stages—acute resuscitation, diagnostic imaging (e.g. CT scan), operating theatre, intensive care unit, provision of pain control and in transporting the child to a more specialized centre. An understanding of the mechanisms and nature of injuries in children and awareness of the differences between children and adults in this context is vital. This article gives an overview of the common paediatric injuries encountered and the appropriate management of trauma in children.

The history of trauma care

The past two decades have seen enormous advances in the quality of trauma care. After indisputable demonstrations of the existence of preventable deaths after trauma,[13 49] formal regional trauma systems were set up across the USA, with designated trauma centres, pre-hospital care and strict inhospital guidelines for management.[4] In 1988, the Royal College of Surgeons of England commissioned a Working Party to evaluate trauma deaths in England and Wales.[6] This too showed that more than 20% of trauma deaths could potentially have been avoided with better medical management (more than 60% of those without CNS injury), and several recommendations were made for improvements in care.[38]

Over the same period, several studies demonstrated that preventable deaths also occurred in the paediatric trauma population.[30 40] In the USA, regional paediatric trauma systems evolved,[24 36] but in the UK less progress has been made in this direction. However, there has been recognition that trauma merits more attention in the various paediatric life support courses which are available, and several now have specific components dedicated to trauma management. The trauma patient is now recognized to present a complex problem, requiring the (often simultaneous) attention of several disciplines. The need for rapid multi-system assessment and treatment can only be met by a coordinated trauma team with a designated leader for each trauma patient. All team members should have a defined role and the leader's responsibility is to ensure that the necessary assessments and interventions are carried out strictly according to clinical priorities. Education of medical and nursing staff through courses such as advanced trauma life support (ATLS),[2] advanced paediatric life support (APLS),[1] paediatric advanced life support (PALS)[5] and paediatric emergency trauma advanced life support (PETALS),[35] which stress the importance of a coordinated approach and the priorities of the 'ABCs', has been a major factor in achieving more effective care in the first hours after injury. The results of the UK Multiple Trauma Outcome Study (MTOS) suggest that fewer deaths are occurring in children who arrive alive at hospital, even in those with severe injuries (personal communication, 1997).

As most injured children in the UK are taken directly to the nearest hospital, regardless of whether it is a paediatric centre, it is essential that all 'front-line' staff are aware of the differences which exist between children and adults in terms of patterns of injury, physiology and emotional response.

Causes and mechanisms of paediatric injury

Injuries in children may be unintentional or intentional. Although the latter are much less frequent, unfortunately they are a significant cause of morbidity and mortality. The optimal diagnosis and management of intentional injury is much more difficult because of the frequent lack of an accurate history; a high index of suspicion about the potential force of injury is therefore necessary, particularly in cases of possible head or abdominal injury.

Most paediatric injuries in the UK are unintentional and are the result of blunt trauma. As the major determinant of the degree of injury is the magnitude of the impact force, a clear and detailed history of the injury is critical in estimating the severity of injury. Because of the anatomical differences between children and adults (e.g. incomplete bony ossification and a short thoracic cage), even minor degrees of external force can cause significant internal

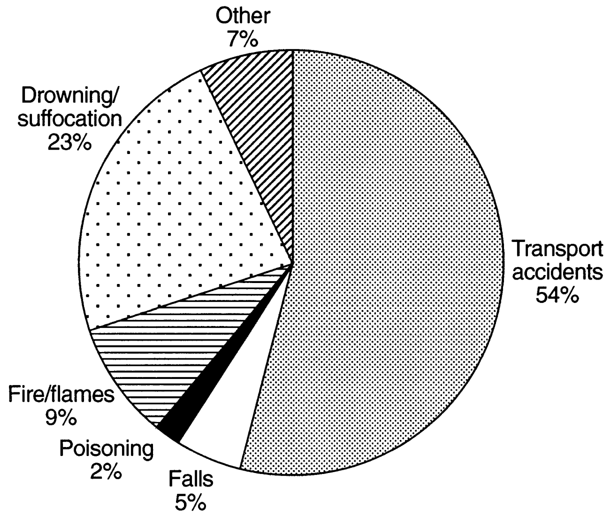

Fig 1 Causes of fatal injury in children in the UK in 1996.[7 8 31]

damage. In all cases significant injury must be assumed until proved otherwise.

