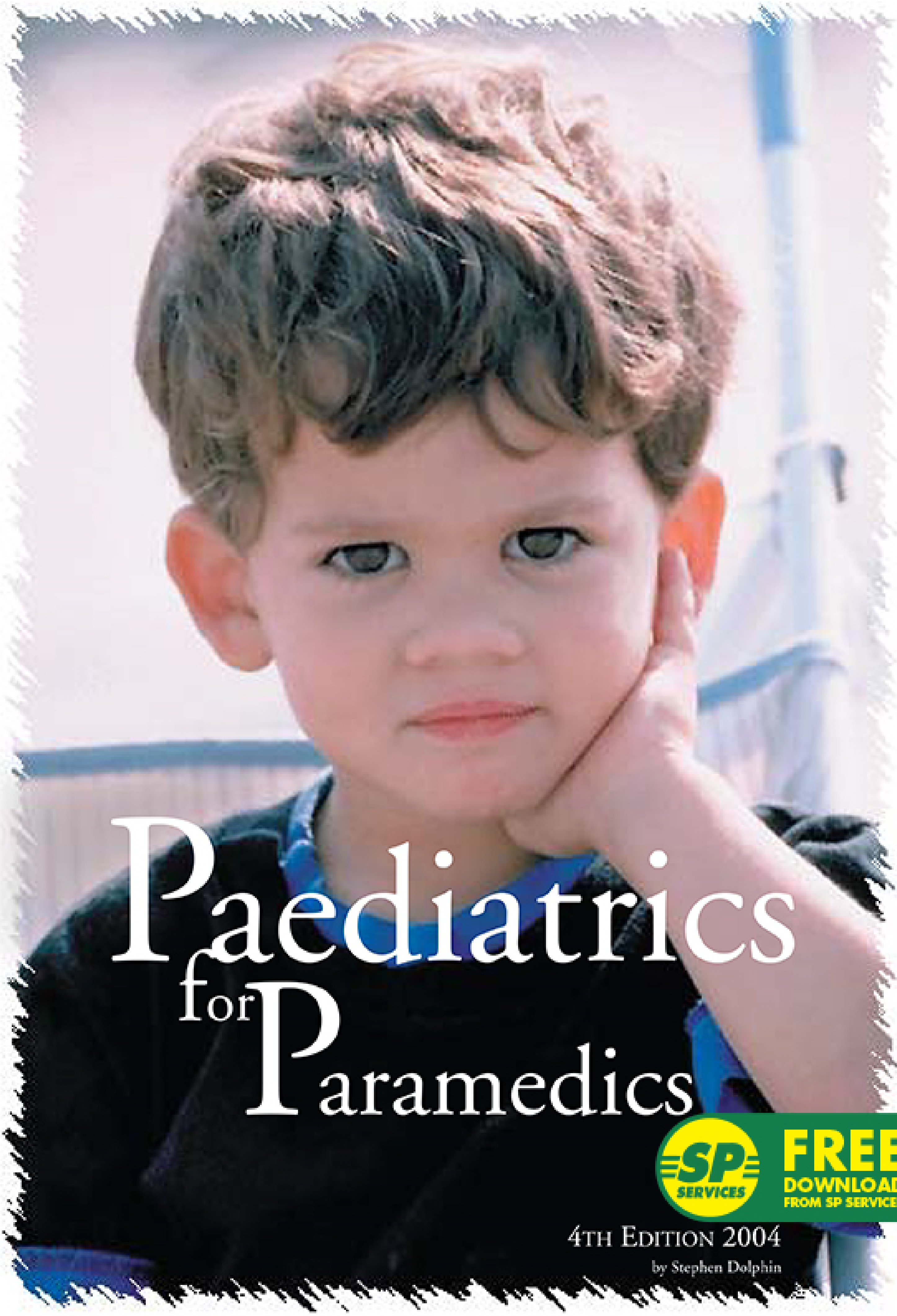

Paediatrics for Paramedics

4TH EDITION 2004

by Stephen Dolphin

PAEDIATRICS FOR PARAMEDICS

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PREFACE

CHILDREN ARE NOT SMALL ADULTS

This may seem an obvious statement, but the differences between children and adults go much deeper than size, language and abilities. The anatomy and physiology of children and adults is so different that a branch of medicine has developed specifically dealing with children. This branch is known as paediatrics.

Ambulance Services have, until quite recently, made very little provision for children. Most Services provide limited, if any, paediatric equipment or specific training. This situation is changing rapidly and this book and training course are part of that process of change.

The statistics for deaths of children are a reminder that although an emergency call to a seriously injured or ill child will be a rare event for most Paramedics, such calls do occur.

In 1991, the last full census year, there were 3027 deaths of children aged 0-28 days, 2078 aged 4-52 weeks, 955 aged 1-4 years and 1128 aged 5-14 years. This shows that the largest group is the infant, with most deaths being caused by congenital abnormalities and factors associated with prematurity. Most of these deaths occur in hospital, and will not involve the Paramedic, except perhaps for transporting the child from Hospital to Hospital with an attendant medical team.

However, when the statistics for the older child are analysed, they show that there is a change in the most common cause of death. From 4-52 weeks, the greatest cause is cot-death. For the group from 1-14 years, it is trauma. There are also significant numbers of deaths from infection in all age groups. These are the cases that Paramedics are called upon to manage.

These statistics just refer to deaths. There are also large numbers of children admitted to hospital every day with serious and life-threatening conditions, either from illness or from trauma. It is these two groups of children, the seriously ill and dying, that this book is concerned with.

It is hoped that the book will also increase the awareness of the special problems associated with treating all children in the pre-hospital environment and so raise the standard of care that children receive for any condition, no matter how serious or trivial.

SPECIAL NOTE

This book is designed to be used by any Paramedic in the United Kingdom. To do this, it includes all the accepted interventions and drugs. However, Ambulance Service Paramedics are controlled by the Local Advisory Panels, and these bodies have differing views on the acceptability of various treatments. These views are formed to take into account the training and resources of each individual Service and may vary from what is shown in this book. In all cases, the views and protocols of the Panels are paramount and must be followed.

Note that the advanced treatments shown here are for use when basics, such as airway control and oxygenation fail. Always institute basic treatment first. It is often sufficient.

Acknowledgements

The National Meningitis Trust provided the basis for part of the section on meningitis and the illustrations of the symptoms in infants and children. This is reproduced with their kind permission.

The Resuscitation Council (UK) provided the basis for part of the section on cardiac arrest. This is reproduced with their kind permission.

The photos of practical procedures feature the hands of Ambulance Technician Kerry James of Berkshire Ambulance Service and Dr Thomas Dolphin. Thanks are due to Essex Ambulance Service for the facilities for taking the photos.

The child featured on the front cover must remain anonymous. He was the first patient to benefit from my advanced Paediatric Training provided by Essex Ambulance Service. The child, aged 2 years and 4 months, had fitted continuously for 40 minutes due to febrile convulsions and was apnoeic. His systolic blood pressure was 84mmHg, his pulse rate was 130, his SaO_2 was 85% and his GCS was 3.

My training allowed me to :

- Assess the child logically and thoroughly
- Protect his airway adequately
- Ventilate him adequately
- Oxygenate him adequately
- Reduce his temperature without inducing hypothermia
- Administer rectal Diazepam
- Administer an intraosseous infusion of 10% Dextrose
- Administer an intraosseous infusion of Hartmanns Solution

Following treatment in the ambulance, and with no further treatment in hospital, he was discharged the next morning with no further problems.

1

Introduction

Paediatric Defined

For the purposes of this book and the data, treatments, procedures and medical implications, "paediatric" means any child up to the age of 12 years. Over that age, a patient is treated medically as an adult.

The legal position is a different story.

One of the most basic and fundamental rights in health care is the right to say what can and cannot be done to your person; the right to consent to treatment or to withhold your consent. This right, for the mentally competent adult, is firmly protected by law. However, the position regarding children is somewhat different.

The Family Law Reform Act 1969 at section 8 states that competent young persons over the age of sixteen years can give consent to medical treatment without regard to the wishes of their parents or those with parental responsibility. However, this does not give young people total autonomy as the ability appears to relate only to the giving of consent and not the withholding of consent. When the treatment which is being refused is life saving treatment the courts may intervene and override the wishes of the young person as shown by Re W (a Minor) (medical treatment) (1992) 3 WLR 758. This case gave us the principle that even when a young person has reached sixteen years old, if they refused consent to treatment then anyone with parental responsibility could override their refusal and give consent on their behalf, the court also retained the right to override the young persons wishes.

The right of children under sixteen years to make their own decisions about medical treatment was until relatively recently non-existent. However, following the case of Gillick v Wisbech & Norfolk AHA 1986 the principle was put forward that children under this age could consent to treatment without parental authority if they were deemed to be of sufficient maturity and understanding to so do.

Although this case dealt specifically with contraceptive treatment the principle of 'Gillick Competence' has been applied to other areas of treatment.

Whether or not a child is 'Gillick Competent' is a matter of fact in each case. There is no predetermined age at which a child will become competent and the variables to be taken into account include the complexity of the issue to be considered; some issues require a higher level of understanding than others.

The Child's Right to Treatment

Children who are not deemed to be Gillick Competent may have consent given for them by their parent or other with parental responsibility. However, as with adults, consent need not be obtained where there is an emergency situation and treatment is urgently required. The decision to adopt this approach often lies with an individuals professional judgement.

In relation to parental consent to treatment, the Children Act 1989 at S2 (7) states that anyone with parental responsibility can act independently of the other(s) in giving consent. This means that consent of both parents, while desirable, is not necessarily required. We can see from the forgoing that the rights of children in relation to the right to medical treatment are not automatic but depend heavily on adult input.

Children and Confidentiality

The law recognises a duty of confidence between a Paramedic and their patient in relation to information obtained by the Paramedic in his/her professional capacity, the patient has the right to confidentiality. In terms of children as patients, the question as to whether they can expect the right to confidentiality appears once again to turn on their capacity to form a confidential relationship with the Paramedic.

The implication of this approach is that when the child is incompetent to form such a relationship the Paramedic is obliged to disclose what he has learnt to the parents. In relation to the child with complete incapacity to enter into a confidential relationship there is what almost amounts to a legal duty on the Paramedic in favour of disclosure. Breach of this duty could give rise to an action in negligence if the Paramedic failed to disclose and harm resulted to the child.

The disclosure need not always be to the parents, in cases of suspected child abuse disclosure would need to be to the person most capable of protecting the child which would normally be the hospital staff in the short term and the local authority in the long term. If the Paramedic does disclose information to a third party, again evidence of resulting damage to the child would have to be found before an action could be brought.

Throughout this section we have seen that the rights of the individual child in relation to health care and medical treatment are not so much given to the child as owed by adults in positions of responsibility to the child, whether parent or health professional. Lack of awareness among these adults as to the existence of these rights automatically decreases their value for the child.

Children themselves are rarely actively informed of their rights in the health care setting. Any rights which children do possess can often be overridden by parents, professionals or the courts in the child's best interests, yet how much effort is put into finding out what the child feels is in their own best interest and how much is the adult perception of what is in the child's best interest?

Summary

Consent to treatment must be obtained for any procedure that is not deemed to be "life-saving". In an emergency, where life-threatening injury and illness is concerned, consent is deemed to be given, but it would be wise to attempt to obtain consent where practicable.

If the child is under sixteen years of age and not fully capable of understanding the implications of giving consent, the consent of those with parental responsibility must be obtained.

If the child is under sixteen years of age and is deemed to be capable of understanding the implications of agreeing to treatment, they can give their consent. They cannot refuse treatment on their own - the refusal can be overridden by those with parental responsibility. (this includes teachers and playgroup leaders etc., holding a consent form).

If the child is over sixteen years of age, they can automatically give consent to treatment, but once again their refusal to agree can be overridden by the parents.

Once patients reach the age of eighteen years, they have full adult rights over consent and refusal of treatment.

Consent in all cases means "informed consent", as the implications of the treatment must be understood by the patient, following an explanation by the Paramedic.

Comparative Anatomy

Children differ from adults in several significant ways. Not only are their airways, lungs, blood vessels, bones and other organs different, but their compensatory mechanisms also act in a different manner.

As a child grows, the relative proportions of certain parts of their bodies change, until they become adult shape and size. The Lund & Browder chart, used for assessing the severity of burns by recording the surface area of different parts, illustrates this. The parts most affected by the change are the head and legs and this affects several things. Proportionally, with age, the head becomes smaller, the thighs and calves become larger.

The Head

The relatively large surface area of the infant head allows body heat to be lost more rapidly, as the head is often exposed. This means that the child is more susceptible to hypothermia in an exposed situation. The head should therefore be protected from the elements as soon as possible. The size of the head also changes the way in which the airway lies when the child is supine. The occipital area of the skull is relatively large in small children and over-extension of the neck will cause airway obstruction, so primary airway protection should be by jaw thrust.

The Mouth

The mouth of a child is, relatively and absolutely, small. This will make it difficult for access for suctioning, airway management and intubation. The tongue is large and subject to swelling, making obstruction more likely.

Unconscious children will have difficulty with the tongue obstructing the airway. The floor of the mouth is soft and subject to damage if jaw thrust is performed by holding the jaw between the tongue and the chin.

The Airway

The linings of the airway and trachea are easily subject to swelling due to their relative thickness. The linings have a sub-layer of loosely-bound areolar tissue, which is very prone to swelling following even minor trauma, such as endotracheal intubation.

They also tend to produce more mucus secretions, making obstruction and the need for suctioning more likely. These secretions also tend to lead to more infections.

Epiglottis, Larynx & Trachea

In small children, the epiglottis is horseshoe-shaped and projects backwards. This tends to make intubation difficult, especially with a curved Macintosh blade, so a straight Miller blade should be used in babies and small children.

In adults, the narrowest part of the airway is the vocal cords. However, in children, the narrowest part is the cricoid ring. This area is also particularly prone to oedema, either from infection or from trauma.

Any endotracheal tube under 5.5mm should be uncuffed, as a cuff would tend to cause more trauma and oedema. The softness of the linings will ensure an adequate airtight seal, whilst at the same time leakage will provide some protection against overinflation of the lungs.

The trachea is relatively short and soft, making compressional obstruction more likely during airway protection manoeuvres. The large head also makes placement on a trauma board difficult without the use of additional padding under the shoulders. The trachea is short and each part after the carina is at the same angle, making displacement of the tube more likely and the risk of intubation of either bronchus the same.

Lungs and Respiration

Small children have small lungs. In addition, the lungs are immature, for the first few days of birth in full-term babies and up to the first few weeks in premature babies.

Premature babies are likely to have a lack of surfactant, a substance that keeps the alveoli from collapsing and are therefore more prone to alveolar collapse (atelectasis) The remedy for atelectasis is premature infants is positive end-expiratory pressure ventilation (PEEP), which keeps the alveoli open. This is normally delivered in hospital by the anaesthetist.

The small size of the airways makes for easy obstruction of the upper airways by very small objects, leading to widespread lung dysfunction.

The chest wall is more flexible than in adults, leaving the chest prone to internal injury without rib fractures, in the case of trauma

Small children are very prone to respiratory failure due to the diaphragm being the main mechanism of respiration. Any injury to the diaphragm or abdomen causing spasm, paralysis, splinting or ineffective movement of the diaphragm will lead to respiratory failure.

Psychology

Children are easily frightened and need careful handling to avoid stress-induced problems, such as hyperventilation, tachycardia and mental withdrawal. All these things will make diagnosis and treatment more difficult and may also tend to exacerbate the condition.

Infants

The infant cannot communicate verbally, so careful observation is required to assess their distress. Infants will often cry when in pain, but may equally be silent or just whimpering.

Infants need human contact, and while this is usually best provided by the parent, any gentle, supportive contact will provide comfort.

Toddlers 1-3 years

These children are very dependent on their parents are often difficult to unlatch from Mum's arms. It is often easiest to treat the child while they are being held on a lap.

Toddlers can be very uncooperative and noisy and the decision to continue treatment in minor cases can depend on whether it would cause more distress than non-treatment.

Children 3-5 Years

These children are beginning to make some sense of the world around them. Unfortunately, the understanding is less than perfect and irrational fears can be uppermost in their mind. You must do your best to reassure the child, but you must be honest in what is happening and what is about to happen. Saying that a potentially painful treatment will not hurt can destroy any trust that the child has in you.

These children often revert to a younger frame of mind when in distress and they must be reassured that it is perfectly acceptable for them to cry and want to be cuddled. A favourite teddy-bear or doll will usually provide a great deal of comfort. Many ambulances carry one or two soft toys, such as a teddy with a flourescent jacket, which will comfort the child and also provide some distraction from the illness or injury.

School-Age Children

Although these children like to think of themselves as quite "grown-up", they can also tend to revert to a younger state when ill or injured. However, their developing ability to communicate will make them easier to deal with than younger children.

It is important to explain to them what is happening, in terms that they can understand. Once again, honesty is vital. Children of this age are often aware of what has happened to their friends in similar circumstances and will be looking to you for reassurance that they will have a good outcome from the incident.

Adolescents

Adolescents generally think of themselves as adults. They will probably want to give any consent required and may refuse consent because of fear of the treatment. It should be remembered that a competent child under 16 can consent to treatment but cannot legally refuse treatment. However, this refusal can be overridden by a parent or other adult with parental responsibility. Witholding essential treatment is not an option.

Adolescents are often concerned about their public "face" and are easily embarrassed. Care should be taken to respect their dignity and privacy.

Post-Traumatic Stress

A recent study has shown that 34% of children involved in road traffic accidents showed signs of suffering the effects of Post Traumatic Stress Disorder when assessed six weeks after the incident. Careful handling at an early stage may help to offset these effects.

2

Patient Assessment

Immediate Recognition of Serious Injury or Illness

Serious injury is defined as trauma that will lead to, or may lead to, circulatory failure, respiratory failure, or a combination of the two.

Serious illness is defined as illness that will lead to, or may lead to, circulatory failure, respiratory failure, or a combination of the two. The causes of these failures are summarised below.

FLUID LOSS	FLUID MISPLACED
Blood Loss Gastro-Enteritis Burns	Septic Shock Cardiac Disease Anaphylaxis

LEAD TO

Circulatory Failure

LEADS TO

Cardiac Arrest

RESPIRATORY DISTRESS	RESPIRATORY DEPRESSION
Foreign Body Croup Asthma	Convulsions Raised ICP Poisoning

LEAD TO

Respiratory Failure

LEADS TO

Cardiac Arrest

These pathways show that serious illness or injury will eventually lead to cardiac arrest in children unless timely and correct intervention is carried out.

The causes of death involving trauma can be classified into those which:

Cause death seconds to minutes

Brain, heart or great vessel destruction.
Loss of patent airway.

