CHAPTER 27
Initial Assessment and Resuscitation of the Trauma Patient

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Introduction

The initial evaluation and treatment of the paediatric trauma patient require an organised, thorough approach. All patients must be assumed to have multiple injuries until proven otherwise. Resuscitation efforts should be early and aggressive to avoid the onset of irreversible shock;[2,3] the ability to recognise and effectively treat shock is all that is required in the vast majority of injured patents in order to gain stability. Adequate assessment and management of the ABCs described in this chapter will provide adequate treatment of the patient's other injuries, leading to an overall improvement in morbidity and mortality. Thus, the ABCs play an essential role in the initial evaluation and treatment of the paediatric trauma patient.

Effective initial resuscitation can reduce mortality in most paediatric trauma patients. Guidelines have been developed to facilitate patient care in a systematic and productive manner. Advances have been made in both diagnostic and therapeutic methods. The evaluation and treatment of paediatric trauma patients will continue to engage paediatric surgeons as efforts in trauma prevention become more successful.

The initial evaluation and care of a paediatric trauma patient uses the same protocols and procedures employed in adult trauma patients, the exception being that children should not be considered as little adults.[4,5] In the same manner as in adults, the primary survey entails ABCDE: **A** is for Airway maintenance/access with control of the cervical spine (C-spine); **B** is for Breathing; **C** is for Circulation with external haemorrhage control; **D** is for Disability and neurological screening; and **E** is for Exposure/Environmental control with thorough examination.[6] This is followed by a thorough secondary survey, which examines the injured child from head to toe.

Guidelines in the Paediatric Advanced Life Support[7] and the Advanced Trauma Life Support (ATLS)[8] provide a consensus framework in which to manage the injured patient:

1. triage;
2. primary survey of the injured child;
3. resuscitation;
4. secondary survey of the injured child;
5. re-evaluation and monitoring the injured child after resuscitation; and
6. Definitive care.

In the prehospital care of the injured child, emphasis is placed on airway maintenance, ventilation, control of external bleeding and shock, immobilisation of the patient, and immediate transport of the child to the closest appropriately functioning (and equipped to handle the injured) trauma centre.[1,5,6] Every effort must be made to provide initial interventions for all life-threatening conditions to the extent possible at the scene of injury and to prevent delays in delivering the injured to such a facility.[6] Management of trauma patients involves a team—it is teamwork, and most of the assessment and resuscitation of the injured is done simultaneously by members of the team, with one of them acting as the leader.[9–10]

Triage

The most developed countries have designated centres where trauma patients, including children, are sent after being "sorted out" at the scene or field of injury. These centres are designated in levels.[10] The following discussion is from the perspective of the West African subregion, Ghana being a good example; but is also true for many other African countries. Most hospitals have an Accident and Emergency (A&E) Department or Emergency Department (ED), where the injured are rushed by various means—ambulances (rare), private vehicles, or any other means available at the time. It is usually in this form that injured children are received in the emergency departments of hospitals, and it is here that the sorting of the injured starts.

Triage is the sorting of patients based on the need for treatment and the available resources to provide that treatment.[8] Children with injuries are usually admitted and sorted for treatment regardless of availability of resources, and then those who cannot be treated in that particular hospital are resuscitated and stabilised before being referred to another hospital that can handle the situation (which may be several kilometres away).

Primary Survey

The primary survey identifies life-threatening injuries that compromise oxygenation and circulation.[6] The vital functions of the patient are assessed quickly and efficiently; this entails a rapid primary evaluation, resuscitation of the vital functions, and later a more detailed re-evaluation of the injured child. The evaluation of the child's ABCDEs is made the priority of the primary survey or initial phase.[11] **F** is sometimes added to ABCDE to signify Further interventions necessary to help manage the patient. It is during the primary survey that life-threatening conditions are identified and effectively managed simultaneously.[11] This initial assessment should not take long and should detect and manage all clinically evident, immediate threats to life. We expand on the ABCDEFs in the next subsections.

A: Airway Access/Maintenance and C-Spine Control

Management of the airway begins by assessing its patency, or assessing for potential obstruction.[12] Any impaired or obstructed airway is optimised by using the jaw thrust manoeuvre[1,11,13] or by looking for and removing foreign bodies and/or clearing the oropharynx of debris, as well as administering supplemental oxygen if required.[1,14] Visible gross debris is manually removed and the airway suctioned to maintain patency, if necessary. In the attempt to assess and manage the child's airway, it is necessary to control the C-spine to prevent its excessive movement. It is wise to always assume C-spine injury until proven otherwise by the necessary follow up investigations.[4] As such, the head and C-spine should always be appropriately immobilised with appropriate devices.