The distribution of causes of fatal injury in children in England and Wales in 1996 is shown in Figure 1. The major cause of paediatric blunt trauma in the UK is the motor-vehicle; traffic-related incidents accounted for more than 38 000 injuries and 48% of paediatric deaths from unintentional trauma.[7 8 31] Children may be injured as pedestrians (45%), bicyclists (19%) or as poorly secured motor-vehicle occupants (36%).[18] Falls also contribute to a significant number of injuries (more than 0.5 million unintentional injuries in 1996); even falls from apparently insignificant heights (especially in young children in the home) may have hidden effects if the child has struck a protruding object or fallen on a hard surface. Other causes such as sports injuries, burns, poisoning and near-drowning are less common, but all may present at accident and emergency departments without warning; awareness of these mechanisms of injury and their likely effects is essential for all staff involved in management.

Initial resuscitation and primary survey

The principles of initial paediatric trauma care are those of all resuscitation episodes—the priorities are airway, breathing and circulation (ABC). The paediatric airway differs from the adult in several ways and familiarity with these differences is crucial. Similarly, knowledge of the normal ranges for paediatric vital signs (which change with age) is essential for rapid recognition and appropriate treatment of respiratory or circulatory compromise. These issues are addressed more fully elsewhere in this issue (see Zideman, pp.157–68). In trauma patients, prevention of hypoxia, recognition of hypovolaemia and restoration of circulating blood volume are of particular importance in preventing secondary cerebral and renal damage. Any difficulties or distress associated with keeping an oxygen mask on a conscious child or rapidly gaining i.v. access are far outweighed by the risks of not doing so.

Airway management is the first priority in paediatric trauma. The large tongue, relatively high and small larynx, short epiglottis and delicate vocal cords of the paediatric patient pose potential difficulties which require a degree of expertise to overcome. Airway management may be complicated by the need for neck stabilization. Neck stabilization in children has always been controversial because of the apparently low incidence of cervical injury in children, but the high incidence of head injuries (see below) and the potential for devastating sequelae after undiagnosed neck injury has resulted in a consensus that the paediatric neck should be stabilized until significant injury has been excluded.[1 20 39] All resuscitation rooms should have a complete range of sizes of neck collars; in the absence of an appropriate collar, the neck should be stabilized with tape and sandbags until cervical spine injury has been excluded.

Rapid chest examination should form part of the assessment of breathing. In children, incomplete rib ossification results in a flexible thoracic cage which compresses readily. Rib fractures are rare and flail chest even rarer, but the absence of fracture does not preclude severe intrathoracic damage after blunt trauma. Pneumothorax and haemothorax are common and should be sought clinically during the primary survey; if these are evident, a chest tube should be inserted without delay. Cyanosis is a late feature of hypoxia in children; tachypnoea, nasal flaring, indrawing and increasing agitation are all indications of hypoxia which should stimulate immediate action to control ventilation and identify chest injuries.

After breathing, circulation is the next priority, and ideally should be addressed simultaneously by another trauma team member. In children, arterial pressure is a notoriously inaccurate measure of hypovolaemia—children may lose up to 25% of their circulating volume without any reduction in central arterial pressure. Consequently, the more subtle signs of hypovolaemia (peripheral shut-down, tachycardia, abnormal lethargy) are much more reliable in the diagnosis of ‘shock’—any of these features are justification for bolus i.v. fluid infusion as a matter of urgency. Fluid restriction because of suspected head injury is *not* appropriate in the resuscitation room; more cerebral damage is caused by untreated hypovolaemia than by fluid replacement. Suspected increased intracranial pressure may be addressed by hyperventilation and elevation of the head of the trolley to 30°; fluid restriction and diuretic administration to control increased intracranial pressure are matters for the intensive care unit after haemorrhage from other injuries has been excluded or controlled.