These injuries are normally beyond the help of the Paramedic. They occur very quickly, usually before the arrival of the ambulance. However, unless the injuries are obviously unsurvivable, for example decapitation or disembowelment, or there is rigor mortis, resuscitation should be attempted and continued until you are told to stop by a doctor.

Cause death in minutes to hours

Bleeding inside the skull. Impaired airway. Bleeding into the chest, pelvis or abdomen. Fractures of large bones.

These are the types of injury that the Paramedic is best placed to deal with. Prompt and appropriate action and prompt delivery to hospital can and does save these patients.

Cause death in days to weeks

Multiple organ failure. Infection.

These causes of death, whilst outside the scope of immediate management by Paramedics, are heavily influenced by your actions in the first few minutes of the incident and during the journey to hospital. Careful and appropriate resuscitation can prevent organ failure and careful hygiene can prevent or limit infection.

Stay & Play or Load & Go

Seriously ill or injured children display a wide range of signs and symptoms and it is not always easy to differentiate between the child that needs immediate treatment and the child that needs immediate hospitalisation.

The primary and secondary survey are a system of examination and assessment that will assist you in the decision to attempt treatment on scene, immediately transport the child to hospital or start treatments and then transport the child.

If the primary survey reveals an immediately life-threatening condition, which can be an obstructed airway, no breathing or no pulse, attempts should be made to deal with them on scene and then the patient should be loaded and transported without undue delay.

When carrying out the primary survey, you should not go on to the next stage until life-threatening problems have been dealt with. This may mean that the primary survey is never completed and the secondary survey is never started, for instance if there is an airway problem that cannot be rectified on scene.

The secondary survey is carried out en-route to hospital, but only if time and treatments of the ABC allow. All other treatments will have to wait until the child is delivered to hospital or some further medical assistance, such a BASICS doctor or a second Paramedic, arrives at the child's side.

If problems are found on the primary survey and they are rectified during transport, the secondary survey can be carried out and any other treatment started.

If the primary survey is completed and no life-threatening problems have been found, the secondary survey can begin on scene. Treatments can be started and the child should be transported to hospital without undue delay.

The Primary & Secondary Surveys

Arrival on scene is the start of the assessment of the child. As soon as you arrive you must begin to note the following, in the order given. Note that items in red italics indicate treatments which, if required, must be carried out before continuing. Further, if any of these treatments need to be carried out, do not delay on scene longer than is necessary to carry them out. Transport the child as soon as possible.

The Primary Survey

Danger, History, ABCDE

Danger

Is there any danger to you or any further danger to the child? If so, attempt to remove or at least reduce this danger before continuing.

History

Are there any signs that give you a clue what has been happening? Does the child look ill? Is there anybody there who can tell you what has happened? Does the history or scene suggest that the cervical spine is in danger? If so, immobilise the head and neck.

ABCDE

A - Airway and Cervical Spine Control.

Is the airway patent?

If not, attempt to clear and secure.
Secure the cervical spine.

B - Breathing

Is the child breathing?

If not, start ventilation.

What is the breathing pattern?

If there is a tension pneumothorax, treat it immediately.

What is the work of breathing?

C - Circulation & Haemorrhage Control

Is there a pulse?

If not, start chest compressions.

What is the nature of the pulse?

Is the child profusely bleeding externally?

If so, apply direct pressure.

Are there signs of internal blood loss?

D - Disability

What is the neurological status of the child?

Are they Alert?	A
Do they respond to Voice?	V
Do they respond to Pain?	P
Are they Unresponsive?	U

E - Exposure

Expose the child to check for obvious injuries and bleeding.

The primary survey must be completed and any resuscitative measures carried out before the secondary survey is begun. If the results of the primary survey show that the child has a patent airway, a stable cervical spine, is breathing adequately and has an effective pulse, then and only then can the secondary survey begin.

THE SECONDARY SURVEY

General

Gain an overall impression of the child's condition.

Head

Check visually for bruising, haemorrhage, deformities and CSF.

Check manually for lacerations, "boggy" areas due to bruising and haematomas, fractures and tender areas.

Check the mouth and oropharynx.

Check pupil reactions - Are they reacting? How quickly? Are they equal?

Calculate the Glasgow Coma Scale.

Check the reflexes.

Neck

Check visually for bruising, swelling and deformity.

Check manually for deformity.

Check manually for surgical emphysema

Check the trachea for deviation.

Check the neck veins for distension.

Chest

Check visually for bruising, lacerations, deformity and the nature of movement.

Check all the ribs visually and manually for tenderness, crepitus, flail segments, intercostal recession and paradoxical movement.

Auscultate all fields of the chest with a stethoscope for breath sounds, wheezes, rales and ronchi.

Listen to the heart.

Percuss the chest for hyperresonance or dull sounds.

Check for capillary refill over the sternum.

Abdomen

Check visually for movement.

Check visually and manually for bruising, lacerations, swelling, tenderness, boarding, guarding and any unusual masses.

Listen with a stethoscope for bowel sounds.

Pelvic Area

Check manually and visually for bruising, lacerations, deformity, crepitus, tenderness, swellings, unusual movement.

Spine and Back

Check manually and visually for swelling and bruising.

Inspect the back of the chest as noted above for the chest.

Check reflexes.

Extremities

Check manually and visually for bruising, lacerations, swellings, deformity, unusual movement, crepitus.

Check distal pulses in all four limbs.

Check peripheral capillary refill in all four limbs.

Check reflexes.

Overall

Check blood pressure.

Check body temperature.

Shock

Shock is defined as inadequate tissue perfusion to meet the metabolic needs of the body. Note that in the primary assessment of shock, it is the signs of inadequate tissue perfusion that are important, not hypotension. Hypotension is a late sign of shock in children and signals that the childs' body can no longer compensate to maintain the perfusion of vital organs such as the brain and kidneys, among others. The change from compensated to decompensated shock is a sudden and ominous sign. The child with hypotension is "crashing" and is heading for complete cardiovascular failure very rapidly, requiring immediate treatment.

Homeostasis

The maintenance of tissue perfusion requires three components, working adequately and in unison. Failure or poor performance of any one component will lead to shock.

The Heart

Small children cannot effectively change their stroke volume, but rely on raising the heart rate to increase the cardiac output. If the ability to raise the rate is reduced, for instance by hypoxia or low blood volume affecting the myocardial performance, the child will no longer be able to maintain adequate cardiac output and will progress rapidly to hypotension and severe shock.

Most children have a healthy heart and heart failure is usually caused by respiratory failure or hypotension. However, occasionally, congenital heart defects and sometimes myocardial infections or dysrhythmias can cause problems and should be considered in the assessment.

Tachycardia can be a sign of pain, fever, anxiety, stress or shock, which require assessment and appropriate management. Bradycardia is a sign that measures such as airway management and ventilation are required and fluid replacement should be considered.

Blood Vessels

Children are able to compensate for a 30-35% blood loss or heart failure by peripheral vasoconstriction. However, this compensation will only operate for a limited time, and blood pressure will fall rapidly when vasoconstriction fails. In the case of anaphylactic shock, septic shock and neurogenic shock, the primary cause of the hypotension is peripheral vasodilation or lack of compensatory vasoconstriction combined with an increase in the permeability of the vessels, both of which lead to decompensated shock.

Blood Volume

Small children have a small blood volume, of approximately 80ml/kg. To an adult, a loss of 250ml of blood would represent just 5% loss, but to a 20kg child, it would mean a 15% loss, which is far more serious. Children bleed and clot at the same rate as adults, so with a smaller initial volume, significant losses with resultant shock happen much more quickly.

Shock is normally caused by failure of one of the three components above - pump failure, container failure or lack of volume. The most common causes of shock in children are hypovolaemia from bleeding, dehydration or vasodilation, and respiratory failure with its resultant hypoxia.

Types of Shock

The types (and causes) of shock are listed below. It should be noted that there is a crossover of causes and classification. The classifications are based on the causes of shock, not the effects.

Hypovolaemic Shock

Caused directly by lack of circulating volume, either from bleeding, dehydration or burns. Also a feature of neurogenic, septic and anaphylactic shock.

Neurogenic Shock

Caused by failure of the nervous system to maintain proper peripheral resistance, resulting in peripheral vasodilation and the subsequent loss of adequate perfusion to the vital organs. Injury to the spinal cord may lead to failure of the autonomic nervous system, allowing the vagus nerve to dominate the heart with resultant relative bradycardia and cardiogenic shock.

Cardiogenic Shock

Caused by the failure of the heart to maintain circulation of the blood of sufficient pressure for adequate tissue perfusion.

Septic Shock

Caused by toxins produced by bacteria and other pathogens altering the peripheral resistance by vasodilation, and altering the permeability of the blood vessels, leading to loss of circulating volume into the periphery and the interstitial spaces. The toxins may also depress myocardial function, leading to cardiogenic shock.

Anaphylactic Shock

Caused by an allergic reaction, resulting in the production of large amounts of histamine. The peripheral blood vessels become dilated and their permeability is altered, leading to loss of central circulating volume into the periphery and into the interstitial spaces.

Stages of Shock

Compensated Shock

Early signs of hypovolaemic shock include tachycardia and peripheral vaso constriction with pale skin. Anaphylaxis, septic shock and neurogenic shock may produce tachycardia and flushing of the skin. Capillary refill may be affected, with a refill time of greater than 2-3 seconds being indicative of early shock. The respiration rate may be increased.

The level of consciousness may be altered. Agitation (which can also be due to pain or fright), and lethargy are common signs.

Significantly, blood pressure is usually normal or slightly raised due to reflex tachycardia. Peripheral pulses are normally present.

At this stage of shock, treatment of the cause, adequate oxygenation and possibly ventilation are required. The history of the incident will tell you if venous access should be obtained (this should be avoided in the case of upper respiratory tract problems).

Decompensated Shock

Skin that was pale and cool will become mottled, and capillary refill is significantly lengthened. Peripheral pulses are no longer obtainable. The respiratory rate will be greatly increased.

The child does not respond to painful stimuli.

Significantly, blood pressure will rapidly fall.

At this stage of shock, aggressive measures, including treatment of the cause, ventilation and fluid replacement should be considered. Note that anaphylactic and septic shock require a colloid rather than a crystalloid, due to the increased blood vessel impermeability.

Assessment of Shock

The presence or likelihood of shock should become apparent during the primary survey and may be confirmed during the secondary survey.

The history will often signpost the likelihood of shock and will alert you to actively seek and treat the condition. At this stage you may be able to determine the cause of the shock and start to outline a treatment plan, but if the child "fails" the primary survey, treatment must commence immediately for life-threatening conditions.

On the secondary survey, a more complete examination can be made. The assessment of cardiovascular status includes many more factors than just the presence or absence of a pulse.

1. Heart rate

Tachycardia due to pain and fear is common is injured children and if this is the only finding, bearing in mind the history, it is not generally taken to be serious. However, if it is combined with other findings of the signs of shock, treatment of the shock should be commenced as tachycardia is also a sign of early compensated shock. Bradycardia is an ominous sign, and signals the need for aggressive intervention, usually by airway management and ventilation to achieve adequate oxygenation. Fluid resuscitation may also be necessary.

2. Pulses

Assess the quality of distal and central pulses. Good central pulses combined with poor peripheral pulses may indicate early compensated shock.

3. Capillary Refill

Check the capillary refill by pressing on the childs' sternum or forehead with a finger or thumb for about five seconds. When the pressure is removed, the capillaries should refill and the skin should become pink within two to three seconds. Delayed capillary refill may indicate shock. If the child is cold, capillary refill may be delayed in any case.

4. Skin Colour

A child that is compensating for hypovolaemic shock will have pale skin due to peripheral vasoconstriction. Decompensated shock usually causes mottled and sometimes blue-tinged skin. True cyanosis is a very late sign in shock. Flushed skin can be caused by attempts at heat loss in a pyrexic child or peripheral vasodilation in a child with anaphylactic, septic or neurogenic shock.

5. Level of Consciousness

Children that have just been involved in an accident are frequently quiet and withdrawn, but can also be agitated and crying inconsolably. However, they usually interact with their parent or siblings, often being "clingy" and reverting to younger type behaviour. This does not reflect a lowered level of consciousness.

If the child is agitated and screaming and does not seem to recognise its parent, care must be taken to interpret this as a possible lowering of the level of consciousness which deserves further consideration as far as the assessment of shock is concerned.

A child that is lethargic, withdrawn, inappropriately sleepy or does not respond to voice or handling can be assumed to be seriously ill. A careful assessment of blood pressure, capillary refill etc. is required and may lead to intervention.

6. Blood Pressure

Remember that a lowered blood pressure is a late sign of shock in a child.

Blood pressure can be difficult to accurately measure in small children, particularly if it is low. It is essential to use the correct cuff size, that covers no more than 2/3rds of the upper arm and does not encircle the arm more than once. Oversized cuffs will give a falsely low reading.

If the blood pressure cannot be measured in the normal way, using a stethoscope, the pressure may be estimated by inflating the cuff and noting when the radial pulse returns as it is deflated.

Treatment of Shock

Compensated shock is an eminently treatable condition. Further, effective treatment at this stage can help to prevent the development of decompensated shock, cardiovascular failure and death.

If compensated shock is suspected due to the history, signs and symptoms, it is mandatory to administer oxygen at the highest rate that can be achieved. This may involve ventilation with bag and mask in more serious cases or where ventilation is compromised.

If there is no history that suggests a spinal injury or if the child is not suffering from croup, epiglottitis or asthma requiring the child to sit up, the child should be laid down, with the feet raised where possible, to encourage venous return to the heart and brain. If your assessment is that the child is seriously ill and fluids and/or drug therapy may be required, venous access should be obtained, either in a peripheral vein or intraosseously in the tibia (unless contraindicated, such as in croup and epiglottitis).

Analgesia is an effective form of treatment for shock and Entonox, morphine or Nubain should be considered. Morphine and Nubain are contraindicated under the age of 1 year, whilst Entonox should only be used where the child will understand.

If the child is in uncompensated shock, high concentration oxygen should be administered, with more emphasis being placed on ventilation, to ensure adequate oxygenation and reversal of hypoxia. The airway should be protected as appropriate, an oropharyngeal or nasopharyngeal airway usually being adequate. Intubation should be considered.

The child will usually be laying flat and the feet should be raised, as before. Peripheral venous or intraosseous access should be obtained as soon as possible and a bolus of 20ml/kg of Hartmanns solution should be given as soon as possible. (Anaphylactic shock and septic shock should be treated in accordance with their own treatment guidelines). If this bolus of fluid does not improve the child's condition, consideration should be given to a second bolus dose.

Shock often produces hypoglycaemia in a small child and a BM stick should be taken as soon as possible. If the blood glucose level is below 3.0 mmol/ml a bolus of 5ml/kg of 10% Dextrose should be given. If this calculated dose exceeds 100ml, the portion after 100ml should be given after five minutes.

The child should be monitored closely to assess any changes in the level of shock. The cardiac monitor should be closely watched to assess any changes in the heart rate.

3

Airway Control

Airway Control

The patient that has a lowered level of consciousness from any cause must be treated as if they have no airway control of their own. Failure to obtain and maintain an adequate airway will render any other procedures practically meaningless.

Basics

After safety considerations, the first physical check on the condition of a patient is of the airway and cervical spine. If the airway is not clear, do not continue until it is, but remember to protect the cervical spine.

It is not always necessary to intubate a patient, in fact it is often impossible or impractical, making the use of basic control all the more important. It may be that simple manoeuvres, such as those described below, will open the airway and thoughtful positioning will maintain it. The use of basic techniques will also save valuable minutes in a time-critical patient.

If intubation can be avoided, it should be. Intubation is fraught with dangers and complications, particularly in children. However, if the patient is to be treated on their back, or there are copious secretions, blood or vomit in the airway, it may be necessary .

Approach

On your approach to the patient, listen for the sounds characteristic of lack of airway control. These signs include snoring, snuffling, rasping respirations, bubbling and also silence.

Snoring and snuffling are generally caused by the tongue, which in infants and toddlers, is relatively large in proportion to the oral cavity. However, they can also be caused by swollen tonsils and other structures at the back of the oral cavity. Rasping respirations can be caused by a foreign body in the throat or upper respiratory tract infection and oedema such as in croup. Bubbling can be caused by fluid in the airway, either blood, vomit, oral secretions or fluid brought up from the lungs. In the presence of respiratory effort, silence denotes a completely blocked airway.

Whatever the cause or effect, the presence of these sounds should alert you to the need for airway control.

Basic Airway Control Techniques

Head Tilt / Chin Lift

Place the heel of your hand on the child's forehead and tilt the head back gently. The amount of tilt to be applied depends on the age of the child. Babies should have a neutral head position and all other patients should be placed in the "sniffing" position. Place the fingers of your other hand under their chin and lift gently, taking care not to grip too hard on the child's delicate soft tissue. In babies, opening the mouth is not generally necessary, as they are obligate nose-breathers. Older children may need to have their mouths opened with your thumb.

If the child has been subject to trauma involving the cervical spine, the head tilt may cause further damage and a jaw thrust technique should be used.

Jaw Thrust

Place your elbows on the surface behind the child's head and hold it with your palms. Place your fingertips in the angle of the jaw and gently lift the jaw to clear the airway. A head tilt of 5° can be safely applied without endangering the cervical spine.

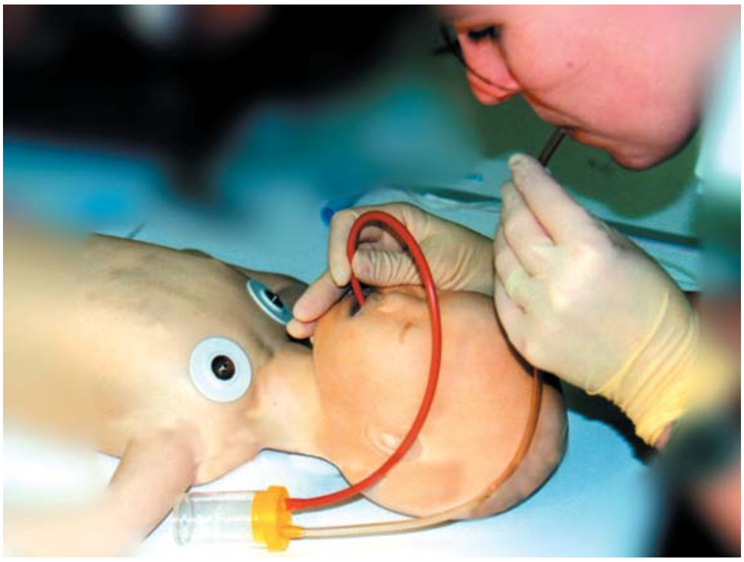
In either case, following the manoeuvre, check for chest movement. Place your ear over their mouth and listen for breath sounds. It may be possible to feel their breath on your cheek, but small children have a very small tidal flow, so this may not always be possible.