The child's breathing is carefully assessed again once a patent airway is established, and if there is the need to provide ventilatory support, this must be done immediately. A child has a large head relative to body size, a short neck and therefore a short trachea, a small and anterior larynx, a floppy U-shaped epiglottis (the narrowest part

of the airway being the cricoid ring), and a small oral cavity with a relatively large tongue.[2,11,14] Knowledge of these facts will aid in the choice of equipment to maintain a patent airway (e.g., an oropharyngeal airway; a nasopharyngeal airway, provided a basal skull fracture has been ruled out; or an endotracheal tube).

Signs of impending or present respiratory failure include decreased breath sounds, tachypnoea, intercostal space retractions, cyanosis, stridor, grunting, nasal flaring, abnormal chest wall motion, noisy breathing, and paradoxical breathing. If such signs are detected, measures should be taken immediately to restore normal airway by positioning the patient and using the jaw thrust method without head tilt to create a patent airway, by suctioning or removing secretions, and by giving 100% oxygen via a paediatric mask. (Note that the head tilt/chin lift manoeuvre is not recommended because it may exacerbate a spinal injury.) Nasal prongs should not be used because, with them, oxygen concentration cannot be controlled.

B: Breathing

Once the airway is patent or secured, it is necessary to check whether the child is breathing adequately.[1] The respirations must be spontaneous, unlaboured, and at a rate that is normal for the age of the child (Table 27.1); chest expansion should be equal bilaterally; and if the child speaks, the speech should be normal. Look for the rise and fall of the chest and abdomen, listen at the child's nose and mouth for exhaled breath sounds, and feel for exhaled air flow from the child's month. If respiration is inadequate, then provide ventilatory assistance,[4,6] which may include supplemental oxygen, bag-mask ventilation, or even endotracheal intubation. If available, use pulse oximetry to monitor oxygen saturation. The indications for endotracheal intubation include the inability to ventilate the child by bag-mask or the need for prolonged airway management, respiratory failure, and shock unresponsive to volume resuscitation.

Table 27.1: Normal vital signs for infants and children.

Age	Heart rate (beats/min)	Systolic BP (mm Hg)	Respiratory rate (breaths/min)	Blood volume (ml/kg body weight)
Neonate	100–160	60–90	30–60	90
Infant	90–120	80–100	30–40	80
2–5 years	95–140	80–120	20–30	80
5–12 years	80–120	90–110	15–20	80
> 12 years	60–100	100–120	12–15	70

While ventilating the child, be sure the lungs are symmetrically auscultated to ensure air exchange in them;[14] the chest is also percussed to exclude pneumo- or haemothorax; and finally, the chest is inspected and palpated to exclude injuries to the wall that may compromise ventilation to some extent.

Note that adequate ventilation, combined with fluid resuscitation to maintain perfusion, is the basis for resuscitation in the paediatric trauma patient. Therefore, treat any life-threatening chest injuries immediately to alleviate any respiratory distress. Potentially life-threatening injuries include tension pneumothorax, open pneumothorax, flail chest, cardiac tamponade, airway obstruction, and massive haemothorax.[5] These injuries should be actively sought in an injured child and treated appropriately and immediately.

C: Circulation

For a positive outcome in paediatric trauma patients, it is necessary to recognise hypovolaemia.[6] An attempt should be made to stop any external bleeding, if present, by direct manual compression over the wound or proximal to the point of bleeding. It is known that children have an increased physiological reserve and manifest signs of hypovolaemic shock much later, with hypotension followed quickly by complete cardiovascular collapse.[1] It is not easy to diagnose the severity of shock in injured children. Tachycardia is usually the earliest and most reliable measurable response to hypovolaemia in children, but anxiety and pain can confound tachycardia as an indicator of hypovolaemic shock.[1] Clues to immediately recognising early signs of hypovolaemic shock in children include tachycardia; mental status change (level of consciousness); decreased pulse pressure; respiratory compromise; skin perfusion (cold peripheries/cool extremities, mottled skin); decreased urine output (minimum urine output for infants and children ranges from 1 to 2 ml/kg per hour); delayed capillary refill; hypothermia; and hypotension.[1,4,6] Hypotension is a late finding and occurs in profound shock. Hypotension must be treated immediately and aggressively if the child is to survive without any adverse consequences.[3,4] Children have an amazing cardiovascular reserve, so one should not be led into a sense of security with regard to the status of the child's circulating blood volume if the initial vital signs of an injured child are normal. Hypotension in a paediatric trauma patient is an indicator of uncompensated shock and occurs following the loss of more than 45% of the circulating blood volume,[8] estimated to be 80 ml/kg body weight (see Table 27.1).[6,11,14]