Injured children with any signs of hypovolaemia should have an initial i.v. clear fluid bolus of 20 ml kg^{-1} (representing the 25% of circulating volume which may have been lost). Failure to normalize vital signs and peripheral perfusion with one 20 ml kg^{-1} bolus is an indication for

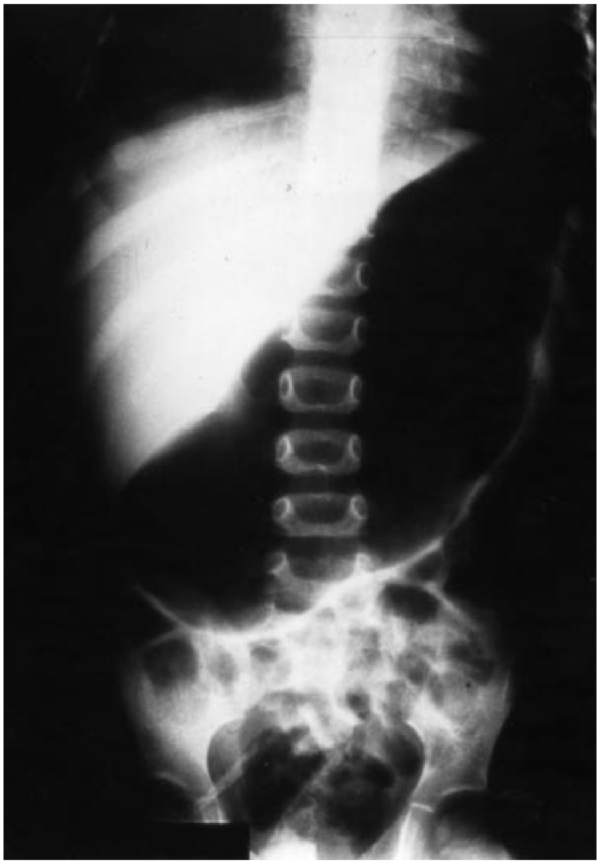

Fig 2 Massive gastric dilatation caused by air-swallowing in a conscious child after femoral fracture.

further bolus infusions; if more than two such boluses are required, blood should be administered. It is also important to remember that maintenance fluids are required in addition to volume replacement; maintenance requirements should also be calculated on an individual patient-weight basis and should include dextrose, especially in young children. If immediate and adequate peripheral i.v. access cannot be achieved, the intraosseous route is a useful and effective measure in children.[1 22] Large volumes of fluid (including blood) and drugs can be readily administered via a tibial intraosseous needle until more secure access is obtained. Central venous line insertion (jugular and subclavian) is potentially hazardous in small children and should only be undertaken by experienced personnel.

One further paediatric peculiarity is worthy of note. Children have a particular tendency to aerophagia when distressed. Even minor injury may result in sufficient air-swallowing to cause significant gastric distension (Fig. 2). This feature may at best cause confusion about the presence of intra-abdominal injury, and at worst may significantly inhibit diaphragmatic movement, exacerbating any co-existing respiratory injury. Gastric distension also increases the likelihood of vomiting and aspiration, a major concern for those responsible for airway management. For these reasons, the presence of even minimal abdominal distension, respiratory compromise or diminished consciousness is an indication for the passage of an oro- or nasogastric tube. Although this intervention may be potentially distressing for a conscious child, the consequences of untreated gastric distension may be fatal. The tube need not be large as its main function is to remove gas, and experienced paediatric staff can pass a gastric drainage tube rapidly and with minimum discomfort to the child.

Once the airway, breathing and circulation (ABC) have been controlled, a rapid assessment of disability ('D') is required. Initial evaluation of the central nervous system should be made using the AVPU scale (*A*lert, responsive to *V*oice, responsive to *P*ain or *U*nresponsive).[1 14] This forms a useful baseline from which further and more complex evaluations can be conducted. If stabilization of the ABCs is prolonged, it is useful to document the AVPU rating intermittently; this can be done by the trauma team leader or an appropriate delegate without disrupting the resuscitation process. Comprehensive neurological examination, including Glasgow coma scale (GCS) assessments, should form part of the secondary survey.