Airway Adjuncts

Once a good airway position has been achieved, check the mouth for obstruction by blood and vomit etc. Do not use a finger sweep for children as the soft palate can easily be damaged

SUCTION

Suctioning should also be gentle, for the same reason. Mechanical suction should not be used in babies and very small children, a mouth-operated catheter and reservoir being preferable. If a mouth-operated device is not available and mechanical suction has to be used, a yankauer catheter with a side-vent for adjusting the pressure, or a soft catheter with a Y piece should be used.



PHARYNGEAL AIRWAYS

Once the airway has been opened and cleared, if the Paramedic stays in position and physically maintains the airway, they are then trapped in this position. Removal of manual positioning will result in the airway once again becoming blocked. Intubation is the “Gold Standard” for hands-free airway control, but as previously mentioned, it is fraught with danger and should be avoided wherever possible.

A simpler and less traumatic method of controlling the airway is the use of oropharyngeal and nasopharyngeal airways.

As the tongue of a child is significantly larger in proportion than an adults, it is particularly important to maintain the space between the tongue and the trachea to allow the free flow of air. However, as the child’s mouth is so delicate, a nasopharyngeal tube is safer, as it avoids the fragile soft palate. In addition, babies are nose-breathers, so this would be the more natural route for airflow.

Disadvantages of nasopharyngeal tubes are the lack of availability of sizes less than 6.0 and the contraindication in base of skull fracture. Should the correct size not be available, a cut-down endotracheal tube can be used. If you suspect a base of skull fracture, the oropharyngeal tube should be used.

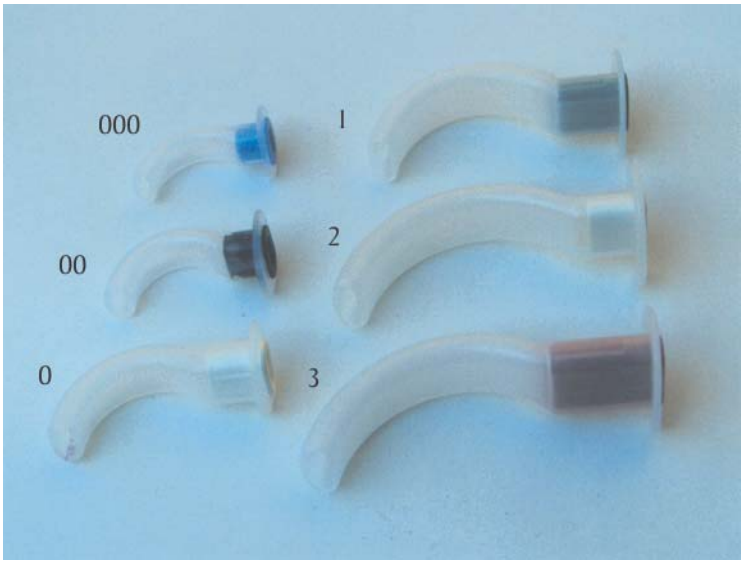
The methods of insertion of the tubes are basically the same as for adults (except for a small change in babies and very small children).

Oropharyngeal Airways

Assess the size of tube required by placing a tube against the child's face, a correct size tube reaching from the centre of the front teeth to the angle of the jaw.

Open the airway with either head tilt / chin lift or jaw thrust as appropriate and slide the tube into the mouth.

Babies and small children should have the tube inserted with the concave side sliding across the top of the tongue. Older children should have the tube inserted with the concave side towards the palate, with a final twisting action to bring it 180° into the final position.



Nasopharyngeal Airways

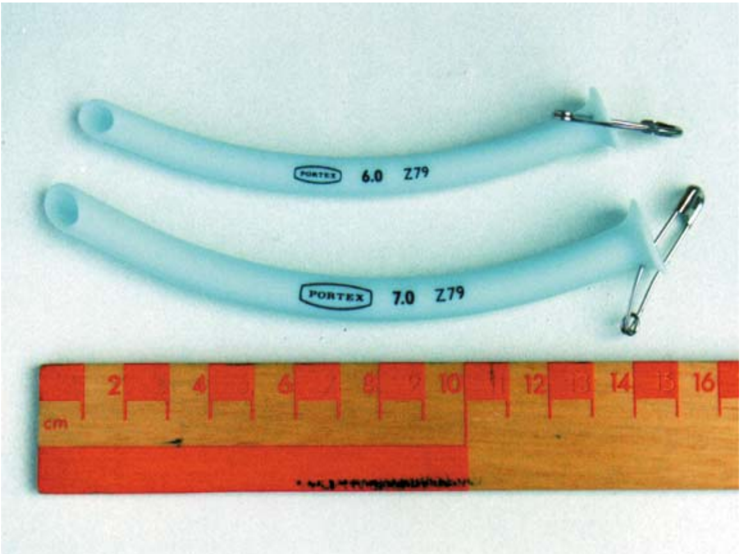
The use of a nasopharyngeal tube is contraindicated in suspected base of skull fracture and also in babies and very small children.

Assess the size of tube required by placing the tube against the child's face, a correct size tube reaching from the tip of the nose to the tragus of the ear, which is the small piece of cartilage immediately in front of the ear canal. The correct diameter can be judged when the tube is inserted into the nose and the tube just fits without the external parts being compressed.

If the tube is a tight fit, or appears to be too long, revert to an oropharyngeal airway or a cut-down ET tube. Do not cut the naso-pharyngeal tube to length as this may leave sharp or ragged edges.

The nasal passage should be lubricated with KY jelly and the tube inserted at right angles to the face (following the line of the passage). Passing the internal structures in the nose is made easier by turning the tube gently back and forth as it is inserted.

The tube should be inserted until the flange reaches the edge of the nasal passage externally. A safety pin is supplied with the airway and this should be passed through the outer flange to prevent the airway entering too far into the nose.



ADVANCED AIRWAY CONTROL

Endotracheal Intubation is the "Gold Standard" of non-surgical advanced airway control for use on scene by Paramedics. Cricothyroidotomy is discussed later.

Intubation should only be used in babies and small children when all other basic methods fail, as the procedure is fraught with danger for the child. The least trauma that can be caused in order to gain airway control the better.

4

Respiratory Emergencies

Recognition of Respiratory Distress

The death of a child from airway obstruction is preventable in most cases, yet it is still the cause of death in the majority of fatal incidents. These deaths are nearly all caused by a failure to recognise a problem with the airway, failure to appreciate the seriousness of the situation or a complete failure to manage the airway adequately.

Resuscitation of the child from any serious illness or injury depends on control of the airway. The child must receive proper oxygenation and ventilation to survive. The different airway anatomy, age-related differences in physiology, and the increased susceptibility of children to respiratory infection all lead to an increased risk of respiratory distress and failure in children. Early recognition of the need for respiratory support may prevent the child from descending the spiral of respiratory depression, respiratory failure and respiratory arrest that leads to cardiac arrest.

ANATOMY & PHYSIOLOGY

Airway anatomy in the infant and young child differs from that of older children and adults. In infants and toddlers, the tongue is relatively large in proportion to the oral cavity. The young child with decreased consciousness is at high risk of airway obstruction as muscle tone is lost and the tongue falls back against the posterior pharynx.

Infants under 2 months of age will not readily breathe through their mouth if the nasal passages are occluded. This means that nasal obstruction with mucus or blood can lead to marked respiratory distress.

The trachea is shorter and narrower than that of adults. The small diameter leads to a marked resistance to airflow in case of oedema or a foreign body. A reduction of the diameter by ½ will give a 16-fold increase in resistance. This in turn leads to increased work of breathing and respiratory fatigue.

The shortness of the trachea may lead to complications during intubation. The trachea in the newborn is only 5cm in length and that of an 18 month old toddler only 7cm. With so little margin of error, right main bronchial intubation and accidental extubation are common problems in infant airway management.

The larynx in children is relatively anterior and high, making the vocal cords more difficult to visualise. The smallest diameter of the adult airway is at the vocal cords whilst the smallest diameter of the paediatric airway is below the vocal cords at the level of the cricoid ring. Swelling of the narrow sub-glottic trachea, as in croup, leads to significant upper airway obstruction.

This anatomical narrowing also dictates endotracheal tube size. It is the reason why only uncuffed tubes are chosen for children less than 8 years of age. The narrow sub-glottic region provides a functional seal, preventing air leak around the tube without the use of a cuff.

In normal babies, use of the diaphragm is prominent, resulting in the appearance of see-saw or belly breathing. In the presence of airway obstruction or lung disease, the work of breathing increases. This leads to exaggeration of this abdominal breathing pattern. Increased work of breathing also results in the appearance of retraction. Prominent sub-costal, intercostal and suprasternal retractions are seen as accessory muscles are used to maintain tidal volume.

The Physiology of Respiratory Distress

As the respiratory muscles fatigue, infants and children may demonstrate increasing respiratory effort, a sign of respiratory failure. Respiratory failure is a clinical state, characterised by inadequate oxygenation of the blood and inadequate elimination of carbon dioxide. It may be seen as the end stage of any airway or lung disorder. Respiratory failure may also be a consequence of inadequate central respiratory drive.

The child in respiratory failure may show any or all of the following signs of inadequate tis sue and organ oxygen delivery.

- Decreased level of consciousness
- Tachycardia or bradycardia
- Weak proximal pulses
- Poor skin perfusion

Assessment

Assessing a child that is experiencing respiratory distress is in itself distressing for the Paramedic. The urge to "do something" is very strong. However, a calm and ordered approach to assessment will quickly determine the cause of the problem and therefore lead to a solution.

Arrival

On arrival at the scene, immediately start to calm the child if possible. A frightened child may be breathing rapidly or irregularly, just because they are crying or screaming. The throat may have become sore from shouting and the child will be short of breath. It is virtually impossible to listen to the chest of a crying child.

Before you start to touch the child, observe them as you talk to them. From this observation you will be able to determine the respiratory rate.

Respiratory Rate

A rate of over 60 breaths per minute is abnormal in a child of any age. The use of accessory muscles can be seen and you will be able to hear any significant stridor or wheeze.

Rapid respirations can be a sign of respiratory distress, but abnormally slow respirations are a clear signal of respiratory fatigue and impending respiratory arrest. The work of breathing will increase as the child becomes more distressed or fatigued and this will be reflected in intercostal retractions and the clear use of accessory muscles.

Retractions, Nasal Flaring and Grunting

As the child fatigues, retractions may diminish, This is an ominous sign. It signals an inability to continue this extraordinary breathing effort. Respiratory failure must be suspected in a child with a history of severe distress who is no longer tachypnoeic or retracting.

Nasal flaring and grunting may be present. Nasal flaring is an attempt to gain a little more airway diameter and grunting is an attempt by the child to produce positive end-expiratory pressure (PEEP), which will keep collapsing airways open a little longer. If the child is agitated beyond what would be expected, or is aggressive or lethargic, hypoxaemia should be suspected and actively sought.

Cyanosis

If any signs of hypoxia are present, as noted above, administer high flow oxygen, through a non-rebreathing mask. Cyanosis is a late sign of severe hypoxia in children. Do not rely on a pulse oximeter to tell you that a child requires oxygen therapy. The child will clearly display their need before you even touch them.

Position

Children that are experiencing airway obstruction of any kind will often sit up and lean forward, as it improves the chest movement and air entry for a given effort of inspiration due to more efficient use of the accessory muscles of respiration. If they were in that position for a time but are now too tired to keep upright, they are on the verge of respiratory failure due to fatigue.

Heart Rate

Tachycardia is often found in children that are distressed for any reason. However, if bronchioles become completely closed, as in severe asthma or extensive smoke inhalation, the child will rapidly become very hypoxic and is close to respiratory arrest.

Auscultation

Finally, auscultation of the lung fields should be undertaken. Listen over both sides of the mid-axillary line and the trachea. This will allow you to confirm equality of breath sounds and distinguish between upper and lower airway noises. Snoring is due to very proximal upper airway obstruction and is commonly heard in patients with decreased level of consciousness as the tongue falls back against the posterior pharynx. Manual manoeuvres to open the airway such as chin lift or jaw thrust will generally relieve this obstruction.

The chest sounds will provide a wealth of information about the condition of the child. Listen with the stethoscope over the third or fourth rib in the mid-clavicular line on both sides, then move to the left and right axilla. Listen to the bottom of the lungs at the front and then at the back. Finally, listen to the top of the lungs at the back.

Breath Sounds

Unequal breath sounds can be caused by pneumothorax and haemothorax, and also damage to the ribs on one side, particularly flail chest. Pneumonia of one lobe of a lung will reduce breath sounds in one area, rather than one side.

Stridor

Stridor, a high-pitched noise heard on inspiration, is a sign of upper airway obstruction. As the obstruction worsens, inspiratory and expiratory stridor may be heard, often without a stethoscope. Stridor is typically heard in patients with croup, epiglottitis or a tracheal foreign body. Burns to the upper airway and smoke inhalation are a common cause of stridor.

Wheezing

Wheezing is heard with the obstruction of the lower airway. These high-pitched musical sounds are heard most commonly on expiration and are caused by bronchoconstriction in a child with asthma, bronchiolitis or a bronchial foreign body. Smoke inhalation causes bronchoconstriction, oedema and fluid in the lower airways, so the wheezing may be accompanied by crackles or rales. Wheezing is only produced when air passes through the constricted bronchioles. If the bronchioles become completely closed, as in severe asthma or extensive smoke inhalation, the child will rapidly become very hypoxic and is close to respiratory arrest.

Crackles & Rales

Crackles, or rales, are fine inspiratory noises heard with lung disease, such as cystic fibrosis or if there is fluid in the lungs.

History

A brief history will also help to define the cause of respiratory distress and assist in emergency treatment decisions. The history should include questions on

- The presence and duration of fever
- The acute onset of choking or coughing
- Difficulty swallowing or drooling
- Any change in voice quality
- A past history of wheezing or respiratory problems
- Current medications

Management of Respiratory Distress

Cardiopulmonary arrest is the final common pathway of inadequate tissue oxygen delivery from any cause . When a child is resuscitated from an isolated respiratory arrest a good outcome can be expected, but when hypoxaemia leads to full cardiopulmonary arrest, the prognosis is grim. Early intervention to correct inadequate oxygenation and ventilation is the key to a good outcome.

100% Oxygen

High flow supplemental oxygen should be administered to every child in respiratory distress. In the emergency situation there is no contraindication to delivery of 100% oxygen to any paediatric patient.

Avoid Agitation

Care should be taken to avoid unnecessary agitation. Agitation may precipitate worsening respiratory distress. Infants and young children may be upset by attempts to place facemasks. In that case, allow the parent to administer blow-by oxygen by holding the mask or oxygen tubing near the child's face.

Allow the parent to remain with their child wherever possible and permit the child to remain in his position of comfort. Never force a child to lie down for an examination or transport as this may worsen his distress. Painful procedures such as IV placement should be undertaken only if clearly necessary in the emergency situation.

Assisted Ventilation

Respiratory failure should be suspected in the child with an altered level of consciousness. Agitation will give way to lethargy as hypoxaemia progresses or severe carbon dioxide retention develops.

Positive pressure ventilation should be initiated when a child in respiratory distress is noted to have a decreased level of consciousness or is poorly responsive. Assisted ventilation is also needed when central cyanosis or periods of apnoea unresponsive to supplemental oxygen are observed. Although mouth-to-mouth or mouth-to-mask rescue breathing may be life-saving, ventilation with a paediatric bag-valve-mask and 100% oxygen is preferred.

The child that does not respond to bag-valve-mask ventilation with improved responsiveness, colour or pulse is not being adequately oxygenated or ventilated. Reposition the head. Check the mask seal and oxygen flow. Endotracheal intubation should be considered if a clinical response is not rapidly seen.

Children at the end of their respiratory reserve may stop breathing entirely so suddenly that you are taken by surprise, so always have the bag and mask ready to ventilate at a moments notice.

Aims of Treatment

If the child is to be transported, a stable airway and adequate oxygenation must be ensured before transport.

Attention to clinical signs and symptoms, and frequent reassessment of the child's work of breathing, mental status and perfusion will allow early recognition of respiratory compromise. No matter what the underlying diagnosis, early intervention, oxygenation and ventilation are the key to stopping the progression from respiratory distress to respiratory failure and arrest.

CROUP

The characteristic seal-bark of a child with croup signifies an acute inflammation of the upper trachea and larynx. The upper trachea is particularly rich in soft tissue and is prone to inflammation and swelling. The vocal cords also become inflamed and swollen, causing them to enlarge, lowering the note sounded when air passes over them.

Croup is usually a night-time phenomenon and is predominantly found in children aged between 6 months and 5 years. It is usually caused by a respiratory viral infection, but can be due to bacterial infection. However, the pre-hospital treatment is the same in both cases.

Croup causes an inspiratory stridor as the air is forced past the swollen tissue of the trachea and larynx and a seal-bark cough as the vocal cords vibrate. The difficulty in inspiration causes respiratory distress related to the level of inflammation. The degree of distress can be assessed by noting intercostal and sternal recession, tachycardia, tachypnoea and agitation. This respiratory distress leads to hypoxia and can lead to a lowered level of consciousness and respiratory failure.

When examining the child, do not put anything into their mouth or directly examine the upper airway, as this could precipitate laryngospasm. Also, the condition is easily confused with epiglottitis and complete airway obstruction could ensue. In case of any doubt, treat as for epiglottitis.

The primary aim of treatment of croup is to protect the airway. It may become necessary, in extreme cases, to intubate or even carry out a needle cricothyroidotomy. However, with careful handling and, in severe cases, prompt drug therapy, this is not usually necessary and should be avoided if at all possible as an experienced anaesthetist will usually be the only person capable of intubating the child.

In severe cases where the airway appears to be in danger of closure and the child is severely hypoxic, 3ml normal saline mist should be given via a nebuliser mask, driven by high flow oxygen. Oxygen saturation ($Sa0_2$) should be monitored carefully and ventilation should be considered if respiratory failure is imminent. The ECG should be monitored. The child should be kept as calm as possible, in order to reduce oxygen requirement and to prevent further swelling. If the child will not tolerate a mask on their face, the parent should be encouraged to hold the mask as close as possible to the face in order to achieve as high a level of therapy as possible. The nebuliser must be upright to work correctly. However, if the child's level of consciousness becomes lowered, it may be necessary to protect the airway by jaw thrust and/or chin lift.

If the child is progressing towards respiratory failure, they should be transported to hospital at high speed. However, if the condition is mild or if they are settling and improving after a moderate or severe episode, a normal journey will do much to keep the child calm and further reduce the severity of the condition.

EPIGLOTTITIS

In children, the epiglottis is proportionately large and is prone to inflammation and swelling. Bacterial infection can precipitate severe swelling and consequent laryngeal obstruction, leading to respiratory distress, respiratory failure and cardiac arrest. Immunisation has reduced the incidence of epiglottitis, but it is still a possibility that must be considered where a child is displaying symptoms of upper respiratory tract infection.