Vascular Access and Venous Cannulation

Once adequate ABCs have been established, the next priority is vascular access and venous cannulation. This can be difficult in the early stages of shock, and the largest bore cannula possible should be used. If necessary, two percutaneous intravenous (IV) cannulae should be placed in the upper extremities,[3] preferably in the veins on the dorsum of the hands. Generally, two to three attempts are made at cannulating a peripheral vein; if this fails in children younger than 6 years of age, an intraosseous (IO) access is established by using the anterior tibial plateau about 3 cm below the tibial tuberosity[1,4-6] (Figure 27.1) or the inferior one-third of the femur about 3 cm above the external condyle;[14] if a percutaneous line is established later on, the intraosseous line should be discontinued. There are special IO needles for this purpose; a 16 G or 18 G needle should be used. The chosen site of the bone is entered perpendicularly. Aspiration of marrow indicates that one is in the correct position.[15] An injured limb should never be used for IO cannulation.[11] The potential complications of IO infusions include infection, cellulitis, and osteomyelitis.[4,15]

Other options are saphenous vein cutdown at the ankle[6] (above the medial malleolus); median cephalic vein cutdown on the elbow (not to be performed on the injured limb); or central venous cannulation using the femoral, subclavian, or internal jugular veins.[1,12] Central venous lines should be used in the postresuscitation stabilisation phase for monitoring and should not be attempted by an inexperienced doctor.

Once venous access is established, blood samples are taken for the determination of full blood count, grouping and cross-matching, urea,

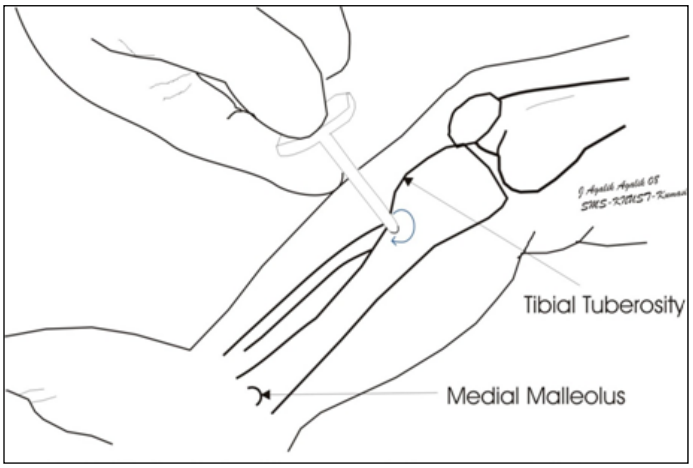

Figure 27.1: Method of setting up an intraosseous infusion.

creatinine and electrolytes, prothrombin time (PT), and amylase, after which volume replacement begins.

Initial fluid replacement will depend on the child's weight and should consist of warm isotonic crystalloids. Warm intravenous fluids will prevent hypothermia during the initial phase of resuscitation. As we know, hypothermia results in vasoconstriction, acidosis, and consumptive coagulopathy[6]—all deleterious to the injured child. The weight of a child (in kilograms), if unknown, can easily be estimated by using the following formula:

$$\text{Weight} = 2 \times (\text{age in years} + 4) \quad \text{or} \quad \text{Weight} = [5 \times (\text{age in years} + 3)]/2$$

Systolic blood pressure (SBP) and diastolic blood pressure (DBP) in children can be estimated by using the appropriate formula:

$$\text{SBP} = 80 + (2 \times \text{age in years})$$

$$\text{DBP} = 2/3 \times \text{SBP}$$

Resuscitation

The solutions to use for resuscitation include isotonic normal saline (NS) (0.9%) or Ringer's lactate (RL) at an initial bolus of 20 ml/kg body weight with a goal to achieving haemodynamic stability and improvement and restoring tissue perfusion as quickly as possible.[6,12] If there is no improvement in the haemodynamic status within 30–60 minutes, then another bolus of 20 ml/kg body weight of the same warm crystalloid solution should be given, for a total of 40–60 ml/kg;[12] in the case of children with evidence of haemorrhagic shock who fail to respond to fluid resuscitation, they should receive a transfusion of grouped and cross-matched packed red blood cells at a dose of 10 ml/kg body weight, or whole blood at a dose of 20 ml/kg body weight.[4,6,13] Of course, the source of bleeding should be identified and appropriately managed.

The algorithm in Figure 27.2 can be used for the initial assessment and resuscitation of a child admitted with trauma.

During resuscitation, it is prudent to have a urinary catheter in situ because urine output is an excellent indicator of volume status and can be used to guide resuscitation.[2] Aim to get about 2 ml/kg or more per hour of urine for children up to 1 year of age and about 1 ml/kg per hour for older children. If there is suspicion of a pelvic fracture with the possibility of injury to the urethra, then passage of a catheter is contraindicated (this is a relative contraindication).