As in adult practice, only three radiological investigations are recommended during initial assessment and stabilization: chest, lateral cervical spine and pelvis x-ray. Any need for further diagnostic investigations, including ultrasound, CT scan or extremity radiology, will be identified during the secondary survey and should only be undertaken once the ABCs have been stabilized.

Secondary survey

The secondary survey is a complete and detailed head-to-toe clinical examination of the entire child to identify and document all injuries. Priorities for treatment and further investigation can then be defined and specialist advice sought as required. During the secondary survey, a close watch should be maintained on the ABCs—if any deterioration is observed, the secondary survey should be abandoned and the ABCs re-stabilized. It is rare to be unable to achieve control of the ABCs with appropriate resuscitation and even rarer to require emergency surgery in order to do so; attempts to rush an unstable patient to the operating room before adequate resuscitation should be resisted at all costs.

Head injuries

Head injuries account for more than 50% of all trauma-related deaths in children, either alone or in conjunction with other system injuries.[44] It is relatively rare to see multi-system injury in children without an associated head injury. The disproportionately large head and weak neck musculature in children (especially in those less than 3 yr old) puts them at particular risk for contre-coup brain injuries even at low velocities. Surgically treatable intracranial haemorrhage (epidural or acute subdural haematoma) occurs in less than 10% of paediatric head injuries[11 15]; in most children the problem is diffuse brain injury and cerebral oedema. Skull fractures occur in approximately 27% of all paediatric head injuries and in 40% of those with a GCS less than 8,[26] but the presence or absence of a skull fracture is not an indication of the severity of injury.

The degree of cerebral damage can only be estimated by a comprehensive neurological examination. In order to monitor progress, repeated assessments are required and these should include some objective criteria such as the GCS.[43] As one of the components of the GCS is based on verbal response, the scale must be modified to take account of the child's age and expected verbal skills; even a normal 2-yr-old will score only 13/15 on the conventional scale. Several such modified scales have been created and should be available in all accident and emergency departments.[14 41 47] Evidence of significant or progressive intracranial injury (such as localizing signs, GCS $\leqslant$12 or a decrease in GCS of 2 points from the initial level) is an indication for CT scan. However, the need for CT (or other diagnostic imaging) should not take precedence over stabilization of the ABCs. In the rare situation where clear evidence of potentially treatable intracranial bleeding requires immediate CT before stabilization is achieved, active resuscitation should continue during transport and imaging. If chest and/or abdominal injury is suspected, it is useful to document these during the same CT episode.

Cerebral damage after trauma may be primary or secondary. Primary brain injury is that which occurs at the moment of impact and cannot be altered. Secondary brain injury is that which results from any subsequent hypoxic or ischaemic insult; while this hypoxia–ischaemia may be the result of cerebral oedema after primary injury, it can also be caused or exacerbated by hypoxia and hypovolaemia resulting from other injuries. Cerebral blood flow (CBF) is a function of systemic arterial pressure, arterial blood gases, metabolic demands of the brain and intracranial pressure (ICP). The injured brain has increased metabolic demands, and therefore requires optimum systemic pressure and oxygenation. Thus to minimize secondary cerebral damage it is vital to restore and maintain full oxygenation and circulating volume in all injured children, regardless of the presence or absence of head injury. Hypoglycaemia may also cause further secondary damage to the injured brain, and hence the importance of including dextrose solutions in maintenance fluids during resuscitation, particularly in small infants. Seizure control and prevention is also important in minimizing secondary cerebral damage. Children have a particular tendency to convulse after even minor head trauma[10] and close observation with immediate availability of anti-seizure drugs is an important component of optimal management.