Although epiglottitis can appear to be similar to croup, there are several features which may make it possible to distinguish the difference. Fever is usually much higher and the child becomes very ill over a short time span. They will normally be very still and unresponsive, leaning forward and drooling the saliva that they cannot swallow. The stridor is usually less marked and there is normally little or no cough as the infection is higher than the larynx and trachea. However, the inflammation can spread lower and cause a cough and more marked stridor.

Again, the mouth and upper airway must not be directly examined, diagnosis being made purely on the signs and symptoms. If the epiglottis is prodded or disturbed, complete airway obstruction can ensue within seconds. Treatment of epiglottitis is centred on maintaining the airway and oxygen saturation. High flow oxygen should be administered and the $Sa0_2$ carefully monitored. The child should be kept as calm as possible. They are normally happier on their parent's lap. Do not attempt cannulation, airway manoeuvres, or even making the child lay flat as these are likely to precipitate respiratory arrest which will be virtually impossible to resolve without the skills of an very experienced anaesthetist.

The child should be transported as soon as possible, as epiglottitis can rapidly develop and cause total airway obstruction. In this case, bag and mask ventilation should be attempted to maintain oxygenation, but if this is impossible, intubation or needle cricothyroidotomy may be necessary, but will be extremely difficult to achieve due to the swelling of the epiglottis. Note that a smaller ET tube will be required.

Bronchiolitis

Bronchiolitis is normally only found in children under the age of 1 year. It is not usually an emergency call, as development is gradual and the child has normally been taken to their GP first, suffering from feeding difficulty. It can be confused with asthma, but children of this age are not normally prone to asthma. If the child has a slight wheeze, fever and dyspnoea, bronchiolitis should be suspected. As the wheezing is from inflamed bronchioles and not smooth muscle contraction, Salbutamol has no effect.

The child will not normally have airway problems, unless the level of consciousness is lowered. However, a close check should be kept on the airway and the work of breathing. With oxygen saturation levels being a good guide to hypoxia. Sternal and intercostal recession will only be evident at a relatively late stage. Hypoxia should be prevented by high flow oxygen.

If the child is showing signs of dehydration, with hot, dry skin, dry mucosal surfaces, lowered consciousness, and delayed capillary refill, consideration should be given to a fluid challenge of 20ml/kg crystalloid. Blood glucose should be checked and if it is below 4.0 mmol, 5ml/kg of 10% Dextrose should be given intravenously or intraosseously.

Anaphylaxis

Anaphylaxis is the immediate response, involving smooth muscles and capillaries throughout the body of a sensitised individual, which follows intravenous (and occasionally intracutaneous) injection of antigen (allergen). It is an allergic response.

The first exposure of a person to a foreign substance causes the production of antibodies in order to control or destroy that substance. Subsequent exposure will produce large numbers of antibodies. The type of antibody involved in allergic reactions is the IgE antibody, which are located on mast cells. Mast cells are particularly concentrated in the smooth muscle of the respiratory system, the skin and the endothelium of capillaries. The mast cells react to the presence of the allergen by producing, among other substances, histamine. Histamine causes the capillaries to dilate, causing loss of blood from the systemic circulation and subsequent lowered blood pressure. As the capillaries become larger, the capillaries become more permeable and fluid is lost to the interstitial space, causing yet lower blood pressure and also tissue swelling.

Histamine in the smooth muscles of the bronchioles causes uncontrolled contraction and therefore bronchoconstriction and therefore difficulty in breathing and hypoxia. Histamine also causes an overproduction of mucus.

Signs & Symptoms

The general picture of severe anaphylaxis is therefore that the patient is:

- Wheezing with difficulty in breathing, bronchoconstriction and laryngeal swelling)
- Has swelling, of the face and neck, but also general, (excess interstitial fluid)
- Is pallid (from the fluid-filled swelling)
- Is shocked, collapsing & tachycardic (from low blood pressure)
- Has loose bowel motions or diarrhoea (from gut smooth muscle contraction)
- Is sweating (from the release of adrenaline to counteract the allergic response)

Management of Anaphylaxis

The immediate management of a patient suffering from severe anaphylaxis centres on the hypoxia and the shock.

The airway must be protected. In extreme cases, this may involve endotracheal intubation or even cricothyroidostomy as the laryngeal swelling reaches crisis levels. Oxygen must be given at a high concentration, ventilation should be considered if breathing is obviously impaired and the level of consciousness is lowered.

If there is any indication of an anaphylactic reaction, administer epinephrine IM immediately (age-related dose).

Transport rapidly and alert the receiving hospital.

Secure IV or IO access as appropriate, en-route. Do this early.

If wheezing is present, nebulise salbutamol with oxygen (age-related dose).

If symptoms persist, give chlorphenamine (age related dose).

If the journey is likely to be longer than 30 minutes, give hydrocortisone (age related dose).

If the child is hypotensive, give a fluid challenge of 20ml/kg of crystalloid.

Give further epinephrine IM every 5 minutes if required.

If the child is still hypotensive, give a second fluid challenge of 20ml/kg of crystalloid.

Do not give epinephrine IV.

If the patient has only a mild or moderate reaction, only some of the above treatments are appropriate, (usually just chlorphenamine) depending on the symptoms found. Wheezing is particularly common, and should be treated with Salbutamol as for asthma (which is an allergic reaction localised in the bronchioles). However, it should be noted that a mild or moderate reaction can very quickly become a severe reaction, so the patient should be taken to hospital and carefully monitored.

ASTHMA

Many children suffer from asthma and the figures appear to be rising relentlessly. However, most of these children have their asthma well controlled and do not concern the Paramedic. The children that are seen are those that are suffering an acute episode and they need rapid assessment and treatment to prevent the condition progressing to respiratory failure. The condition can be provoked when an allergen, (which can include pollen, cat hair particles, house dust mite scales and certain fumes), enters the lungs and produces an allergic reaction by the mast cells in the bronchioles. The condition can also be brought on by an infection of the respiratory tract, which produces the wheezing by the inflammation of the bronchioles. Any infection is usually accompanied by a fever and a history of illness over the past few days. Allergic asthma is normally of rapid onset.

In asthma caused by an allergen, histamine is produced by the mast cells, causing the smooth muscle to contract. The epithelium lining the airways can also become inflamed. This produces the characteristic wheeze, cough and dyspnoea as the child attempts to force air into the alveoli.

The air can become trapped in the alveoli because the inspiratory effort is more efficient than the expiratory effort. This can lead to the use of accessory muscles to expire as well as to inspire. Expiration can be assisted by the venturi effect of the pursed lips, a change of posture to leaning forwards and large movements of the chest wall, leading to intercostal and sternal recession.

As the smooth muscle contraction continues and intensifies, and the inflammation worsens, the wheezing can cease as the smaller airways close completely. Dyspnoea progresses to respiratory depression due to exhaustion and lowered level of consciousness. Respiratory depression can progress to respiratory failure if the condition continues unchecked. The pulse becomes increasingly rapid as the body responds to the hypoxia and cardiac insufficiency.

Blood pressure begins to fall as a result of impaired ventricular refill. The level of consciousness falls due to the hypoxia and exhaustion, causing a fall in the rate of respiration, causing a further fall in oxygen saturation and the child spirals into cardiac arrest.

The signs and symptoms of a mild episode of asthma include wheezing, coughing and dyspnoea. This is usually treated, without recourse to the ambulance service, with inhaled Salbutamol from a hand-held "puffer" and/or spacer and resolves quickly. Salbutamol given by paramedics is always by nebuliser.

Assessment

The primary assessment of asthma is by peak flow readings, if the child is capable of using the meter. If not, clinical signs must be used.

Asthma is usually obvious, but other diagnoses must be considered, such as croup, bronchiolitis, obstruction by foreign body, and epiglottitis. These all have their own characteristic clinical pictures and diagnosis of asthma should not present many difficulties.

Severe Asthma

The child is unable to speak in full sentences (depending on their age) Accessory muscles are being used (with or without recession) Wheezing is very pronounced and can be heard without a stethoscope The respiration rate is over 50 The pulse is tachycardic, (related to their age) Their peak flow is less than 50% of the expected level for a child of it's size

Life-Threatening Asthma

The level of consciousness is lowered or they are more agitated than normal during an episode They show signs of exhaustion They are making less respiratory effort than expected for a given level of hypoxia The oxygen saturation is less than 85% Cyanosis is present The chest has become silent Their peak flow is less than 33% of the expected level for a child of it's size

Asthma is usually obvious and once diagnosis is clear, treatment should begin immediately. Unchecked, mild asthma can progress very rapidly through severe asthma to life-threatening asthma and death.

Assessment of Asthma

Assess the airway and if there is no problem, assess the effectiveness and work of breathing. Listen to the chest. If possible, obtain a peak flow reading at this stage, but do not delay treatment unnecessarily in an effort to obtain a figure. The immediate treatment of asthma, after the protection of the airway, is to nebulise the child with Salbutamol driven by high flow oxygen.

Treatment

High-flow oxygen is required during and between nebulisations. Unless the child is under one year, nebulisation may be repeated every 15 minutes as required, unless the side effects (tachycardia etc) become significant, unless the child is under one year, when only a single dose is permitted.

Children under the age of five years should be nebulised with 2.5mg Salbutamol.

Children aged six to eleven years should be nebulised with 5mg Salbutamol.

Children over eleven years should be nebulised with 5mg of Salbutamol.

Acute severe or life-threatening asthma should be treated with ipratropium concurrently with the salbutamol.

If possible, take a peak flow reading 15 minutes after the nebulisation is finished.

If the journey to hospital is likely to take more than 30 minutes, give hydrocortisone IV at a dose of 4mg/kg.

The blood glucose level should be checked if the child shows signs of exhaustion. 5ml/kg of 10% dextrose may be required. At all times, monitor the airway, the respiration rate and effort, the oxygen saturation, the ECG and the level of consciousness.

Transport the child to hospital as quickly as possible, whilst maintaining a smooth ride, as agitation can increase the severity of the attack.

Life-threatening asthma may require treatment with sub-cutaneous epinephrine in a dose of 10mcg/kg, repeated after 5 minutes if the child continues to deteriorate, ***but this treatment must only be used in the most severe, life-threatening cases where other treatments have failed.*** Epinephrine must not be given intravenously.

5

Trauma

Trauma

The descriptions of injuries and their treatments shown below are separated from each other and from other sections of this book for convenience. However, it should be borne in mind that injury or illness to one body part or system can often give other problems elsewhere. The logical progression of the primary and secondary surveys will lead you to find or suspect these injuries and their connection with one another.

KINEMATICS

This section deals with the mechanics of trauma. A very basic understanding of the principles of the laws of motion is helpful in the proper assessment of a child that has been subject to trauma. The assessment includes what can be seen, felt and heard when the child is examined, but just as importantly includes a prediction of the type and extent of the injuries that may have been caused, many of which cannot be directly detected on scene. This is why the phrase "mechanism of injury" is used as a reason why particular treatments, such as applying a cervical collar or starting an IV line, are applied even though no obvious injuries have been found.

Transfer of Energy

When a moving object meets a stationary object, or two moving objects meet, there will be a transfer of energy. The amount of energy transferred is dependent on two factors, the mass (or weight) of the objects and their velocity (speed). The extent of the damage, or injury, caused is directly related to the energy involved.

The energy transferred can be calculated from an equation. The actual units used does not matter. What does matter is an understanding of the principles. The equation is:

Energy= mass x the velocity squared

$$E = M/2 \times V^2$$

As an example, consider a car travelling at 30mph that hits a stationary child pedestrian. Using the formula, the energy of the impact is as follows:

$E = M/2 \times V^2$

= Mass (say 1,500kg) / 2 x speed (say 30mph) squared

=(1,500 / 2) x 302

=750 x 900

=675,000 units of energy

If, however, the car is travelling at 40mph, the calculation has a rather different result.

$$\begin{aligned} E &= M/2 \times V^2 \\ &= (1{,}500 / 2) \times 402 \\ &= 750 \times 1600 \\ &= 1{,}200{,}000 \text{ units of energy} \end{aligned}$$

This shows that the most important part of the equation is the speed. The speed of the car only rose by a third, but the energy involved nearly doubled. The size of the car (or other moving object) is relatively unimportant.

This equation also applies when a child falls. The further they fall, the faster they are moving, due to the effects of gravity. The faster they are moving, the more likely it is that they will suffer injury. Once again, you do not need to know the exact acceleration applied when gravity pulls the child to the ground, what matters is the principle.

This calculation is the basis for the Government campaign to "kill your speed", which states that a 10mph increase in speed of impact will double the chances of killing a pedestrian.

Deceleration

It is known that gravity accelerates a falling body at a constant rate of 9.81 metres per second (about 22mph) for every second that they are falling. Therefore, if they fall for two seconds, their speed will have increased to 44mph. If they fall for three seconds, they will reach 66mph. This brings to mind the old saying "The highest fall the hardest".

However, it is not the fall that causes the injury, it is stopping that is the problem. The energy involved causes direct injury, which will be visible in the form of bruising, fractures, etc., but when the human body comes to rest, it takes time for the different parts to stop moving, and they stop moving at different times.

If a car slowly decelerates from 40mph to 0mph by the action of applying the brakes, the person in the car also decelerates from 40mph to 0mph. The change in velocity takes several seconds, so the rate of deceleration is small and the forces applied to the body are therefore small.

Consider a person in a car travelling at 40mph (20 metres per second) that slows down to 0mph over 10 seconds. The deceleration involved is:

20 metres per second / 10 seconds

= 0.2 metres per second per second. Remember that gravity is 9.81 metres per second per second

If the car were to hit a solid concrete block at 40mph, the deceleration would take place over about $^{1}/_{10}{}^{th}$ of a second. Therefore the deceleration would be:

20 metres per second/ 0.1 seconds

= 200 metres per second per second. Remember that gravity is 9.81 metres per second per second.

The rate of deceleration is directly related to the materials involved. If a solid object meets a solid object, the deceleration to 0mph is almost instant.

However, cars have crumple zones which absorb some of the energy of impact and slow the rate of deceleration, thereby reducing the force with which the person hits the dashboard.

Seat belts have a similar effect as they stretch and slow the rate of deceleration. Your deceleration is slower if you hit soft sand when you fall than if you hit concrete.

In the car that hits a concrete block, the chest wall and the heart are both brought to rest by the impact with the dashboard. However, the chest wall stops some time before the heart, as the heart has to travel forward and be stopped by the chest wall before it comes to rest.

The aorta is well-connected to the back of the chest wall, but the heart is relatively loose inside the chest cavity. Therefore, if the chest and aorta stop moving suddenly and the heart does not stop quite so suddenly, the connection between the two will be placed under strain. This can cause rupture of the aorta.

The same applies to all the internal organs, such as the lungs, the brain, the liver and the spleen. This difference in stopping is the basis of the prediction of internal injuries using the "mechanism of injury".

Acceleration

The principles described at the beginning of this section to injury from deceleration, are the same for acceleration.

Being the opposite of deceleration, acceleration can cause just as much injury. If a child's head is hit by a moving object, the energy transferred to the head will cause the head to move away in the opposite direction. This causes an acceleration of the head which can be calculated in the same way as the deceleration from stopping at the bottom of a fall or hitting a concrete block.

The skull will accelerate, but the brain will lag behind, as it is only relatively loosely connected to the skull. This will cause stretching and tearing of the connections. The head is connected to the body by the relatively weak cervical spine. This connection will be put under strain by the sudden movement of the head and may cause fractures of the spine and damage to the supporting structures, such as tendons, ligaments and muscles.

General Principles

The nature of the injuries to be predicted in a child subject to trauma will depend on the direction and energy of the forces applied. Whilst you assess the child, you must examine the history of an incident as well as the signs and symptoms. The history can be a valuable guide to predicting injuries that you cannot see.

There is no need for complex calculations on scene of actual energy and forces. This would involve weighing the patient, the other object or objects involved and knowing their exact speed at the time of impact. However, a knowledge of the differences that weight, speed and acceleration make are helpful in making meaningful predictions of injury.

Blood Loss

Children have about 80ml of blood per kilogram of body weight. A 5 year old child, of average 18kg weight will therefore be expected to have about 1440ml or 1.4 litres of blood. (About 2½ pints). Therefore a loss of only 500ml from a fractured femur will amount to one third of the child's total blood volume.

Children are capable of a greater degree of vasoconstriction than adults, so they can compensate for blood loss for longer periods. The heart is capable of great feats of tachycardia and increases in stroke volume. However, when this compensation reaches it's limit, collapse of blood pressure can be sudden and catastrophic. In significant trauma, assume that they have suffered significant blood loss. An example of this is a fractured femur. If a 10 year old child loses 1/2 a litre of blood into the thigh tissue, that can be 20% of their total blood volume, but even at this level of loss, they may be compensating so well that they are showing no signs of shock at all.

Any child that has suffered significant trauma should be given a fluid challenge of 20ml/kg of crystalloid as soon as the primary survey allows, when they are showing early clinical signs of shock. This can be followed by a further bolus dose of 20ml/kg if you consider that the blood loss is large or the child is still shocked. Children are also prone to hypoglycaemia when shocked as they have small glycogen stores. Children subject to significant trauma should therefore have their blood glucose level checked. If it is below 4 mmol/l then 5ml/kg of 10% Dextrose should be given in addition to the crystalloid fluid challenge.

Oxygen

All children suffering trauma should be given high concentration oxygen, as near to 100% as is achievable.

PAIN RELIEF

Adequate analgesia is important in the treatment of any condition that causes pain. Not only will the child be happier and therefore more amenable to treatment, but clinical shock may be reduced. Pain can cause muscle contractions in fractures and may actually increase the severity of the fracture due to additional overlap in unaligned fractures. Injury of any kind can be very painful and the distress of the child will be reflected in their respiratory response, which may further compromise respiratory distress. As far as patients are concerned, if they are in pain, the Paramedic will be seen to be doing a good job if they can provide relief from that pain.

Entonox, morphine and Nubain are the mainstays of analgesia for the Paramedic.

Entonox®

Entonox has an additional benefit in that it is composed of 50% oxygen, so the child will receive oxygen therapy at the same time as analgesia.

Children who are capable of understanding how to take the gas can be offered Entonox in the same way as for adults and with the same contraindications:

- Severe chest injuries
- Severe head injuries (excluding minor head wounds)
- Impaired consciousness
- The Bends
- Psychiatric disturbance
- Alcohol or drugs impairing consciousness

Care should be taken to ensure that the child is acquainted with the likely effects that Entonox will have on their perception etc., as young children are easily frightened.