Fluid resuscitation for children with isolated head injury should be considered carefully so as not to cause a rise in the intracranial pressure with too much fluid.[4]

D: Disability

A rapid neurological survey is performed to assess the level of consciousness, pupillary response, symmetry and size. The mnemonic AVPU is used to quickly assess the child's conscious level:[1] **A**lert, response to **V**erbal stimulus, response to **P**ainful stimulus, **U**nresponsive.

In using this rapid method of assessment, it is necessary to observe the ability of the child to follow simple commands and the quality and rapidity of the responses.[15] The pupils are briefly tested for size, equality, and bilateral reactivity. Both pupils should react briskly and positively.

The Glasgow Coma Scale (GCS) (see Chapter 26) can be used either during the primary survey or during the secondary survey for a more detailed neurological assessment of an injured child, especially after resuscitative efforts. There is evidence available to indicate that children who present with an initial GCS score of 6–8 in the presence of hypotension (SBP <90 mm Hg) have a significantly increased mortality rate;[12] therefore, it is important to prevent systemic hypotension during the initial efforts at resuscitation of the paediatric trauma patient, especially children with head injury.[12] A GCS score ≤ 8 is an indication for intubation of the child with head injury.[3] Administration of phenytoin (10–20 mg/kg body weight), diazepam (0.25 mg/kg body weight) or phenobarbital (2–3 mg/kg body weight) may be given if traumatic brain injury is suspected.[12] Mannitol (0.5–1 gm/kg body weight) and furosemide (1 mg/kg body weight) should be used with care because they can exacerbate hypovolaemia in haemodynamically unstable patients.[12]

It is prudent to perform neurological assessment of the injured child frequently to detect any changes that might occur during the resuscitation period.

E: Exposure

Expose the child by completely cutting away clothing where necessary; it is also wise, however, to preserve evidence of torn clothing as well as to address patient modesty. The patient must be well exposed to aid thorough physical examination and to facilitate practical procedures.[1,4,15] Expose both front and back to ensure that no injuries are missed—for this, the child should be log rolled while maintaining C-spine immobilisation. The child is also assessed for signs of heat or chemical exposure to determine whether there is a need for irrigation of the affected area. Measures should be taken to prevent the child from losing heat and becoming hypothermic during exposure and examination in the A&E department.[13,15] The child is kept warm and intravenous fluids warmed before being administered. This may not be a requirement in our subregion where intravenous fluids are usually warm, except for blood and blood products. Lastly, signs of child abuse are assessed and carefully documented.[13] Nothing should be left out as being unimportant.

F: Further Interventions

Further interventions include:[13]

- the passage of a nasogastric tube to decompress the stomach since acute gastric dilatation may precipitate vomiting and aspiration; compress the inferior vena cava leading to diminished venous return to the heart and result in hypotension; splint the diaphragm leading to respiratory embarrassment.
- insertion of a urinary catheter in the urinary bladder; and
- managing pain relief by using the appropriate analgesics, such as morphine (0.1 mg/kg), once the primary survey is completed.

Other necessary confirmatory investigations can be done at this stage when the child is considered stable enough to be moved.

Secondary Survey

Once tachycardia, hypotension, hypoxia, and hypothermia have been managed, then a secondary survey with definitive treatment can be safely started.[6] The secondary survey begins when the primary survey is completed, resuscitation has been started, and the child is responsive or haemodynamically stable.

The secondary survey involves a more detailed systemic assessment of the patient than the initial evaluation (from head to toe, front and back) and initiation of relevant diagnostic investigations[3,6] (all the necessary radiographs and laboratory tests). It should never be started in a haemodynamically unstable patient. Attention should be paid to the history and signs and symptoms of the present injury. The history should be taken directly from the child (if the child is old enough and cooperative to do so), from family, and from bystanders, or other relevant persons. It should include the name, age, and what happened. It may sometimes be necessary to interview older children in the absence of caregivers if accurate information is to be obtained in areas such as child abuse, drug and alcohol use, and sexual abuse.

It is in the interest of both the child and the doctor to allow a parent to be by the child.[4] This will calm anxiety from both parent and patient and allow the physician to completely examine the child. Again, pain must be treated adequately, and all critically injured children must be admitted to an intensive care unit (preferably, a paediatric intensive care unit).