Despite these measures however, the diffuse cerebral swelling which occurs in many children after head injury may be sufficient to increase ICP to a level which inhibits CBF; in such cases measures to reduce ICP may be indicated. These include maximizing venous drainage (avoiding neck lines where possible and elevating the head of the bed), hyperventilation to reduce arterial carbon dioxide partial pressure (Pa_{CO_2}) (reducing Pa_{CO_2} to 3.3–4.0 kPa causes a significant decrease in ICP)[23] and administration of diuretics such as mannitol and furosemide. All of these interventions must be carefully controlled and monitored and as such should only be undertaken in a paediatric intensive care setting. Direct measurement of ICP against which to monitor the success or failure of ICP-reducing manoeuvres is useful (e.g. via direct ventriculostomy or subarachnoid bolt) but it should be remembered that measured ICP is only one indicator of patient progress; repeated clinical assessment is likely to be the most accurate prognostic tool.

Mortality for children with severe head injuries (GCS $\leqslant$8) is reported to be 6–32%.[47] Mortality for those with epidural or subdural haematoma is higher.[48] However, despite the high incidence and relative severity of many paediatric head injuries, the functional outcome of head trauma is generally better in children than in adults. The reasons for this are not clear, but may reflect an increased ability to adapt in the young. Nevertheless, the potential morbidity and its subsequent effects on a previously healthy young life can be devastating; strenuous efforts must be made to minimize secondary brain injury and alleviate the effects of the primary insult as quickly as possible.

Neck injuries

The incidence of cervical spine fracture in children with severe head injury is estimated to be 7–10%.[47] Up to 20% of children with one spinal fracture will have a second, non-contiguous site of spinal injury. However, the paediatric cervical spine is much more mobile than its adult counterpart, and significant neck injury with spinal cord damage may occur in the absence of bony malalignment or fracture.[33] The hypermobility is a result of several factors—lax intraspinal ligaments and joint capsules, relatively undeveloped neck musculature and horizontally orientated intervertebral facet joints. These features also account for the normal variant 'pseudo-subluxation' of the cervical spine seen in children which may make cervical radiographs difficult to interpret for the inexperienced (Fig. 3).

Because of the potential for hidden cervical damage, the paediatric neck should be stabilized in all cases of severe head or multi-system trauma until injury is excluded. This may make airway management more difficult, and airway skills teaching for trauma victims should always include experience with neck collars *in situ*. There is nothing more devastating than to resuscitate an injured child successfully only to find that a latent cervical injury has been converted to an overt quadriplegic syndrome. The urgency of assessing the cervical spine is only superseded by stabilization of the ABCs; rarely, the degree of cervical injury may be an indication to cease resuscitation altogether (Fig. 4).

Thoracic injuries

Chest trauma is present in more than 25% of children with blunt force multi-system injury[29] and has a mortality of approximately 26%.[34] However, undiagnosed or in-

Fig 3 Compression fractures of C3 and C4 after hyperflexion injury. C1 and C2 are normal.

adequately managed chest injuries are responsible for up to 30% of preventable deaths after injury.[21] Mortality is higher in younger children, with those less than 1 yr being particularly at risk.

In common with the cervical spine, the paediatric chest wall is much more flexible than the adult rib cage. Incomplete costal ossification, elastic cartilaginous joints and relatively thin intercostal musculature contribute to a plastic thoracic cage which offers little protection from blunt trauma. Consequently, even minor compression forces may result in severe intrathoracic injury without evidence of rib fracture. Pulmonary contusions with associated pneumo- or haemothorax are common,[16] and the effects increase with time (Fig. 5). Ventilatory support may be required as the contusions progress, and close attention should be paid to oxygenation at all times.

Life-threatening tension pneumo- or haemothorax should be identified and treated during the primary survey, but a detailed search for more subtle injuries should be conducted during the secondary survey. The absence of pulmonary contusion on initial chest x-ray should not be falsely reassuring if the mechanism of injury suggests potential thoracic compression. I have seen one 2-yr-old boy with tractor tyre tracks across his chest whose initial chest film was unremarkable; within a few hours, the predicted massive intra-thoracic damage was evident. In all chest injuries a high index of suspicion should be maintained for at least

Fig 4 Cervical radiograph of a 2-yr-old child injured by a slow moving car in a car park. Initial resuscitation restored cardiac output, but after this x-ray, resuscitation was abandoned.