Nubain and morphine

Nubain should be administered in a dose of up to 150mcg/kg IV, given slowly over five minutes. The dose should be carefully titrated according to the response. If adequate analgesia is obtained after only 1 or 2mg, then stop at that level and only top up as necessary. The initial dose can be repeated after a further 5 minutes if required, to a total of 300mcg/kg.

Morphine should be diluted with water for injections or 0.9% sodium chloride to a concentration of 10mg in 10ml. It should be administered as a dose of 0.05mg/kg, (0.05ml/kg) given slowly over 2-3 minutes. Further doses may be given up to a maximum of 0.2mg/kg, titrated to response. It should be noted that morphine acts only after 5-10 minutes and reaches a peak in about 20 minutes. Naloxone must be immediately available, with the dose pre-checked to avoid delays, in case of respiratory or cardiovascular depression. Nubain and morphine may be used in children over the age of one year.

The contraindications for Nubain and morphine are the same as for adults:

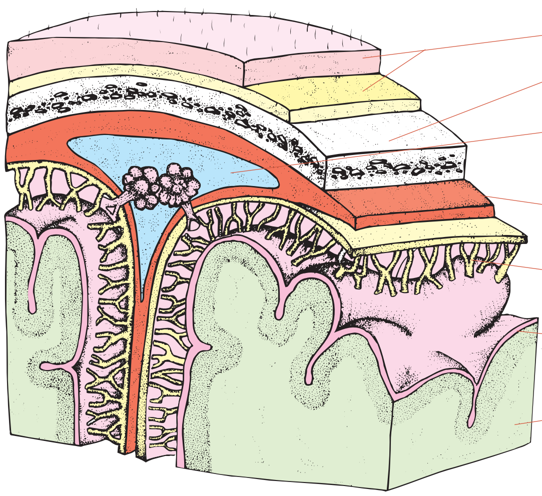
- Monoamine-oxidase inhibitors prescribed for depression, such as Parnate, Nardil & Marplan (rare in children)
- Pregnancy
- Head Injury (excluding minor head wounds)
- Impaired respiration
- Psychiatric patients
- In conjunction with other strong analgesics such as Dihydrocodeine & Co-Proxamol

Take care to maintain close observation on the level of consciousness, which may become reduced with Entonox, Nubain or morphine. Nubain and morphine can also cause respiratory depression, especially if given rapidly.

Nubain and morphine carry a significant risk of causing nausea and vomiting, especially if given rapidly and also if the child is bumped about during transport. Metoclopramide is contra-indicated under the age of 20.

HEAD INJURIES

Whatever the cause of the trauma, the results will be determined by the energy of the blow and the location of the impact. The more energetic the blow, the more injury will be caused. Also, with serious blows to the head, secondary damage can be caused, as described later. Trauma to the head can have several immediate effects and several later effects.



The assessment of any head injury should begin with holding the child's head still, as a cervical spine injury should be suspected with any head injury.

The most important observation in head injuries is the level of consciousness. In the primary survey this is limited to AVPU, a simple determination of the level of consciousness. In the secondary survey, the more sophisticated Glasgow Coma Scale is used, as previously described.

Blunt Trauma

Any blow to the head that does not cause penetration into the cranial cavity is considered to be blunt trauma. The clinical severity of the injury is determined by the effects on the brain. If there are no effects on the brain other than a mild concussion, with no loss of consciousness, it is considered to be a minor head wound.

The child should still be monitored carefully, as signs and symptoms of brain injury may develop later. A blow to the head sufficient to cause a skull fracture will usually cause unconsciousness.

The fracture itself may cause bleeding in one of the meningeal arteries, leading to an extra-dural haematoma within minutes or hours. Trauma causing tearing at the margins of the brain, close to the skull will usually cause venous bleeding in a sub-dural haematoma, leading to a slow rise in intracranial pressure The exact location of the haematoma is not important to the Paramedic, the signs and symptoms that it produces are the factors that determine management.

Penetrating Trauma

A blow to the head that causes penetration of the skull will invariably lead to damage to the brain, and is always a serious injury. Not only will the brain tissue be damaged, but there will be bleeding into the cranial cavity, causing a haematoma and there may be skull and scalp fragments driven into the brain. This will be further complicated by infection.

Whatever the cause, there may be stretching and rupturing of the brain tissue, connective tissue and blood vessels as the brain accelerates in the cranium and crushing and pressure on the brain as it collides with the inside of the skull. The brain may tear as it is pushed across the projections of the inner face of the skull.

The ruptured blood vessels will bleed into the cranium, causing brain irritation and compression from the haematoma. The compressed brain will be bruised, leading to further swelling and pressure.

The Lucid Interval

Following unconsciousness from a head injury, a child may appear to recover, to the point of being able to speak and get up. However, if this is followed by a subsequent lowering of the level of consciousness, the period of apparent recovery is termed the Lucid Interval.

If the injury was not severe enough to cause damage to the brain tissue, the level of consciousness can rise from it's initial low level to apparent recovery, albeit probably with signs and symptoms of concussion. They may be pallid, their skin cold and clammy, their pulse thready and rapid, their respirations shallow and rapid and they may have headache, nausea and vomiting, with amnesia.

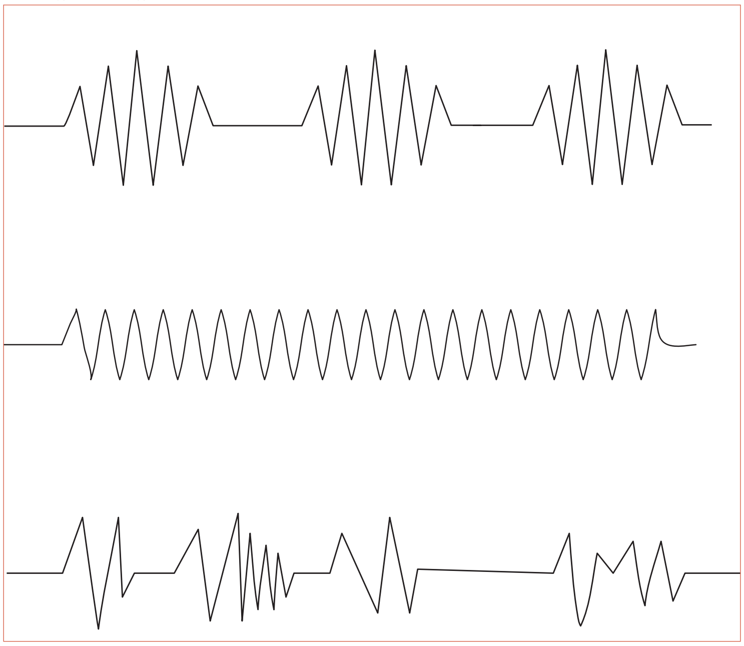
However, the injury may have caused the brain to be moved within the skull. The brain is enclosed by the meninges. The pia mater and the arachnoid mater are closely connected to the brain, but the dura mater is closely connected with the skull. Movement of the brain will place strain on the connection between the dura mater and the arachnoid mater, resulting in small tears in the blood vessels supplying the meninges and the brain. These small tears allow a small leakage of blood into the extra-dural, sub-dural or sub-arachnoid space. This small haemorrhage may gradually build up into a haematoma, a collection of blood in an enclosed space, and create pressure on the brain.

If there is increased intracranial pressure, the level of consciousness will gradually lower, the headache will become worse, and the child may begin to exhibit the signs and symptoms of brain injury. This apparent recovery should be carefully documented, with reference both to the times of recovery and relapse and the levels of consciousness found. The lucid interval is a clear sign of an intracranial bleed, which will require rapid treatment by surgery.

Raised Intracranial Pressure

Pressure in the intracranial cavity can rise because of a haematoma from a tear or laceration in a blood vessel or from direct swelling of the brain tissue in response to injury. As the pressure rises, it may exceed the pressure in the arteries supplying the brain with oxygen and glucose, cutting off vital supplies. The response to this will be a rise in systemic blood pressure in an effort to overcome the pressure difference.

The pattern of respirations may change as the body attempts to increase the oxygen saturation and reduce the carbon dioxide levels of the blood. At low levels of increased pressure, the pattern of respiration will alternate between slow, shallow breaths to deep, rapid breaths, with a period of apnoea in between. This is known as Cheyne-Stokes respirations. As the pressure rises further, and the brain stem is compromised, this may change to deep, rapid respirations, known as central neurogenic respirations. Eventually, the pressure is so great that the brain stem is unable to control the respirations and erratic breathing begins, interspersed with long periods of apnoea, followed eventually by complete apnoea.



The raising of systemic blood pressure will cause a reflex slowing of the heart due to signals from the carotid bodies in the aorta, but the heart will beat with increased force as the brain signals that it still requires high pressure to maintain blood flow. The rising blood pressure, alterations to the pattern of breathing and the decrease in pulse rate is known as Cushing's Triad, and is a clear sign of rising intracranial pressure. However, if it is noted, it should be realised that the patient is in a serious condition and the prognosis is grave.

Pupil Reaction

The raised pressure will also affect the cranial nerves. The constriction and dilation of the pupils is controlled by the third cranial (oculomotor) nerve, which arises in the mid-brain, and is the highest cranial nerve that will produce a measurable effect in an unconscious patient. (The first and second are the olfactory and optic nerves, which control the sense of smell and vision). Cranial nerves are paired, and pressure on one will produce an effect in the pupil on the same side. The dilation of both pupils indicates equal pressure on both sides of the mid-brain, possibly caused by a huge rise in the intracranial pressure as the brain stem is forced down through the foramen magnum. (known as "coning"). The normal state of the pupil is dilated, as the muscle relaxes. If the nerve is disabled due to pressure, the pupil will dilate.

Responses

The rise in pressure will make alterations to the response to painful stimuli. The response is related to the level of the brain that is affected. At first, when the brain is only slightly affected, responses may be normal. At relatively slight pressure, the child will attempt to localise the painful stimulus and make attempts to remove it. Later, as the pressure rises, it can only withdraw from them. Further rises in pressure will begin to deactivate the cortex of the brain, which controls higher functions. The response to painful stimuli is now flexion of the arms and extension of the legs. More pressure will now begin to deactivate the whole of the cerebrum, including the fibres that transmit impulses from one part of the brain to others. The response to painful stimuli will now be extension of the arms and extension of the legs, known as decerebrate posturing. Both decorticate and decerebrate posturing are extremely grave signs.

When the medulla, the most primitive part of the brain, becomes compromised, even the basic life functions of the brain are affected and the patient will not respond in any way to stimuli, be unable to maintain blood pressure and regular heart beats and will not regulate breathing. The patient will become apnoeic, the pulse rate will fluctuate wildly in rate and strength and they will be effectively dead.

Levels of Consciousness

AVPU

The AVPU scale is a very inaccurate and subjective scale and cannot be used to calculate a trauma score. The advantage it does have is that it can (and should) be used in the primary survey to make a very rapid assessment of the level of consciousness.

- A = Alert
- V = Responds to Voice
- P = Responds to Pain
- U = Unresponsive

Glasgow Coma Scale

The most important observation in head injuries is the level of consciousness of the child. This is conventionally measured using the Glasgow Coma Scale (GCS), a scale of the responses to stimulation. The scale has three components, eye opening in response to stimulation, verbal response to stimulation and motor response to stimulation. The GCS should be used where possible (see AVPU below) as it is an accurate method of assessment that can be passed on to another carer and can be reproduced and reassessed by that other carer. The three different components can also give information relating to the area of the brain affected and the seriousness of the child's condition.

Glasgow Coma Score

Eye Opening		
	Spontaneous	*4*
	To Speech	*3*
	To Pain	*2*
	None	*1*
		Total
Verbal Response		
Older Child		
	Orientated	*5*
	Confused	*4*
	Inappropriate Words	*3*
	Incomprehensible	*2*
	None	*1*
Younger Child		
	Social Smile	*5*
	Cries, but Consolable	*4*
	Persistently Irritable	*3*
	Restless & Agitated	*2*
	None	*1*
		Total
Motor Response		
	Obeys Commands	*6*
	Localises Pain	*5*
	Withdraws from Pain	*4*
	Flexion Response	*3*
	Extension Response	*2*
	None	*1*
		Total

Eye Opening

Spontaneous	= 4
To Speech	= 3
To Pain	= 2
None	= 1

Spontaneous implies that the eyes are open without prompting from the Paramedic. However, if the eyes are open, check that a score of 4 is accurate, as the eyes may be open, but the patient may not be aware of their surroundings. This can happen with petit mal fits and concussion.

To speech requires direct speech input from the Paramedic to make the eyes open. Ask them to open their eyes.

To pain requires some tactile stimulus, such as rubbing the sternum or pinching the ear lobes. A response from simply touching their shoulder would usually imply that speech would be enough, especially if the patient is deaf.
None means just that. No matter what you do to stimulate the patient, they make no effort to open their eyes. How they respond with body movements or speech is not part of the eye opening response.

Verbal Response

Older child

Orientated	= 5
Confused	= 4
Inappropriate words	= 3
Incomprehensible	= 2
None	= 1

Younger child

Social smile, looks around	= 5
Cries, but consolable	= 4
Persistently irritable	= 3
Restless & agitated	= 2
None	= 1

Orientated can be difficult to assess, especially with the younger child. If they are too young to respond with speech, check to see if they are interested in their surroundings, how they interact with their parent and how they interact with you. If they are crying inconsolably, this part of the GCS can become meaningless.

Confused may also be difficult to assess in young children. If they are crying, it can be very difficult to get any sense out of a toddler. A crying baby can not be assessed for speech.

Inappropriate words will only apply to a child that can speak normally, usually over the age of 18 -24 months.
Incomprehensible will only apply to a child that is known to be able to talk. Before the age of about 1 year, most babies do not have any vocabulary that a stranger can understand. However, the parent may be able to understand what the child means.

None means that no matter what stimulus is applied to the child, be it verbal or tactile, no attempt at speech or sound is made.

Motor Response

Obeys commands	= 6
Localises pain	= 5
Withdraws from pain	= 4
Flexion response	= 3
Extension response	= 2
None	= 1

Obeys commands will only apply to a child old enough to understand the command and obey it normally. A small child may be very reluctant to obey a command from a stranger, particularly if the child has just been injured or is ill. If there is no response to a command from you, ask the parent to ask the child.

Localises pain is usually straightforward, except in small babies.
Withdraws from pain will only apply to children able to make coordinated movements normally, such as over the age of about 3-6 months.

Flexion response is more straightforward as it relates to a primitive level of brain activity. This will apply to all children

Extension response is also straightforward.

None is very simple and applies to all children.

The Glasgow Coma Scale is useful, but only if you can expect the verbal responses to be meaningful. If not, revert to the AVPU Scale

Skull Fractures

Types

The two types of skull fracture that concern the Paramedic are fractures to the vault of the skull and the base of the skull. Most fractures of the vault occur to the thin parietal bone as the head is struck on the side or to the occipital bone as the child falls backwards or is struck from behind. The frontal bone is relatively strong and is not often fractured. Fractures of the base of the skull are commonly caused when the child falls in a vertical position and the top of the head is struck directly or when the spine transmits a blow to the base of the skull.

Signs and symptoms

Vault Fractures

The child will usually have a lowered level of consciousness, although quite small blows can fracture the parietal bone without loss of consciousness. There will be swelling and perhaps laceration to the scalp. There is a possibility of a depression being visible, although this is uncommon except in cases of very heavy blows to the head. All the signs of concussion or compression will be exhibited, depending on the level of injury to the brain.

Base of Skull Fractures

The child will almost certainly have a lowered level of consciousness, as base of skull fractures usually involve more bleeding into the brain. The leakage may also involve cerebro-spinal fluid, which will be seen as a clear straw-coloured fluid, possibly stained with blood. Large amounts of blood may disguise the CSF, but it will appear to be thinner in consistency than normal blood. The bleeding is likely to travel along simple pathways and leak into the tissue surrounding the eyes, giving rise to the classic black eyes. These can be differentiated from those caused by a blow to the face by the fact that the bruising will be strictly limited to the orbital margin. Blood and CSF may also leak along the ear canal and exit from the ear. Leakage around the ear canal will produce what appears to be bruising to the scalp around the back of the ear. This is known as Battle's Sign. Once again, all the signs of concussion or compression may be exhibited.

Treatment

The treatment stated here assumes that the head injury is the only injury present. The primary and secondary survey should be carried out as normal.

On arrival, if a head injury is suspected, the child's head and cervical spine must be immobilised. Get the history, if possible and then ensure the child has an adequate airway. Manoeuvres to maintain the airway must be kept to a minimum, with as little interference in the region as possible, as attempts at intubation may lead to a rise in intracranial pressure, the very condition you are trying to prevent. Head injuries require 100% oxygen, as this supplies the brain with additional oxygen and also reduces intracranial swelling and therefore pressure. The pulse rate and force of contractions will be kept to a minimum if the brain is supplied with sufficient oxygen. Severely injured children will usually be deeply unconscious. A particular problem with the administration of oxygen may be that the level of consciousness is raised, but only slightly. This can lead to combative behaviour, arising from brain irritation by intracranial bleeding. This must not deter you from giving oxygen. The child will have to be restrained sufficiently to prevent further injury, particularly to the cervical spine.

Check the blood pressure, and if it is low, start to look for other injuries, as head injuries do not cause hypotension. If other injuries are found to be causing the hypotension, give a fluid challenge of 20ml/kg of crystalloid. Repeat this challenge if necessary. However, take care to only maintain the blood pressure at normal levels. Keep a careful check on the blood pressure as the fluid is given and watch for signs of rising intracranial pressure. Be prepared to stop the infusion at any time. Over-infusion will lead to rises in intracranial pressure and is impossible to counter in the field.

Check the blood glucose level as soon as possible, as injury will often cause hypoglycaemia. The brain operates with oxygen and glucose and little else. If the blood glucose is below 3mmols, give 5ml/kg of 10% Dextrose intravenously. Take care to watch for signs of rising intracranial pressure and be prepared to stop the infusion at any time. The child should be immobilised for transport, mainly for the protection of the cervical spine, but also to prevent the child thrashing about if there is brain irritation. The child must be transported to hospital as rapidly and smoothly as possible as surgical and medical intervention will be required to reduce raised intracranial pressure.

Pain relief is not normally required in head injuries and Entonox, morphine and Nubain are all contraindicated.

Minor Head Wounds

A minor head wound is defined as minor trauma to the head that does not cause any change in the level of consciousness. The scalp is a thick layer of spongy tissue and is well-supplied with blood vessels. A small scalp laceration often produces a large amount of bleeding which, if unchecked, could lead to hypovolaemia. However, as the skull provides a good base to compress the scalp against, direct pressure with a dressing will often immediately control the haemorrhage. As the scalp is very elastic, small lacerations will usually need suturing or gluing due to the skin stretching over the skull. Always administer 100% oxygen.