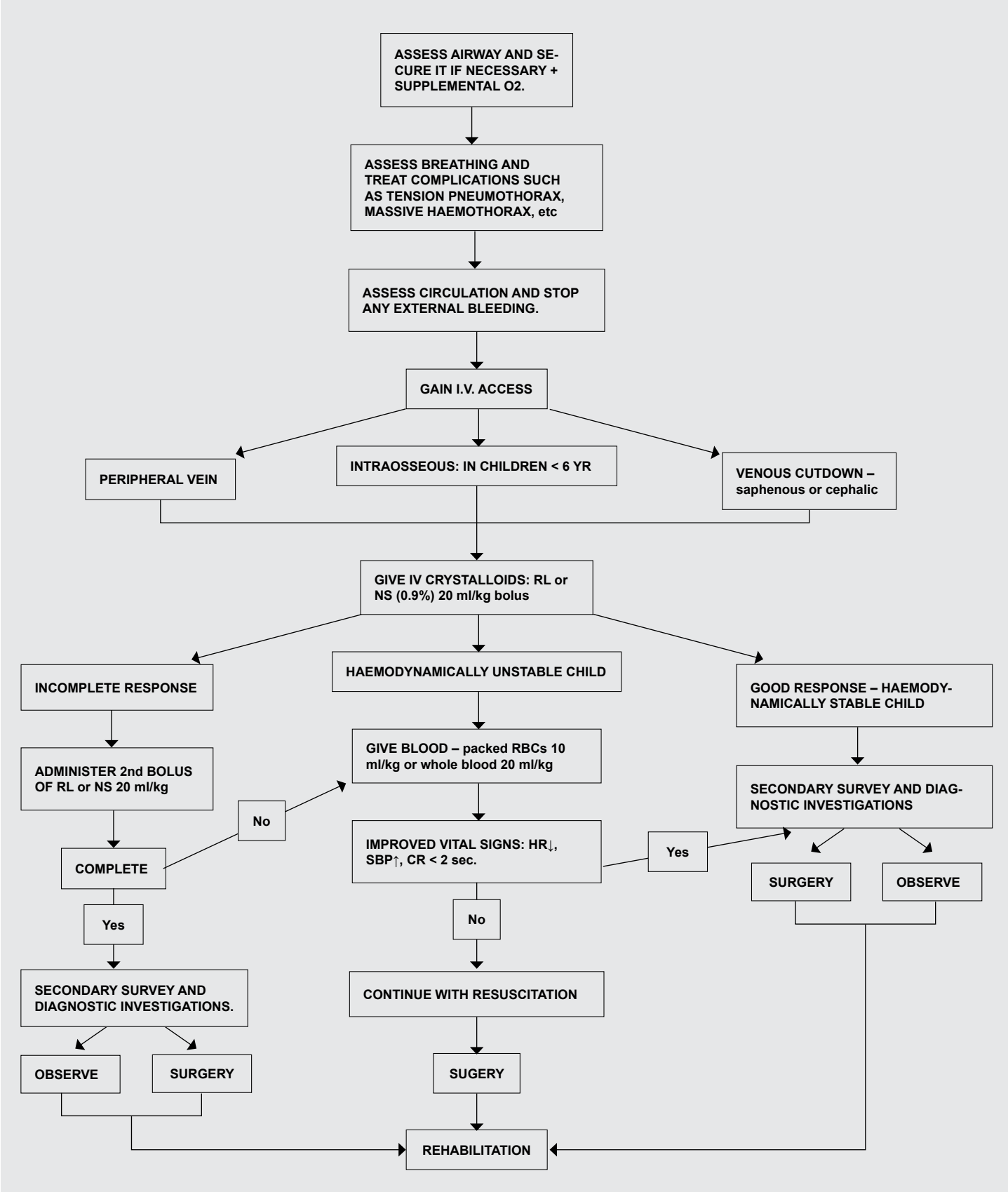

Figure 27.2: Algorithm for the initial assessment and resuscitation of a paediatric trauma patient.

A good and focused history is necessary to be able to ascertain the mechanism of injury. The mnemonic SAMPLE can be applied here.[1]

S: Signs and symptoms as they relate to the chief complaint;

A: Allergies, including medications, food, and environmental factors;

M: Medications the patient currently takes—over-the-counter drugs, compliance with prescribed dosing regimen, time, date and amount of last dose;

P: Past pertinent medical history, including medical and surgical problems, preexisting diseases or chronic illnesses, previous hospitalisations; for infants, a neonatal history of gestation, prematurity, congenital anomalies, and so on;

L: Last oral intake of liquids, food, and—for adolescent females—sexual activity;

E: Events related to the current injury, such as onset, duration, and precipitating factors, associated factors such as toxic inhalants, drugs, and alcohol; injury scenario and mechanism of injury; and treatment or first aid given at the site of injury or by caregivers.