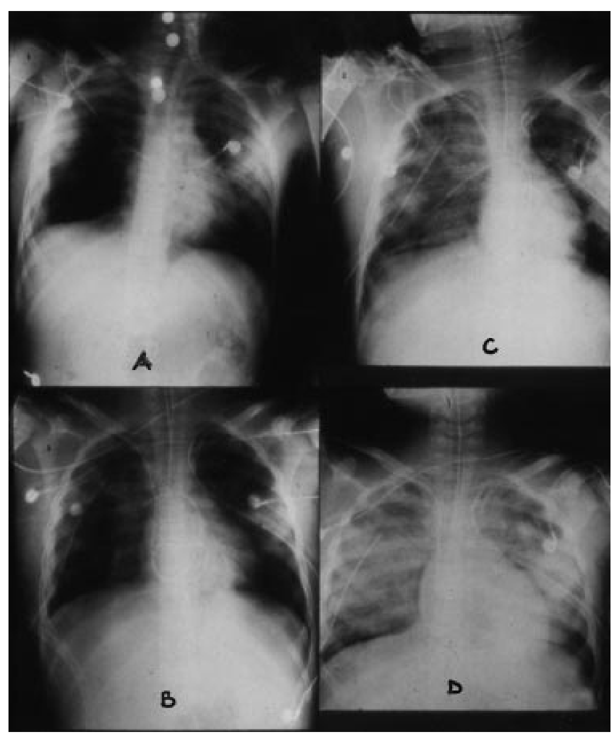

Fig 5 Progressive pulmonary contusions in a 15-yr-old victim of blunt thoracic trauma: (A) 1 h after injury; (B) at 6 h; (C) at 24 h; and (D) at 48 h.

48 h, with careful attention to breathing patterns and oxygen saturation.

Thoracotomy is rarely required in paediatric blunt injury, although for penetrating injuries the same principles should be used as in adults.[16] Occasionally, a severe deceleration force results in avulsion of vessels at the hilum; in such cases the resulting haemorrhage is evident from the chest drainage and circulatory status, and thoracotomy is required to achieve haemostasis.

Chest drains in children are best inserted under a semi-open technique rather than by stylet. Under local anaesthesia, an initial skin incision should be deepened using artery forceps, until the pleura is seen. The pleural space should be entered using a small blade or the points of the artery forceps, and the drain should be inserted under direct vision. All drains should be connected immediately to underwater drainage and secured to the skin with a sturdy purse-string suture.

Myocardial contusions, recognized as a potential hidden cause of mortality in adults, are surprisingly rare in children.[16] Similarly, major vessel injuries or ruptures are rarely a problem in paediatric patients; sadly, most children with such injuries die rapidly at the scene of the accident.[9 16]

The primary diagnostic imaging technique for chest injuries is the plain chest radiograph. Sequential imaging may reveal progressive damage from contusions or mediastinal injury. In cases where severe injury is evident, more detailed information may be obtained from computed tomography (CT); conversely, unsuspected thoracic injuries may be found in the lower chest during CT evaluation of abdominal injuries.[16] The most important component of diagnosis in paediatric thoracic injury remains basic clinical evaluation and regular re-evaluation.

Abdominal injuries

As with the chest, the paediatric abdomen is much more vulnerable to the effects of blunt trauma than the adult abdomen. The short and pliable thoracic cage offers little protection to the upper abdominal organs, and consequently the liver, spleen and kidneys are often damaged by relatively minor impacts. Abdominal injuries are almost three times as common as thoracic injuries in children, but are much less likely to be associated with a fatal outcome if treated optimally.[17]

In children, the preferred management strategy for solid organ damage is non-operative. Selective non-operative management with careful attention to achieving haemodynamic stability and maintaining close observation is successful for virtually all renal injuries, most splenic injuries (including rupture) and the majority of liver injuries. Splenic preservation is of particular importance in children because of the potential risk of overwhelming post-splenectomy sepsis which persists for life and is up to 80 times higher than that of the non-splenectomized population.[12] Even if operation is required to control bleeding, strenuous attempts to repair and salvage the spleen should be made. The splenectomy rate after splenic injury in children is now only about 10% in most major centres.[42]