The skull also provides a solid base for the formation of large swellings of the scalp in response to even quite small blows. Provided the level of consciousness is not altered, these are usually a minor problem. The swelling should be checked to see if it is “boggy”, which indicates a haematoma under the scalp, which will need hospital treatment.

In all cases of apparently minor head wounds, the level of consciousness is the main observation. An immediate change in the level, however brief, will signal possible brain injury and the child should be taken to hospital for full assessment and observation. A gradual lowering of the level of consciousness is a sure sign of a growing problem within the skull and the child should be taken to hospital immediately.

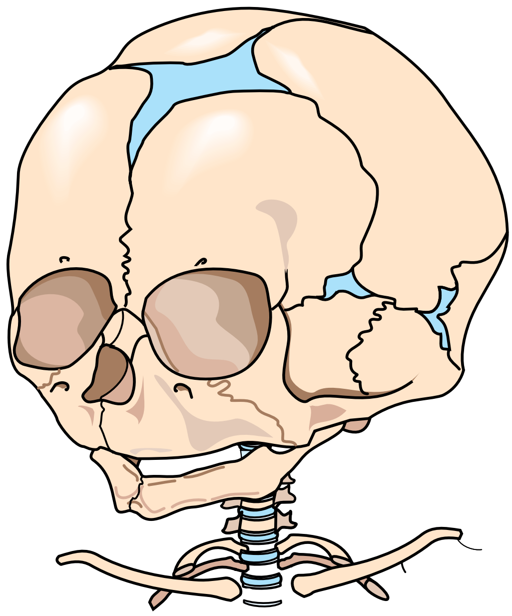
A more severe blow to the head may cause minor or significant brain injury and is considered to be a head injury. The damage to the brain may include cerebral concussion, cerebral contusion, cerebral laceration or a combination of all three. Further, a haematoma may develop which causes raised intracranial pressure and direct pressure on the brain, with it’s associated problems. Injury to the brain may also lead to problems with the airway, breathing and circulation.

Very large impacts can damage the brain so severely that life cannot continue. These injuries are usually obvious as they involve a history of a heavy blow and obvious external damage.

There can also be causes that have life-threatening implications but no signs of external damage. A serious road traffic accident where the child is strapped into a car seat can cause such rapid acceleration/deceleration to the head that the brain is literally torn loose within the skull, but there are no external head wounds.

The skull of a baby or small child is composed of plates, as in adults, but these plates take some time to fuse together. Serious impact can cause these plates to override one another, causing serious damage to the brain and connective tissue.

Two areas of the skull, the fontanelles, which are located at the junction of the parietal bones and the frontal bones at the front of the skull and between the parietal bones and the occipital bone at the rear, are gaps in the skull covered with membrane. The fontanelles can reflect the level of pressure within the skull, bulging and pulsating under high intracranial pressure, (and, incidentally, being sunken in dehydration).



Chest Injuries

Blunt trauma

A child's chest is different from an adult's chest. The ribs are more elastic and provide less resistance to impact, so that any blunt trauma is likely to be transmitted directly to the lungs and other soft structures. This can be without evidence of fracture to the ribs which would guide a Paramedic to looking for a lung injury. This elasticity can lessen the possibility of a flail segment of rib-cage, but it is still possible. The soft tissue is less robust than in an adult, so there is more likely to be soft tissue damage for a given force of impact. The lungs themselves are smaller and more easily compromised by swelling, fluid infiltration and small airway blockage.

Penetrating Trauma

Once again, as the chest wall is thinner and less robust than an adult's, any injury from a sharp object is more likely to cause penetration, with it's attendant dangers from pneumothorax and haemothorax. However, as the ribs are more elastic, blunt trauma is less likely to turn into penetrating trauma from the sharp end of a fractured rib.

Assessment & Treatment

Check visually for bruising, lacerations, deformity and the nature of movement. These can be key indicators that there may be a problem with the chest or that a problem is likely to develop. Bruising will indicate simply that there has been blunt trauma of some kind and that the chest, particularly in the area of the bruising needs to be fully assessed.

Flail Chest

In the unlikely event of a flail chest segment being found, the chest should be supported on the injured side with a blanket folded to an appropriate size and taped in position. The child is likely to be hypoxic and in respiratory distress and will require high flow oxygen through a non-rebreathing mask. Any shock present should be treated with a fluid challenge of 20ml/kg of crystalloid, followed by a second bolus dose of 20ml/kg if required.

Lacerations should be carefully checked for leakage of air from the chest, indicating an open pneumothorax. Check that the air entry is equal on both sides of the chest. A reduced air entry and/or hyperresonance (checked for by tapping the chest) will confirm the pneumothorax, but will not differentiate between a simple or tension pneumothorax.

Seal any open wounds immediately with a gloved hand. The wound should be dressed with an occlusive dressing which is open on one side to allow air to escape on expiration. Ensure that the length of the opening is as small as possible whilst still being effective. The child will be hypoxic and in respiratory distress which should be treated with high flow oxygen therapy from a non-rebreathing mask. Ventilation may possibly be required in rare cases, but a strict check should be kept for a tension pneumothorax. A simple, closed pneumothorax is unlikely in itself to cause significant hypoxia or respiratory distress. It will be discovered by the reduced air entry on the affected side. However, if the child is to be ventilated, the simple pneumothorax will become a tension pneumothorax and will need to be treated as described below.

Tension Pneumothorax

Keep a close check on the chest for tension pneumothorax. This will be shown by reduced sounds of air entry on the affected side, reduced chest movement on breathing, hyperresonance on the affected side and rising hypoxia and respiratory distress in the child. There may also be distended neck veins, but these are difficult to see in most children due to the thicker subcutaneous fat. Tracheal deviation away from the affected side is a very late sign and should not arise if treatment is timely and effective. However, if the pneumothorax has developed before your arrival, it may be seen. This is an immediately life-threatening condition and must be treated with thoracocentesis (chest decompression) immediately, as described in Chapter 8. Tension pneumothorax is one of the conditions that will stop the progress of the primary survey.

SHOCK

The trauma to the chest may cause shock, which should be treated with a fluid challenge of 20ml/kg of crystalloid, followed by a further bolus of 20ml/kg if the signs of shock are still present.

If the injury has caused bleeding inside the chest, a haemothorax may develop as the blood fills the chest cavity. This will cause lung collapse, with its attendant hypoxia and respiratory distress. The chest will be dull to percussion on the affected side, with reduced air entry and chest movement. The child will also display the clinical signs of shock. The child will require high-flow oxygen through a non-rebreathing mask and may also require ventilation. Once again, check for the development of a tension pneumothorax if the child is ventilated. Any shock will require treatment with 20ml/kg of crystalloid, with a second bolus dose if required.

Definitive treatment of haemothorax requires the insertion of a chest drain and will therefore require immediate transport to hospital, unless a doctor with the necessary equipment is already on scene.

HEART SOUNDS

The heart sounds should be checked with a stethoscope. Bleeding into the pericardial cavity can occur and reduced or muffled heart sounds indicate the presence of cardiac tamponade, which cannot be treated on scene except by a doctor with the correct equipment. This is an immediately life-threatening condition which will rapidly lead to cardiac arrest if unchecked.

The child will be hypoxic and hypotensive, with little or no palpable pulse, depending on the extent of the tamponade. A fluid challenge of 20ml/kg of crystalloid should be given with a second bolus dose of 20ml/kg if clinical signs of shock are still present. In the case of cardiac arrest, the protocol for Pulseless Electrical Activity will be the most likely treatment, but asystole will quickly intervene.

If the child is found to be hypoxic and in respiratory distress with or without clinical signs of shock, internal damage or contusion of the lungs, causing blood to enter the alveoli, should be suspected. There may be no external signs of damage. Careful auscultation of the chest may reveal bubbling or wheezing, often limited to one or two lobes of the lungs. There is no definitive treatment for this in the field, but the child should be given high-flow oxygen through a non-rebreathing mask. Ventilation may become necessary. Care should be taken to differentiate this condition from asthma, which may be pre-existing in the child. Asthma is more likely to be found throughout the chest and should be treated with Salbutamol as necessary.

Blunt trauma to the abdomen may be followed by hypoxia and respiratory distress. In this case, a ruptured diaphragm should be suspected. There is no treatment in the field, except high-flow oxygen through a non-rebreathing mask and a 20ml/kg fluid challenge if signs of clinical shock are found. A second dose of 20ml/kg may be given if required.

PAIN RELIEF

Pain relief in chest injuries can be a problem. Entonox is contraindicated, as it will exacerbate any seen or undiscovered pneumothorax. Nubain and morphine are contraindicated if there is a lowering of the level of consciousness or respiratory difficulties. A lowered level of consciousness will also lower the patients perception of pain, so analgesia may not be required. If the patient is conscious, breathing normally and in pain, morphine or Nubain are the drugs of choice.

SUMMARY

As can be seen, the most common findings in chest injury are hypoxia, respiratory distress and shock. All cases should be treated with high-flow oxygen, possibly with ventilation. Shock, if found, should be treated with a 20ml/kg fluid challenge of crystalloid followed by a second bolus dose of 20ml/kg if required.

There are five life-threatening conditions associated with chest injuries, which can be found on the primary survey. Those which can be treated by paramedics on scene are flail chest, tension pneumothorax and open pneumothorax. Massive haemothorax and cardiac tamponade cannot be treated on scene. All other conditions will normally be found on the secondary survey.

Abdominal Injuries

A heavy blow to the abdomen of a small child can be devastating. The muscles of the abdominal wall are much thinner and weaker than an adult and they also have less padding in the form of fat. The diaphragm is more exposed than in adults and the liver and spleen are therefore more liable to injury due to the lack of protection from the ribs. Even the upper lobes of the liver and spleen are susceptible because of the relative elasticity of the ribs.

Damage to the abdominal organs can cause devastating blood loss, particularly if the liver and spleen are injured. The liver is prone to being sliced into two during heavy deceleration/acceleration as it is looped by the round ligament, which acts like a cheese wire.

As the child will compensate for blood loss very well, any bleeding into the abdomen may remain undiscovered for some time, until circulatory collapse suddenly intervenes. The presence of external bruising in a child's abdomen is highly indicative of internal injury. Penetrating trauma can produce the same signs and symptoms with the added complication of external blood loss and infection.

ASSESSMENT

The abdomen is examined by palpation. Warm areas may be found in the area, but this is unlikely due to the efficient vasoconstriction in response to shock. The child may also be hypothermic, so any areas thought to be warmer than the rest may in fact be normal temperature and only different from the other areas because the other areas are cold. As in adults, the abdominal wall will become tender and rigid if there is blood in contact with the peritoneum. The child may be guarding the injured abdomen with flexed abdominal muscles and an inability to relax the muscles is usually significant. A rigid abdomen in an unconscious child is a sure sign of internal injury and bleeding and a signal for immediate transport to hospital. The child may be showing the clinical signs of shock, but this is usually a late sign and treatment should not wait until it is present.

Rigidity of the diaphragm will lead to respiratory insufficiency as the diaphragm is the main muscle of respiration in babies and small children. Therefore if there is otherwise unexplained difficulty in breathing, diaphragm injury should be suspected and sought.

TREATMENT

Any child that is the subject of significant blunt or penetrating trauma to the abdomen should be given high flow oxygen through a non-rebreathing mask.

A fluid challenge of 20ml/kg of crystalloid should be given as soon as the primary survey allows and a further 20ml/kg bolus should be given after ten minutes. Hypoglycaemia should be countered with 5ml/kg of 10% Dextrose. Should the abdominal contents protrude from the wound, do not attempt to replace them as torsion and subsequent ischaemia are likely to develop, costing the child a section of their bowel. The viscera must be kept moist as cell death will occur in a dry environment. A sterile pad soaked in sterile fluid, such as any crystalloid, should be used to cover the wound. The sterile pads should then be covered with an occlusive dressing to keep them moist. Do not apply pressure to the viscera, unless they are bleeding profusely, as their blood supply will be compromised.

The child should be transported to hospital immediately as internal bleeding cannot be stopped in the field.

Pain relief

Pain relief in the child with abdominal injuries can be a problem. Entonox is the drug of choice. Nubain and morphine may cause paralysis of the gut and exacerbate any abdominal problems and should not be used unless the pain is very severe and not controlled by Entonox. If Nubain or morphine are used, a careful check should be kept on the condition of the child and any sudden worsening of the condition or unexpected increase in pain may require the administration of Narcan to reverse the effects of the Nubain or morphine.

Injuries to the Extremities

Fractures Children's bones are not fully formed and calcified until they reach adolescence. Babies and small children's bones are very soft and pliable and are not generally subject to simple or complicated fracture. Instead they may bend or split in what is known as a "greenstick" fracture. This will take considerable force. The fractures are just as painful and damaging, but the external signs of a fracture are often missing as the bone is not grossly deformed. As they grow towards adolescence, this pliability is gradually lost and the bones fracture in the same way as an adult's, with the same consequences.

A fracture to a large bone can cause a loss of ½ litre of blood, (often virtually invisible in the chubby thigh of a small child), and this should be compensated by a crystalloid fluid challenge of 20ml/kg if clinical signs of shock are present, followed by a further bolus dose of 20ml/kg after ten minutes where clinical signs of shock are still present.

The child should receive high flow oxygen through a non-rebreathing mask.

The trauma and shock may have made them hypoglycaemic, which should be checked and corrected with 5ml/kg of 10% Dextrose. It should be noted that an attempt at intraosseous infusion should only take place in an uninjured limb. Any fluid infused through a fractured bone will simply leak out into the tissues. This will not only fail to compensate for fluid loss, but will also contribute to compartment syndrome from raised pressure in the limb, which could lead to loss of the limb.

Pain Relief

Most pain from fractures in children will be amenable to Entonox. If this is ineffective, Nubain or morphine may be used for severe pain. as noted earlier.

Injuries to the Spine

The cervical spine is particularly susceptible to injury where rapid movement of the body is involved. Any head injury, any injury above the clavicles, any injury resulting from rapid acceleration/deceleration, any heavy blows to the body and any injury from an unknown cause can be assumed to have caused a cervical spine injury until proven otherwise by x-ray examination in hospital. The remainder of the spine, whilst still susceptible to injury, is less commonly involved, but should be subject to the same precautions.

The child will not always display signs and symptoms of a spinal injury, so if the mechanism of injury is present, the child should have his head and neck immobilised in a stiff cervical collar and then be strapped to a trauma board for removal and transport.

Injury to the spine may cause hypotension. If significant hypotension is found, a fluid challenge of 20ml/kg of crystalloid should be given, with a further 20ml/kg after a further ten minutes. The spinal cord is dependent on glucose for function, so the blood glucose level should be checked and corrected with 5ml/kg of Dextrose if required. The spinal cord is also dependent on oxygen. High-flow oxygen should be given through a non-rebreathing mask.

Burns

Children are more liable to be burnt than adults because of their inquisitive nature. They will pull down saucepans from the stove, play with matches or grab for a cup of tea held by an adult. The child may also be placed or climb into in a bath that is too hot. Child abuse often involves burns from cigarettes and hot water.

Children suffer more serious injuries from burns than adults due to their large body surface area compared with the body mass. Fluid loss is more extensive and the effects of the loss of skin area are greater. The skin is thinner and therefore more liable to full thickness burns than an adult. The burn will place severe stress on all the body systems, often leading to multi-organ failure. Burns Assessment The extent of a burn is measured as a percentage of the total body surface area (BSA). Only areas of actual skin destruction should be included, not simple reddening of the skin. Skin destruction can easily be identified by the surface of the skin peeling away from the body, skin distortion or charring in the case of flame burns. The usual rule of nines estimation of area does not work correctly with small children because the relative areas of the head and legs are different to adults. The special provisions of the Lund & Browder chart should be used for patients up to the age of about 15. A very rough guide can be obtained from estimating the child's hand at 1% of BSA and calculating the total area, but this is usually inaccurate.

Any burn of more than 1% in a child under the age of two is considered to be serious. Any burn of more than 15% in any child is considered to be critical and life-threatening. The formula for estimating the risk of death from a burn in an adult is age + %BSA = %risk. However, smaller children do not fit with this formula and the risk is higher with younger children.

The depth of the burn is not usually relevant to treatment. Partial thickness burns are just as serious as full thickness burns. However, the deeper the burn is, the more likely it is that longer term problems will arise.

Flame burns

Flame burns can be caused in house fires, by the child's clothing catching fire or by playing with matches or candles. Whatever the cause, the major consideration special to flame burns are inhalation of smoke, flames and toxic gases.

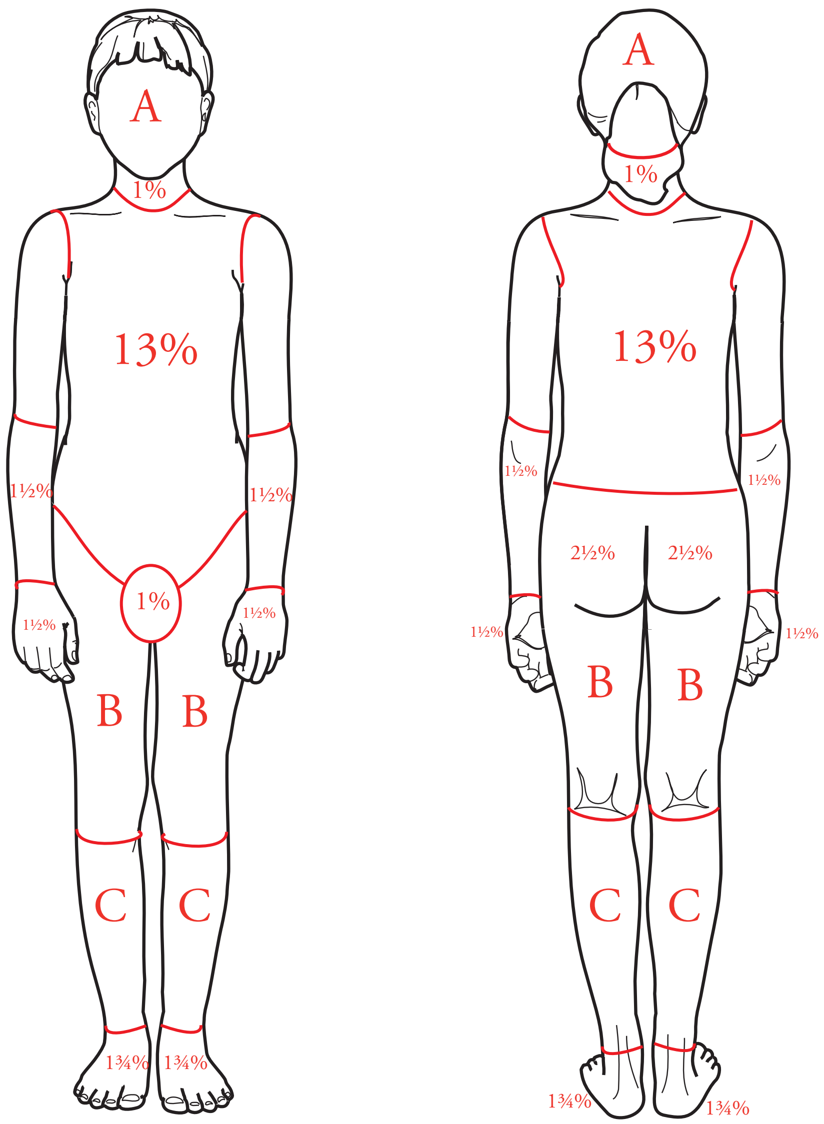
The inhalation of smoke and flames will cause damage to the upper airway, causing oedema and perhaps laryngospasm. The child will have stridor as air is forced past the swollen tissue and this will cause severe difficulty in breathing. If laryngospasm persists, they will have stopped breathing altogether.