When treating children with injuries, the clinician should bear in mind the possibility of child abuse and examine the child appropriately. A history not consistent with the injury or multiple injuries not consistent with what had happened should cause the clinician to have a high index of suspicion and try to exclude child abuse.[1,6]

After taking a good history, the patient is thoroughly examined from head to toe, including an evaluation of the child's vital signs, such as temperature, blood pressure, pulse, and respiration as compared to the normal for the child's age group (see Table 27.1). The goal is to recognise and appropriately treat potential life- and limb-threatening pathology. The body is examined region by region to identify the problem(s) and to assess the child for specific injuries to various organ systems.[1] A complete neurological examination is also performed, including the use of either the GCS or its modified version for children. The Paediatric Trauma Score (PTS) should be evaluated and recorded in the notes (see Chapter 26).

The head is examined for bruises, lacerations, contusions, and skull fractures. The eyes are examined for pupillary reaction to light, size, shape, equality, and the conjunctiva for haemorrhage. The face is examined for facial symmetry, epistaxis, rhinorrhoea, raccoon eyes, and bony fractures. Look for trauma to the gums and tongue in the oral cavity, as well as missing or broken teeth. The neck is immobilised until a cervical spine injury (a rare occurrence in children) is completely excluded by evaluating the appropriate radiographs.[4] If the radiographs are normal but the child still has neurological deficits or tenderness over the cervical spine, immobilisation of the cervical spine should continue until the child is seen by a neurosurgeon. Where available, magnetic resonance imaging (MRI) will aid the assessment of the spinal cord in children with suspected cervical spine injury.

Chest

The chest is re-inspected for changes from the initial primary survey to assess thoracic trauma. Both posterior and anterior walls of the chest are inspected. The contour and integrity of the chest wall are noted. The chest is inspected for hyperinflated hemithorax, open wounds, and flail chest. The ratio of inspiration to expiration is compared—a prolonged expiration usually indicates distress.[16] The chest is palpated to exclude rib, clavicular, scapular, and sternal fractures. The presence of rib fractures signifies that significant trauma has occurred. Where the rib fractures are multiple and segmental, then a flail chest may occur and paradoxical respiratory motion may be noticed.[8]

In the presence of contusions or haematomas on the thoracic wall, the examining physician should have in mind the possibility of occult injury to the chest. The lungs should be auscultated for the presence or absence of breath sounds and whether heart sounds are heard clearly or are muffled. Absent or reduced breath sounds may indicate the presence of a pneumothorax or haemothorax; distant or muffled heart sounds may be suggestive of cardiac tamponade.

Thus, in examining the chest of an injured child, the physician tries to exclude life-threatening injuries such as tension pneumothorax, open pneumothorax, cardiac tamponade, and massive haemothorax. In the management of children with chest trauma, a chest radiograph (supine or erect) will confirm the presence of a haemo- or pneumothorax. If a child is hypoxic after chest trauma, then suspect lung contusion and put the child on supplementary oxygen with chest physiotherapy, and give adequate analgesics to control pain.

Abdomen

Abdominal trauma patients should be assessed to decide which need further investigations and which will benefit from an immediate laparotomy because of an unstable condition. The abdomen of the stable patient is examined for tenderness, guarding, or distention.[1] If any intraabdominal solid organ injury is suspected, an abdominal ultrasound scan, in the form of **f**ocused **a**bdominal **s**onography for **t**rauma (FAST) in experienced hands, will be helpful.[5,6,12,17]

An abdominal ultrasound scan will visualise the presence or absence of fluid in the peritoneal cavity. Visualisation of fluid by using ultrasonography, in the right upper quadrant, the left upper quadrant, and the pelvis suggests solid organ injury or a mesenteric injury. FAST is particularly useful in the hypotensive child and is the evaluation of choice for the determination of significant amounts of fluid in the paediatric abdominal cavity.[12] It can also be used to diagnose pericardial tamponade. In a stable patient, however, the choice of investigation for abdominal trauma evaluation is a computed tomography (CT) scan.[1,6,18] It remains the gold standard for the accurate diagnostic evaluation of the child involved in trauma.[12] The CT scan provides a structural evaluation of organs better than an ultrasound scan, and if combined with intravenous contrast injection at the time of the scan, improves the clinician's ability to determine the severity of organ injury.[18]

The stable child with a suspected blunt abdominal injury that does not demand immediate surgery should be closely observed and re-evaluated several times, preferably by the same examiner. The abdominal symptoms can change over time.