Liver

Appropriate management for liver injuries depends on the severity of the injury. Most classification systems have been devised from adults, and have not been evaluated fully in children. Nevertheless, radiological grading of injury from grade I (least severe) to grade VI (most severe) may be helpful in assessing the likely need for operation.[28] In general, injuries of grades I–III may be treated successfully non-operatively.[28 45] However, injuries involving extensive tissue destruction or posterior lacerations which may involve the hepatic veins should be explored. Obviously, any child who cannot be haemodynamically stabilized or who requires high blood transfusion volumes ($>$ 40 ml kg^{-1} 24 h^{-1}) to achieve stabilization should undergo laparotomy. The surgery of hepatic trauma in children is complex and potentially hazardous; any child with suspected significant liver injury should be transferred urgently to a specialist centre for detailed evaluation and treatment.

Kidney

As with the liver and spleen, the kidneys are relatively unprotected in children, and consequently more vulnerable to injury after even minor blunt trauma.[3] Most renal injuries are minor, comprising simple contusions or lacerations within an intact renal capsule. Occasionally, the capsule may be breached, but even then, bleeding is usually contained within the peri-renal fascia. Only rarely does critical injury occur, such as renal avulsion or complete destruction. In most cases (apart from critical injury), renal injuries can be treated conservatively after stabilization of haemodynamic state. Severe contusions may heal leaving cortical scars but these rarely cause major functional deficiency. Occasionally, damage to the renal pelvis results in a persisting urinoma which may require drainage. The overwhelming majority of renal injuries require no surgical intervention.[3]

Gut

Gastrointestinal injuries are relatively uncommon after blunt trauma in children. Gastric distension caused by aerophagia is a common feature after even minor trauma. Severe blunt trauma or deceleration injuries may result in intestinal perforation, mesenteric haematoma or shearing injuries at the ligament of Treitz. The classic ‘lap belt’ injury (perforation or transection of the small bowel as a result of the pressure from inappropriately fitted seat belts, often associated with lumbar spine injury)[32] is now seen less commonly, suggesting that parents are heeding public advice about booster seats and shoulder restraints. All intestinal perforations should be explored surgically. The pancreas may also be injured after severe compression of the upper abdomen (especially from bicycle handlebars), but pancreatic injuries alone cause relatively few early symptoms or signs.[37] Consequently, any child with a history of potentially significant upper abdominal trauma should be monitored carefully and evaluated radiologically for pancreatic damage.

It is therefore evident that the majority of intra-abdominal injuries in children (with the exception of severe solid organ damage or intestinal perforation) can be managed successfully non-operatively. However, assessment of the severity of injury to each organ is critical in selecting those patients who require surgery. As many injuries appropriate for conservative management can result in some intra-peritoneal bleeding, diagnostic peritoneal lavage to establish the presence or absence of blood is *not* helpful, and is virtually contraindicated. Radiological imaging provides much more detailed information about the severity and anatomy of injury, and the need for operative intervention should be based on the clinical status of the child rather than the presence of intraperitoneal blood.

The most appropriate radiological investigation for abdominal trauma is CT scan. The CT scan should be conducted using both i.v. contrast (to highlight organ perfusion and bleeding) and enteral contrast (to identify intestinal perforation). In experienced hands, abdominal ultrasound can give exceptionally detailed information on all solid organs and may be a useful method for initial screening of children in whom abdominal organ injury is uncertain (e.g. the unconscious child with equivocal abdominal signs). Ultrasound is also useful for repeated monitoring of injuries identified on CT which have been treated non-operatively.