If the smoke and toxic gases reach the lungs, immediate irritation and damage will normally occur, with a response of bronchospasm. This will cause wheezing and difficulty in breathing. However, this may not occur for some hours after inhalation, so a child that has been exposed to smoke should still be taken to hospital, even if they are showing no signs or symptoms of inhalation injury. The smoke and toxic gases will also cause oedema of the lung tissue in the bronchioles and alveoli, leading to severe respiratory distress sometimes leading to respiratory failure.

Children suffering from smoke inhalation or flame burns to the face or upper body must receive high-flow oxygen from a non-rebreathing mask and special attention should be paid to their respiratory function.

SCALDS

Scalds are caused by hot liquids and are just as serious as flame burns. The extent of the burn is likely to be greater than with flame burns as the liquid is splashed and spreads over the body. Immersion in hot water will produce extensive burns. The child should be completely undressed to check for other burns. If the burn is from hot cooking fat, the higher temperature will cause deeper burns but not necessarily larger areas of burns. It must be remembered that the main risk factor from burns is the percentage of body surface area involved.



RELATIVE PERCENTAGE OF BODY SURFACE AREA AFFECTED BY GROWTH

	0	1	5	10	15	Adult
A = ½ of Head	9½	8½	6½	5½	4½	3½
B = ½ of Thigh	2¾	3¼	4	4½	4½	4¾
C = ½ of One Leg	2½	2½	2¾	3	3¼	3½

Treatment

The first part of the primary survey, that any danger must be removed applies particularly to burns. If the child is on fire, the flames must obviously be extinguished. The burnt and perhaps smouldering clothing must be cooled with sterile saline and removed as soon as possible, except in the case of clothing that sticks to the burnt area. Pulling off clothing will destroy the upper surface of the burnt skin and contribute to further damage, further pain and further risk of infection.

If the child has been scalded, the clothing must be cooled with sterile saline and removed as soon as possible. The ABCDE of the primary survey must be carried out, paying particular attention to the airway and breathing in the case of flame burns. However, it should be noted that intubation may be particularly difficult due to swelling in the upper airway and needle tracheostomy may be required in extreme cases. Ventilation may also be difficult if there is significant bronchospasm or oedema in the lower airways.

All burnt children must receive high-flow oxygen through a non-rebreathing mask. If there is significant stridor, consider nebulising 3ml saline with oxygen. If wheezing is present, nebulise with Salbutamol with oxygen. Children from the age of two to four should receive 2.5mg. Children over the age of five should receive 5.0mg.

A fluid challenge of 20ml/kg of crystalloid should be given if severe shock is found, followed by a further bolus of 20ml/kg after a further ten minutes, if no improvement. The child with significant burns is likely to become hypoglycaemic, which should be checked and corrected if necessary with 5ml/kg of 10% Dextrose.

The burned area must be cooled for at least ten minutes with sterile saline and covered with cling film. Take care not to wrap the cling film too tightly around the limbs as swelling of the burnt area will occur and tight dressing will compromise circulation to the limb Tight dressings around the trunk will compromise breathing. When cooling the burn, take care not to cause hypothermia. Only the burnt area should be cooled and the rest of the body should be kept warm. Pain Relief Simple reddening of the skin and partial thickness burns are extremely painful. Full thickness burns are not usually painful due to destruction of the nerve endings in the skin, but the edges of the burn will almost certainly have partial thickness damage.

Pain Relief

Children who understand the instructions can be offered Entonox and morphine or Nubain should be administered in an age-related dose.given slowly over five minutes and repeated after a further ten minutes. Take care to maintain close observation on the level of consciousness, which may become reduced. Morphine or Nubain can also cause respiratory depression, especially if given rapidly and also carry a significant risk of causing nausea and vomiting.

Near-Drowning

Several things normally happen when a child unexpectedly falls into cold water. The mammalian diving response will come into play and the colder the water, the faster it will happen. The child will suddenly stop breathing and their pulse rate will rapidly fall. As they cough and choke on the water, their larynx, if touched by water, will close spasmodically. Their peripheral circulation will rapidly close down, shunting blood to the brain and vital organs. As they become more hypoxic, the level of consciousness will begin to fall and they will no longer try to breathe or stay afloat.

All these things will serve to protect the child from breathing water into the lungs. The cold water will also protect the brain and other organs from the effects of hypoxia. The colder the water, the more protection given. If the child is pulled from the water immediately, it may be that they are not seriously affected.

Drowning

When a child continues to be submerged for a significant period, (depending on the temperature of the water), they will die and post-mortem examination will show that they have drowned, the cause of death being asphyxiation. Nothing the Paramedic can do will make any difference. The perceived prognosis should not stop attempts at treatment. Aggressive resuscitation has been known to save many children who have apparently drowned. The child will be hypothermic, which gives protection against hypoxia, and the child is not considered to be dead until they are warm and dead. This warming will not be complete until the child is in hospital, where sophisticated warming techniques can be used. If you find a child that seems to have drowned, carry out full resuscitation until you reach hospital. Near-Drowning If they are rescued after a short time (once again depending on the temperature of the water), and any period of recovery follows, no matter how short, they are said to have suffered a near-drowning. The treatment is the same if they appear to have drowned or they have suffered a near-drowning. The only difference comes when the level of consciousness differs.

Get them out of the water as soon as possible, but bear in mind that they may have other injuries, particularly cervical spine injuries. If possible and practical, get them on to a trauma board before bringing them out of the water. Trauma boards float and provide an excellent platform for CPR.

If the monitor shows VF and you decide to shock, remember that the shock will be much less effective due to the hypothermia. The same level of shock should be given as normal. (2J/kg for the first shock and 4J/kg for subsequent shocks). Remember also that the child is wet and will need to be dried as much as possible to avoid danger.

Chest compressions should be applied as normal. Once resuscitation is under way, move the child to the ambulance and transport immediately to hospital.

En-route to hospital, intubation should be carried out if necessary. A fluid challenge of 20ml/kg of crystalloid should be given, but over-infusion should be avoided as the lungs may already be compromised by oedema and free fluid. Only give a second bolus of fluid if the blood pressure is low. Hypoglycaemia may be present and should be checked. If necessary, correct it with 5ml/kg of Dextrose. This additional fluid, although necessary, may further compromise the lungs and respiratory function of the child. If this fluid is given, PEEP must be employed to avoid widespread collapse of the alveoli.

The child must be warmed, actively if possible, but at least with warm blankets and a warm ambulance, to counter the hypothermia. As the child is warmed, asystole may well change to ventricular fibrillation.

It should be noted that if the child has been immersed in warm water, such as a bath, the larynx is less likely to have closed in spasm and there is therefore more likelihood of water in the lungs. There is also less likelihood of hypothermia giving protection from hypoxia.

6 Medical Emergencies

Meningitis

Meningitis is an inflammation of the meninges surrounding the brain and spinal cord and has many causes, including bacteria and viruses.

Viral meningitis is nearly always a relatively minor illness, limited to 4-10 days of headaches and general malaise. There is no cerebral oedema unless encephalitis develops, which is discussed elsewhere.

Acute bacterial meningitis is the most virulent form that the Paramedic is called upon to deal with, so for the purposes of this section, only this is dealt with in detail.

Bacterial Meningitis

Acute bacterial meningitis is an infectious inflammation of the meninges, also involving the cerebro-spinal fluid (CSF). It is a notifiable disease. Bacterial meningitis is quite rare, but it can be very serious and needs urgent treatment with antibiotics. There are about 2,000 reported cases of meningitis each year in the UK., equivalent to about 3 cases per 100,000 population.

The bacterium is extremely virulent, due to its enclosing polysaccharide capsule, which resists phagocytosis by white blood cells, and its lipopolysaccharide-endotoxin complex, making it chemically very toxic to the body, as described below.

If bacterial meningitis is diagnosed early and treated promptly, most people make a full recovery. However, in 15% of cases it proves to be fatal, often within hours of the onset of symptoms. It can also lead to permanent handicap such as deafness or brain damage.

Meningococcal meningitis

There are three strains of meningococcal meningitis - A, B & C. The group B strain is the most common bacterial form in the UK, but people travelling from Africa may develop Group A. Some forms of bacterial meningitis affect neonates. The most common are E Coli and group B streptococcus. These forms are rare and often referred to as neonatal meningitis.

Hib meningitis. Hib (Haemophilius influenzae type b) meningitis was the most common bacterial form in infants. It is now extremely rare and has almost been eliminated by the Hib vaccine which was introduced into the UK routine immunisation programme in 1992.

Vascular effects of meningitis.

The inflammation is similar to that in any other tissue. Bacteria and/or their toxins induce vascular congestion by the attraction of large quantities of phagocytic neutrophil white blood cells. This causes increased permeability of venules and capillaries by enlargement of the fenestrations in the vessel walls. The secretions of the first cells attract more cells. The bacteria also cause secondary tissue damage.

Small and medium-sized sub-arachnoid arteries show changes from the beginning. Endothelial cells swell, multiply and crowd into the lumen within 48-72 hours of onset. The adventitial connective tissue (the arachnoid itself) becomes infiltrated with white blood cells. Local arterial wall necrosis may occur. Neutrophil and lymphocyte infiltration of the artery walls eventually leads to fibrosis.

In the veins, swelling of the endothelial cells and infiltration of the adventitia occur. Diffuse infiltration of the entire wall may happen. Local necrosis of the walls and phlebitis may appear. Ischaemic lesions are known to occur in meningitis, most commonly in the setting of cortical thrombophlebitis. Extensive cortical necrosis may occur without vascular thrombosis of any kind.

Obstructive and Compressive Phenomena

Although the spinal and cranial nerves are surrounded by pus from the beginning of the infection, the neural sheaths become infiltrated by inflammatory cells only after several days. Rarely, the endoneurium may become infiltrated, and degenerating myelinated fibres with fatty macrophages and proliferating Schwann cells and fibroblasts can be found. More often, there is little or no damage to the nerve fibres.

Infiltration of the optic nerve and olfactory bulbs may occur, but more frequently, there is a proliferation of glial cells beneath the pia mater, like in the rest of the brain. Swelling of the optic disc may develop. Usually, the arachnoid membrane is a good barrier against spread to other spaces in the cranium. A sub-dural reaction may result in sub-dural effusions. This is more common among infants, with rates of up to 40% among infants less than 18 months old. These effusions and infiltrations can cause photophobia.

In a greater percentage, there are microscopic collections of fibrinoid exudates beneath the dura, particularly at the spinal levels. Abundant pus may cause blockage of fluid drainage channels, producing hydrocephalus. In the later stages of meningitis, fibrous sub-arachnoid adhesions interfere with CSF circulation or compress the spinal cord. The phenomena cause the neurological symptoms and signs commonly found in meningitis.

Within a few days, the sub-ependymal space and the perivascular spaces in the ependyma may be filled with neutrophils and, later, lymphocytes and plasma cells. The surface cells of the cellular membrane surrounding the central canal of the spinal cord and the ventricles of the brain (the ependyma) may start to peel away. Microglia and astrocytes proliferate and may bury the ependyma. Hydrocephalus may stretch (and break) the ependymal linings. Serious brain damage is by now being caused.

Clinical Features

The earliest signs and symptoms are sometimes mistaken for and dismissed as influenza.

The basic clinical features are:

In Babies & Children

- Fever, with cold hands and feet
- Refusing feeds or vomiting
- High-pitched moaning cry, or whimpering
- Dislike of being handled, fretful
- Neck retraction with arching of back and Brudzinski's sign*
- Convulsions
- Tachycardia
- Tachypnoea
- Periods of apnoea
- Blank and staring expression
- Child is difficult to wake and lethargic
- Photophobia
- Pale, blotchy complexion
- Blotchy or pinpoint rash
- Waterhouse-Friderichsen syndrome*
- Bulging fontanelles (a late & serious sign - often masked by dehydration)

In Children and Adults

- Intense malaise
- Vomiting
- High temperature / fever
- Violent or severe headache
- Neck stiffness and Brudzinski's sign*
- Photophobia
- Drowsiness or lethargy
- Joint pains
- Fitting
- Tachycardia
- Tachypnoea
- Pale, blotchy complexion
- Purpuric (blotchy) or petechial (pinpoint) rash
- Waterhouse-Friderichsen syndrome*

Many of these signs are often absent in the early stages of the disease. Any unwell child, especially those with unexplained fever, should be examined for rash and neck stiffness.

Brudzinski's sign

- Contralateral sign; on passive flexion of the leg on one side, a similar movement occurs in the opposite leg.
- Neck sign; if the neck is passively flexed, flexion of the legs occurs.

These signs may be absent in the very old, very young and in those who are deeply unconscious.

Waterhouse-Friderichsen syndrome

Vomiting, diarrhoea, extensive purpura and petechiae. (haemorrhage into the skin - the so-called glass test, where the marks do not disappear under pressure from a drinking glass), cyanosis, tonic-clonic convulsions, and circulatory collapse. The rash affects mainly the lower body and accompanies 50% of meningococcal meningitis cases.

Note: Staph. Aureus and some viruses may also cause a rash. Lowered level of consciousness and fitting may be due to other causes, such as encephalitis, a cerebral abscess or intracranial haemorrhage.

In any case of unexplained fever accompanied by headaches, meningitis should be suspected.

MANAGEMENT

Bacterial meningitis is a dire medical emergency and transport to hospital must not be delayed. Meningitis can kill within hours of the onset of symptoms.

- Manage the airway and give 100% oxygen
- In septicaemic shock, give 20ml/kg IV colloid
- Give Benzyl Penicillin IV
  - Infants <1 year 300mg
  - Children 1-9 years 600mg
  - Children >9 years 1200mg

Penicillin is only contra-indicated in the case of previous anaphylactic reaction. Previous allergic reaction without anaphylaxis is not a contra-indication, as it is more important to give the penicillin.

Protection of the airway and high flow oxygen is mandatory in all cases. Ventilate if hypoxia is present or if the effort of breathing is greater or less than normal. Intubate only if necessary, as the action may cause a rise in intracranial pressure. Rectal Diazepam can be administered in an effort to control any fitting.

If intravenous or intraosseous access can be gained, a bolus of 20ml/kg of colloid solution should be given immediately, repeated if there is no improvement in blood pressure and/or hydration.

The blood glucose level should be checked and 5ml/kg of 10% Glucose solution should be administered if hypoglycaemia is found.

The following should be closely monitored:

- Airway
- Respiratory rate
- Pule rate and volume
- Blood pressure
- Capillary refill
- Oxygen saturation
- ECG
- Fever (particularly differences between core and periphery.
- Level of consciousness

Alert the receiving hospital.

Prophylaxis for Contacts

Meningococcal meningitis contacts are those in close proximity to the patient. Coughs and sneezes are the most common cause of cross-infection. Droplets are necessary for contagion, not aerosols, so merely breathing in the same air as the patient rarely causes infection. Risk is increased if in contact with the patient for at least 4 hours in the week preceding the onset of illness. Included are household members, day care centre contacts, etc. As the bacteria reside in the nasopharynx, also included are those in contact with the patient's nasopharyngeal secretions (health-care professionals doing mouth-to-mouth resuscitation, ventilation and secretion suctioning).

Diabetes

Diabetes is primarily a disease of the endocrine system and occurs either because of a lack of insulin or because factors in the blood prevent insulin from doing it's job of facilitating the transport of glucose from the blood to the cells

Diabetic children are generally suffering from Type 1 diabetes, which is caused by a lack of insulin. It is unclear what causes Type I diabetes, and although sufferers appear to have a defective gene, there is usually some triggering factor, such as a viral infection. Type I diabetes is also known as juvenile-onset diabetes. Type II diabetes is usually confined to the over-40's and is known as maturity-onset diabetes. It is commonly caused by a defect in the process of glucose metabolism and is usually controlled by diet alone.

Whatever the cause, the diagnosis of diabetes is made from an excess of glucose in the blood. This excess leads to a breakdown of fat in the body, which causes the production of organic acids known as ketones. This causes ketoacidosis, a lowering of the pH of the blood, which can be detected by the characteristic smell on the breath of pear-drops or acetone. The blood glucose level will also be raised.

Other signs of type I diabetes are that the patient has otherwise unexplained weight loss and glucose in the urine, which is measured with a simple dipstick test.

The treatment of type I diabetes is by injection of insulin. This lowers the blood glucose level by allowing the glucose to be metabolised inside the cells. The amount of insulin injected is calculated by a process of trial involving frequent blood glucose tests and urine tests.

If the child's metabolism alters for some reason, usually by some other illness such as an infection, this calculated dose of insulin can be too little to metabolise enough glucose, causing hyperglycaemia or may be too much, causing hypoglycaemia.

Hyperglycaemia

The child will usually be drowsy and show signs of dehydration. They may have deep, rapid, sighing respirations (Kussmaul's breathing), often with a smell of acetone on the breath. The skin is often dry and flushed. Vomiting can occur. (Vomiting for more than a few hours can bring about hyperglycaemia). The patient may also be hypotensive and hypothermic, but these are late signs.

Calls to hyperglycaemic children are not normally an emergency call, but often come from the child's GP. Treatment, after attention to the airway, breathing and circulation, commences with determining the blood glucose level with a finger pinprick blood test. If the child is found to be hyperglycaemic, with a blood glucose of more than 15mmol/l, give a bolus dose of 20ml/kg of crystalloid. The child will need to be taken to hospital for stabilisation with an altered insulin regimen.

Hypoglycaemia

The child will usually be pale, sweating and shaking. They may have pins and needles in the lips and tongue (not to be confused with hyperventilation, which is common in young adults). They may be hungry, with headache and palpitations.

As the hypoglycaemia progresses, they may develop double vision, difficulty in concentrating and slur their speech. Up to this stage, they or their parents will often recognise the symptoms and the child is usually treatable with oral glucose and carbohydrates, such as bread and jam with a glass of milk.