Where the vital signs of the injured child are still unstable after proper and adequate resuscitation and after evaluation of the thoracic cavity, then it is in order to consider either an intraabdominal or pelvic injury and try to find out the cause and treat it appropriately. In such cases, a diagnostic peritoneal lavage (DPL) can occasionally be useful[12,19] in the absence of an ultrasound machine. DPL is a method of rapidly determining whether free intraperitoneal blood is present and is especially useful in the hypotensive child or the haemodynamically unstable trauma patient.[20] In experienced hands, DPL is fast and inexpensive, but more invasive than FAST, and it has a low complication rate. If DPL is to be performed in a child, the volume of fluid to be infused should be about 10 ml/kg of normal saline or Ringer's lactate.[1] The stomach and the urinary bladder should be decompressed by passing a nasogastric tube into the stomach and a urethral catheter into the bladder before the procedure is performed. A positive result is signified by microscopic findings of the presence of more than 100,000 red blood cells (RBCs)/ml, 500 white blood cells (WBCs)/ml, bile, or urine from the sample of fluid infused into the peritoneal cavity. The presence of organic matter or elevated WBC count indicates a hollow viscus has been disrupted.[12]

It is important to note that the presence of free blood in the peritoneal cavity of a child does not always mean a laparotomy is the next logical thing to do.[1] Such a child, if stable haemodynamically, can be managed nonoperatively provided there are no increasing signs of peritonitis, abdominal distention, and hypotension, which would indicate continued bleeding into the peritoneal cavity.

The abdominal examination is not complete if the perineum is not inspected and a digital rectal examination is not done. The perineum should be examined for bruises, haematoma, contusions, and lacerations. The rectum should be assessed for blood in the gastrointestinal tract, and the urethral meatus also should be inspected for blood. This will inform the physician as to the next line of action. For example, in the case of blood in the urethral meatus, the physician will think of a possible urethral tear and try to avoid unnecessary manipulations in passing a urethral catheter or, better still, inform the urologist to do that if there is the need for passing a bladder catheter.

Musculoskeletal Examination

The musculoskeletal system should be inspected. Here the four extremities (upper and lower) should be evaluated for pain, pallor, paresthesia, paralysis, and pulselessness. It is important to inspect the limbs for skin colour, ecchymoses, pallor or cyanosis, for symmetry and for length and position. Where there is suspicion of a fracture, the limb must be straightened and splinted or immobilised.[6] It is important to bear in mind the possibility of compartment syndrome when manipulating and splinting limb fractures. Remember to examine the child's pelvis for fractures.

Skin and Soft Tissues

Skin and soft tissues should be carefully examined, especially in the case of burns. Airway management is paramount in children with burns, especially if they involve the face, with the possibility of inhalation injury. The percentage of body surface area (BSA) burned should be assessed by using the Lund and Browder chart[21] and fluid resuscitation started using either RL or NS at 3–4 ml/kg body weight × % BSA burned, in addition to the maintenance fluid.[1] The calculated amount should be given over the next 24 hours, with half of it being given in the first 8 hours. Burns should be cleaned with normal saline and a nonocclusive dressing applied. The child should be transferred to a burn centre for further management. All the following burns in children should be managed in a burn centre or in a hospital if a centre does not exist: partial thickness burns of over 10% of the BSA; full thickness burns of over 5% of the BSA; burns on the face, neck, hands, genitalia, perineum, feet and over major joints; circumferential burns of any part of the body; electrical or chemical burns; and burns due to inhalation. All children with burns must have appropriate pharmacologic pain management, such as injection pethidine or oral morphine.

Neurological Examination

The neurological examination determines the mental status of the child, or the level of consciousness. The level of consciousness can be determined by using either the GCS or the modified GCS for infants. The size and reaction of the pupils to light are determined. Both pupils are examined for size, shape, equality, deviation, and reactivity to light—direct or consensual. Finally, all the limbs must be examined for spontaneous and purposeful movements, response to verbal commands, and sensory deficits or abnormalities. Where there is paralysis or paresis of a limb, injury to the spinal cord or peripheral nervous system should be suspected and the child immobilised with appropriate immobilisation devices until a spinal injury is ruled out.

Re-evaluation

Ongoing assessment or re-evaluation of the injured child is very critical to successful care and rehabilitation. Re-evaluation is usually performed following the detailed physical examination in the secondary survey. Repeated assessments are essential for the clinician to effectively maintain awareness of changes in the condition of the child. Repeated assessments should be performed every 5 minutes for the unstable child and every 15 or so minutes for the stable injured child.[16] Re-evaluation includes:

- standard respiratory monitoring (ventilatory rate, signs of impaired airway, breath sounds, etc.);
- standard cardiovascular monitoring (pulses, BP, heart sounds, etc.);
- standard neurological monitoring (GCS, pupils, motor and sensory changes, etc.);
- monitoring of temperature; and
- response to pain management.

Definitive care is carried out after the secondary survey. All problems found during the secondary survey are managed at this stage. All the essential investigations are also carried out during this stage of the child's care. The decision to manage the child's problems nonoperatively or surgically (with reference to the haemodynamically stable patient) is also made at this stage.