Extremity injuries

Limb fractures and other extremity injuries are very common in children, and are a frequent component of multi-system injury.[17] However, apart from open injuries with associated uncontrolled haemorrhage, none is life-threatening in the first instance. Consequently, they are lower in the priority list for urgent definitive treatment. Control of external bleeding should be part of the primary survey of circulation, but other extremity injuries should be documented during the secondary survey and listed for treatment only after potentially life-threatening head, chest and abdominal injuries have been controlled adequately. Severe vascular damage with the potential for critical limb ischaemia as a result of complex or displaced fractures may require urgent surgical repair, but the majority of fractures can be stabilized externally with splints until other serious injuries have been dealt with. It is the responsibility of the trauma team leader to identify the priorities for treatment and to ensure that other less critical injuries are not forgotten.

Factors affecting outcome

The immediate factors which affect outcome are the quality and speed of the initial care. However, other factors such as pain control, parental presence, rehabilitation and post-trauma counselling can significantly affect the injured child's emotional response to the event, and consequently affect his or her return to full potential.

The injured child is not the only victim of trauma. Parents and siblings suffer as a result of the incident. The anxiety, fear and guilt which haunts parents after a child has been injured is often also evident in siblings, even those who were not present and had nothing to do with the trauma. Moreover, as is the case with all sick children, the time that the parents have to spend with a hospitalized child is at the expense of other children who may be just as concerned as their parents. For this reason it is essential that the whole family is recognized to have suffered, and that appropriate counselling and support from expert medical and nursing staff are available to the family as a whole.[25 46]

Even after the injuries themselves have been treated, the injured child may take considerable time to return to normal and will require much more support than usual. School performance often suffers, concentration is poor and some children exhibit quite marked fear of encountering the same events again. For some this can lead to complete changes in behaviour (e.g. a previously outgoing child becoming shy and withdrawn) and to refusals to go anywhere where they feel at risk (e.g. a child injured by a car may not wish to cross the street or even get into a car again). It is important that staff treating injured children (even those with minor injuries) recognize these fears and seek appropriate support mechanisms for the child and family. A recent study by the Child Accident Prevention Trust has highlighted a lack of such support in the UK, but perhaps more importantly, demonstrated a lack of knowledge in medical and nursing staff of those avenues which are available.[27]

Role of the anaesthetist in paediatric trauma care

Anaesthetists may be involved in several aspects of paediatric trauma management and the quality of their input can have a significant effect on long-term outcome. Obviously, anaesthetists are likely to be asked to be responsible for airway management and ventilation during the resuscitation phase, and also during diagnostic investigations or surgery which may follow. Optimal oxygenation and fluid replacement are vital during these phases. The anaesthetist is also able to monitor temperature control and to take appropriate action to prevent unnecessary heat loss; this is often overlooked when the child is exposed for the secondary survey in the (often cold) resuscitation room and during transport to radiology, intensive care or the operating room.

Anaesthetists may also be involved in the care of children in intensive care. Any child with sufficiently severe injuries to warrant intensive care should be transferred to a recognized paediatric intensive care unit, and following recent guidelines[19] should be retrieved by a dedicated paediatric intensive care team. However, stabilization before, if not during, any necessary transport is likely to involve local anaesthetists, even if they have no special paediatric expertise. Consequently, it is vital that all anaesthetists, especially those in district general hospitals, are familiar with the principles of paediatric trauma care.

Anaesthetists are probably also the most appropriate personnel to manage pain control, both in the early phases of treatment and during recovery on the ward. Appropriate pain relief is an effective method of reducing emotional stress, and consequently reducing the adverse emotional consequences after a traumatic event. A more detailed review of pain control in children is given elsewhere in this issue (see Morton, pp.118–29), but trauma patients pose a particular problem because of the need to alleviate severe pain without compromising respiratory status and head injury evaluations.

The anaesthetist's role in the continuum of paediatric trauma care is therefore a crucial one, with the potential to influence (for better or worse) the outcome of the 'golden hour' of resuscitation, any subsequent operative treatment and long-term psychological sequelae. In the absence of regional trauma systems with designated paediatric trauma centres, the role of the district general hospital anaesthetist may be paramount; in some cases the anaesthetist may have more experience in paediatric trauma care than any other available discipline. All anaesthetic staff in training (and even consultants) should be encouraged to undertake paediatric advanced life support courses which include trauma management skills.

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