Conclusion

In conclusion, paediatric trauma patients undergo the same principles of management as for adult patients. Children should never be considered as little adults—their physiology, anatomy, and psychological needs differ from those of adults. The primary survey and initial phase of resuscitation of a paediatric trauma patient should address life-threatening injuries that compromise oxygenation and circulation. Control of the airway is the most important and first priority. The evaluation of the paediatric trauma patient's ABCs, disability, and exposure are made the priority of the initial phase. The aim is to stabilise the injured patient by thoroughly assessing for injuries and treating those injuries appropriately before transferring the patient to a trauma centre or to a facility or hospital where the injuries can be managed better.

After the primary survey, during which resuscitation of the patient is carried out at the same time, the patient then undergoes a secondary survey, in which a detailed history is taken and examination is performed; diagnostic investigations are carried out, and the appropriate treatment is instituted. At this stage, a decision should be made as to whether the injured child is to be managed in the present facility or be transferred to a more appropriate centre, provided, of course, that the patient's condition is stable.

Evidence-Based Research

Table 27.2 presents an example of holistic management of a case involving a 5-year-old child who sustained an injury in a traffic accident. Table 27.3 presents a study addressing the use of a CT scan to noninvasively evaluate and treat paediatric patients with head and abdominal injuries.

Table 27.2: Evidence-based research.

Title	Pediatric trauma—the care of Anthony
Authors	Lawton L
Institution	Accident and Emergency, The Radcliffe Hospital, Headington, Oxford, UK
Reference	Accident Emerg Nurs 1995; 3:172–176
Problem	The care of a paediatric trauma patient.
Intervention	The adaption of the ABCs of trauma care for a paediatric patient, taking into consideration the differences between adults and children.
Comparison/ control (quality of edvidence)	This is a practical example of how a 5-year-old child, who was involved in a road traffic injury, was managed holistically. The primary survey of the child and resuscitation started immediately when he was brought into the Accident and Emergency unit.
Outcome/ effect	This study reinforces the point that paediatric trauma care follows the same principles as for adult trauma with important differences such as the child's physiology, anatomy, and psychological needs, which should be taken into consideration if the child with trauma/injury is to survive. The trauma child should never be considered as a "little adult".
Historical significance/ comments	This study reinforces the point that paediatric trauma care follows the same principles as for adult trauma with important differences such as the child's physiology, anatomy, and psychological needs, which should be taken into consideration if the child with trauma/injury is to survive. The trauma child should never be considered as a "little adult".

Table 27.3: Evidence-based research.

Title	The efficacy of computed tomography in evaluating abdominal injuries in children with major head trauma
Authors	Beaver BL, Colombani PM, Fal A, et al
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Reference	J Pediatr Surg 1987; 22(12):1117–1122.
Problem	The efficacy of combined computed tomography of the head and abdomen in evaluating abdominal injury in a child with major head trauma and unreliable physical examination.
Intervention	Combined head and abdominal CT scans were performed on children with serious closed head trauma (GCS ≤ 10) and suspected abdominal injury at the same time.
Comparison/ control (quality of edvidence)	Of 65 children with GCS ≤ 10, 23% were found to have significant intraabdominal injury, but only two required laparotomy.
Outcome/ effect	All patients survived.
Historical significance/ comments	The significance of the study is that, based on the fact that nonoperative treatment of injuries to the spleen, liver, etc. have been carried out successfully, there is a need to find noninvasive methods of evaluating patients with suspected abdominal injury and concomitant severe head trauma without resorting to DPL. With this method, they avoided surgery in 13 children.

Key Summary Points

1. Start the management of the injured child with a primary survey (ABCDEF), which involves assessment, stabilisation, and management of all acute life-threatening conditions.
2. The primary assessment and resuscitation are performed simultaneously, which means there should be a paediatric trauma team in readiness for such an eventuality. There is always a leader of such a team who organises the members of the team to execute various functions.
3. It is necessary to reassess the injured child frequently with normal parameters of the child's age group in mind so as to take the appropriate action should these change for the worse. The proper sequence to bear in mind is: assessment of injured child, interventions and reassessment after each intervention.
4. Always keep the cervical spine immobilised until a neck injury is excluded.
5. Do not hesitate to consult other subspecialties, such as the neurosurgeon, urologist, trauma surgeon, and so forth.
6. Do the minimum radiologic and laboratory investigations necessary during the primary survey period. The rest can be done when the child is haemodynamically stable and a secondary survey has been performed to determine the need for more extensive investigations.
7. Do not hesitate to carry out a laparotomy (for damage control) if all efforts at resuscitating the child are not yielding the desired results, the patient's condition remains unstable, and an intraabdominal catastrophe is suspected.
8. Transfer only haemodynamically stable but severely injured children to the next competent facility. It is good practice to try to stabilise the injured child before transfer.

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