As the hypoglycaemia progresses further, which may take only a few minutes in some cases, the child will lapse into unconsciousness, often first becoming increasingly aggressive and unmanageable. The child may have develop fitting, especially in younger children. Following protection of the airway, breathing and circulation, a finger pinprick blood glucose test should be taken. If the blood glucose is found to be less than 3mmol/l, and the child is not treatable with oral glucose, (because of impaired self-protection of the airway), a bolus dose of 5ml/kg of 10% dextrose will need to be given intravenously. The blood glucose should be checked again following the treatment. A rapid return to consciousness will usually follow.

Should the child be very aggressive and unmanageable, a subcutaneous or intramuscular injection of Glucagen should be given. Children between the ages of 2 and 12 years should receive 0.5mg (half an ampoule) and children over the age of 12 should receive 1.0mg (one ampoule). The Glucagen will mobilise glycogen from the liver, which is released into the blood as glucose. On return to consciousness, a further blood glucose test should be taken.

Following treatment with Glucagen, the child should be given oral glucose and carbohydrate as the immature liver only has small stores of glycogen and a further episode of hypoglycaemia may well follow within a few minutes.

Children suffering from hypoglycaemia should be taken to hospital for further test and checks. Older patients who recover from hypoglycaemia may wish to stay at home, but this should be discouraged as hypoglycaemia can recur very suddenly.

It has been noted that adolescents sometimes falsify their urine and blood test results, particularly when the diabetes disrupts their lives. This may present as sudden and unexpected hypoglycaemia or hyperglycaemia, even though there have been a series of negative urine tests and claims of precise following of insulin use. Your suspicion should be discreetly reported to the hospital staff on admission.

Congenital Diseases

There are many hundreds of congenital diseases and disorders that affect children and they cannot be discussed individually in a book of this nature. If you are presented with a sick child and the parents state that the child is suffering from XXX syndrome or XXX disease, this should be noted and an explanation sought as to the exact nature of the problem. The examination and treatment that follows will normally take the route of that for any sick or injured child that you do not have a diagnosis for - ABCDE followed by a secondary survey and treatment.

However, the parent may have a letter from the consultant or GP which outlines the problem and also suggests a course of treatment or action to be taken in certain circumstances. This course must be followed and the child must be taken to hospital, with the letter.

If the course of treatment does not produce the desired effect, a further examination and assessment will be necessary to determine what to do. A radio call to get advice from the hospital may be necessary and basic life-support treatment may be started. However, if the letter expressly forbids any treatment or course of action, this must be followed.

Status Epilepticus

Fits of any kind in children are extremely dangerous and need to be controlled as soon as possible. Status epilepticus and febrile convulsions present in very similar fashions, but can usually be differentiated by the history.

Epileptic fits are a disturbance in the workings of the brain, caused by an underlying disease, epilepsy. They are normally controlled by a drug, such as Epilim, Phenytoin or Clonazepam, which is taken every day.

Status epilepticus is caused when an epileptic child has one fit after another without recovery of consciousness in between. The underlying cause may be a progression of the epilepsy which has not been matched by a progression in the drug therapy, or some other illness that affects the child's susceptibility to fits.

An single epileptic fit can usually be left to resolve on it's own, whilst taking care of the airway (where possible), breathing and circulation. A normal fit will last for up to five minutes and then subside, leaving the patient in a deep sleep. If the fit subsides and no further fitting occurs, the treatment is usually confined to protection of the airway, prevention of injury to the patient from furniture etc. and the administration of oxygen until they recover.

If the fit recurs within a few minutes or is prolonged, longer than is normal for the particular patient, treatment must be instituted that will stop this fit and prevent further fits. A preliminary dose of rectal Diazepam may be given. Children under 1 year should receive 2.5mg rectally. Aged 1-5 years should receive 5mg rectally. Children aged 6-12 years should receive 10mg rectally. These doses may be repeated after 10 minutes if required. If IV access is obtained, diazemuls should be used at the dose of 300mcg/kg, once only. As always, the airway, breathing and circulation should be closely monitored and high-flow oxygen administered. Close attention must be given to the breathing, as respiratory depression or even apnoea can occur. The patient may need to be ventilated. A bolus dose of 5ml/kg of 10% Dextrose should be given to reverse hypoglycaemia of <3mmol/l, if found.

Unfortunately, rectal Diazepam is rarely effective in true status epilepticus as absorption from the rectal mucosa is too slow. Intravenous Diazepam in the form of Diazemuls will usually be required. The Diazepam is in an emulsion form to minimise inflammation of the vein. As the child will have received a full dose of rectal Diazepam by the time this decision has to be taken, the advice of a doctor must be sought, either the GP or the hospital doctor.

The dose of Diazemuls for children over the age of 10 years is 10mg intravenously. The dose may be repeated after 10 minutes if required. As always, the airway, breathing and circulation should be closely monitored and high-flow oxygen administered. Close attention must be given to the breathing, as respiratory depression or even apnoea can occur. The patient may need to be ventilated. The child will need to be taken to hospital, whether or not they recover from their fit.

FEBRILE CONVULSIONS

Any infection in a small child will usually lead to a raised body temperature. Small children under the age of about three years have an immature temperature regulation mechanism which can give rise to a very high body temperature. The high temperature can often lead to convulsions as the brain is overheated.

The infection also tends to cause hypoglycaemia, another cause of fits. A careful history will help to differentiate between febrile convulsions and epilepsy, but not always - this may be the child's first epileptic fit. A careful examination will reveal the high temperature.

The priorities of treatment are control of the airway, ensuring adequate respirations and oxygenation, and maintaining adequate circulation (which is rarely affected). The definitive treatment that will stop the convulsion is to reduce the body temperature and thereby remove the cause.

However, if the child is still fitting, a single dose of 300mcg/kg of Diazemuls should be given. If IV or IO access cannot be immediately achieved, rectal Diazepam should be administered. A child of 1-3 years should receive 2.5mg, a child of 3-10 years 5.0mg and a child over the age of ten 10mg. If the fits persist for more than 10 minutes, a further dose of Diazemuls should be given IV or IO

If conscious, oral Paracetamol elixir should be given to reduce the temperature. Age 3m - 1 year 125mg. 1 - 5 years 250mg. 6 - 12 years 500mg.

As always, the airway, breathing and circulation should be closely monitored and high-flow oxygen administered. Close attention must be given to the breathing, as respiratory depression or even apnoea can occur. The patient may need assisted ventilation or may need to be fully ventilated. A bolus dose of 20ml/kg of crystalloid should be given to reverse severe dehydration, if found .

If the fits are prolonged, hypoglycaemia may develop due to the small glycogen store held by children. This can be checked with a fingertip blood glucose test. 5ml/kg of 10% Dextrose should be administered if hypoglycaemia <3mmol/l is found.

Poisons

There are thousands of substances, many of them found in the medicine cabinet, kitchen or garden shed, that can poison a child. A list of these poisons and their possible antidotes and treatment regimes, would fill a large book. Fortunately, the Poisons Unit at Guys Hospital maintain a database of poisons, which may be accessed by the hospital doctor.

The basis of Paramedic care for a poisoned child is the same as for any sick child. Following the removal of danger, which may include gases or poisons that are absorbed through the skin, the ABCDE routine is invoked and treatment is based on what you find. If possible, and if no risk is involved, the packet or tin that contained the poison should be taken to hospital. Failing this, if the nature of the poison is unknown, a small sample can be placed in a sealed container for the hospital to see, or even left with the Fire and Rescue Service for them to identify and dispose of safely.

Oxygen must be given to all children affected by poison, except for cases of Paraquat poisoning. Paraquat is not normally available to the domestic market, but there may be old packets of weedkiller around that a child comes across. Paraquat is still available for commercial use and can be found on the farm.

If the child is showing signs of respiratory distress or circulatory failure of any kind, a fluid challenge should be given of 20ml/kg of crystalloid. They should also have their blood glucose checked and corrected, if necessary, with 5ml/kg of 10% Dextrose.

An important point to remember is that the child should be treated according to their signs and symptoms, not just according to what any manual says about any particular poison. The value of these manuals is that they warn in advance of what may happen with any particular poison. The only exception to this is Paraquat poisoning, when no additional oxygen should be given.

Many poisons cause dysrhythmias and so any child that has taken any poison should be monitored.

Opioids

Poisoning from opioids and their derivatives and mimics, such as Morphine, Heroin and Methadone will produce unconsciousness and apnoea very rapidly however they are taken. The child will also become hypotensive.

Following the usual primary survey, they should be treated with a bolus dose of 10mcg/kg of Naloxone Hydrochloride (Narcan), which can be repeated every 3 minutes up to a total of 25 times if there is an inadequate response. If signs of shock are present, a fluid challenge of 20ml/kg of crystalloid should be given, with a further bolus of 20ml/kg after ten minutes if there is no improvement. Hypoglycaemia should be looked for and treated with 5ml/kg of 10% Dextrose if BM <3mmol/l.

Carbon monoxide poisoning

Carbon monoxide is a gas that is produced by the incomplete combustion of an organic fuel. Carbon monoxide poisoning can be caused by inhalation of vehicle exhaust fumes and also fumes from a gas heater with a faulty flue. The major cause in children is house fires.

Carbon monoxide attaches itself to the haemoglobin in red blood cells and thereby prevents the transport of oxygen in the blood, causing tissue hypoxia. The higher the requirement for oxygen, such as in fever or exercise, the faster the carbon monoxide attaches itself to the haemoglobin and therefore the faster the tissue hypoxia develops. Children have an intrinsically higher metabolic rate than adults and are therefore particularly sensitive to carbon monoxide poisoning.

The main symptoms of carbon monoxide poisoning are often vague and variable, leading to misdiagnosis.

Headache, nausea and vomiting are common signs and symptoms. The child will often appear to be drunk, with ataxia, slurred speech and muddled thinking. Severe cases may involve convulsions and unconsciousness.

The pulse will be full and bounding, the pupils will be dilated, and the child will be pallid, often with cyanosis. Only rare, serious, late-found cases will have the cherry-red skin. This colour is caused by a complete replacement of the haemoglobin by carboxyhaemoglobin. As the blood travels through the peripheral veins in the skin, the blood is still bright red and colours the skin. The gas will often cause pulmonary oedema, which will be heard as rales in the lungs.

Treatment involves the usual ABCDE but centres on 100% oxygenation and ventilation to remove the carbon monoxide from the haemoglobin and replace it with oxygen. The child should be kept calm and quiet to reduce the metabolic demand for oxygen.

Tricyclic Antidepressants

Amitryptyline, Amoxapine, Clomipramine, Dothiepin, Doxepin, Imipramine, Lofepramine, Nortriptyline, Protryptyline, Trimipramine.

These drugs will cause many and varied effects, ranging from unconsciousness and convulsions, to dilated pupils, arrhythmias and tachycardia.

Treatment in the field, following the usual primary survey and treatment of the convulsions and unconsciousness, should centre on hyperventilation, which has the effect of raising the alkalinity of the blood. This will reduce the effects of the drug.

Solvents

There are many solvents that are used and abused by children. The effects of solvent abuse are varied and variable. The range covers mild intoxication, eye irritation, convulsions, flushing, hypotension, disrhythmias, nausea, dizziness, CNS depression, apnoea, delirium, headache, hallucinations, visual disturbances and pulmonary oedema. They have just one thing in common, which is that they can all cause sudden death.

Treat the child according to their signs and symptoms, but always bear in mind that convulsions, coma and sudden death are common.

Alcohol

Alcohol is not usually classified as a poison, but has many effects that other poisons share. Normally, the smaller the child, the less alcohol is required to produce these effects.

The main problems caused by alcohol centre on the airway and aspiration of vomit, together with trauma caused whilst under the influence and the difficulty in treating an uncooperative drunken person.

Occasionally, hypoglycaemia can be caused, which can be treated with 5ml/kg of 10% Dextrose infusion. Hypotension is rarely a problem, but this can be treated with 20ml/kg crystalloid fluid challenge in particularly severe cases.

All small children found to be drunk should be taken to hospital. It is not safe to leave them with their parents, as the airway could be compromised by vomit at any time and the parents are unlikely to be suitably trained or equipped.

7

Cardiac Arrest

Cardiac Arrest

Children in cardiac arrest have a better chance of survival to discharge than adults. The arrest situation in children is more amenable to a good outcome because the cause can often be dealt with by the Paramedic at the same time as the arrest itself.

The main cause for cardiac arrest in children is respiratory depression from a number of possible causes, leading to respiratory failure and respiratory arrest, leading to cardiac arrest. If the cause of the respiratory depression can be corrected, the child has a good chance of recovery. It must be remembered that treating the cause of the respiratory depression at an early stage will often prevent a cardiac arrest.

The text for this section is taken from the 2000 Resuscitation Guidelines for use in the United Kingdom, published by the Resuscitation Council (UK), who have given their kind permission to reproduce it.

Paediatric Basic Life Support

Definitions

Sequence of actions

When to go for assistance

Recovery position

Obstructed airway

Foreign body obstruction sequence

Paediatric Basic Life Support Algorithm

Definitions

An infant is a child under the age of 1 year.

A child is aged between 1 and 8 years of age.

Children over the age of 8 years will still be treated as for a younger child but may require different techniques to attain adequate chest compression.

In the following description unless specified a 'child' includes an 'infant'.

Sequence of actions

1. Ensure safety of rescuer and child

2. Check the child's responsiveness:

Gently stimulate the child and ask loudly: "Are you all right?"

Infants, and children with suspected cervical spinal injuries, should not be shaken.

3A. If the child responds by answering or moving:

Leave the child in the position in which you find him (provided he is not in further danger)

Check his condition and get help if needed

Reassess him regularly.

3B. If the child does not respond:

Shout for help

Open the child's airway by tilting his head and lifting his chin.

If possible with the child in the position in which you find him, place your hand on the child's forehead and gently tilt his head back

At the same time, with your fingertip(s) under the point of the child's chin, lift the chin to open the airway. Do not push on the soft tissues under the chin as this may block the airway

If you have any difficulty in opening the airway, carefully turn the child on to his back and then open the airway as described.

Avoid head tilt if trauma (injury) to the neck is suspected.

If neck injury is suspected use the jaw thrust method of opening the airway.

4. Keeping the airway open, look, listen and feel for breathing, putting your face to the child's face and looking along the chest:

Look for chest movements and, in an infant especially, abdominal movement

Listen at the child's nose and mouth for breath sounds

Feel for air movement on your cheek

Look, listen and feel for up to 10 seconds before deciding that breathing is absent.

5A. If the child is breathing normally:

Turn the child on his side

Send or go for help

Check for continued breathing.

5B. If the child is not breathing or is making occasional gasps:

Carefully remove any obvious airway obstruction

Give 2 rescue breaths each of which makes the chest rise and fall. Up to 5 rescue breaths may be attempted to achieve 2 effective ones. Take a breath yourself between rescue breaths to maximise the oxygen you deliver.

While performing the rescue breaths, note any gag or cough response to your action.

For a child

Ensure head tilt and chin lift

Pinch the soft part of his nose closed with the index finger and thumb on his forehead

Open his mouth a little, but maintain chin lift

Take a breath and place your lips around his mouth, making sure that you have a good seal

Blow steadily into his mouth over about 1 - 1.5 seconds watching for his chest to rise

Maintain head tilt and chin lift, take your mouth away from the child and watch for his chest to fall as air comes out

Take another breath and repeat this sequence up to 5 times (a minimum of 2 effective rescue breaths must be given).

For an infant

Ensure head tilt and chin lift

Take a breath and cover the mouth and nasal apertures of the infant with your mouth, making sure you have a good seal. In a larger infant, if the mouth to mouth-and-nose method is difficult, try the mouth to nose technique. In this, the adult's mouth is placed over the infant's nose and rescue breathing attempted. It may be necessary to close the infant's mouth during rescue breathing to prevent air escaping.

Blow steadily into the infant's mouth and nose over 1 - 1.5 seconds sufficient to make the chest visibly rise

Maintain head tilt and chin lift, take your mouth away from the infant and watch for his chest to fall as air comes out

Take another breath and repeat this sequence up to 5 times (a minimum of 2 effective rescue breaths must be given).

If you have difficulty achieving an effective breath, the airway may be obstructed

Recheck the child's mouth and remove any obstruction

Recheck that there is adequate head tilt and chin lift but also that the neck is not over extended. Try the jaw thrust method

Make up to 5 attempts in all to achieve at least 2 effective breaths

If still unsuccessful, move on to foreign body airway obstruction sequence.

6. Assess the child for signs of a circulation:

Look for any movement including swallowing, coughing or breathing (more than an occasional breath)

For trained healthcare providers only check the pulse

Child - feel for the carotid pulse in the neck

Infant - feel for the brachial pulse on the inner aspect of the upper arm

Take no more than 10 seconds to do this.

7A. If you are confident that you can detect signs of a circulation (or a pulse over 60 beats per minute if you have been trained to do so) within 10 seconds:

Continue rescue breathing, if necessary, until the child starts breathing effectively on his own

Re-check regularly for signs of a circulation taking no more than 10 seconds

If the child starts to breathe normally on his own but remains unconscious turn him into the recovery position. Be ready to turn him onto his back and re-start rescue breathing if he stops breathing.

7B. If there are no signs of a circulation, or you are at all unsure: (or the pulse rate is very slow - less than one per second i.e. 60 per minute and there are signs of poor perfusion i.e. unresponsive, immobile)

Start chest compression

Combine rescue breathing and chest compression.

For a child

Locate and place the heel of one hand over the lower half of the sternum (breastbone) ensuring that you do not compress on or below the xiphisternum

Lift the fingers to ensure that pressure is not applied over the child's ribs

Position yourself vertically above the chest and, with your arm straight, press down on the sternum to depress it approximately one third to one half of the depth of the child's chest

Release the pressure, then repeat at a rate of about 100 times a minute

After 5 compressions tilt the head, lift the chin and give 1 effective breath

Return your hand immediately to the correct position on the sternum and give 5 further compressions

Continue compressions and breaths in a ratio of 5:1

In children over the age of approximately 8 years, it may be necessary to use the "adult" two handed method of chest compression to achieve an adequate depth of compression.

Locate the lower half of the sternum (breastbone) and place the heel of one hand there, with the other hand on top

Interlock the fingers of both hands and lift them to ensure that pressure is not applied over the child's ribs

Position yourself vertically above the child's chest and, with your arms straight, press down on the sternum to depress it approximately one third to one half of the depth of the child's chest

Release the pressure, then repeat at a rate of about 100 times a minute

After 15 compressions tilt the head, lift the chin and give 2 effective breaths

Return your hands immediately to the correct position on the sternum and give 15 further compressions

Continue compressions and breaths in a ratio of 15:2

For an infant

For a single or non-professional rescuer:

Locate the sternum and place the tips of two fingers, one finger's breadth below an imaginary line joining the infant's nipples

With the tips of two fingers, press down on the sternum to depress it approximately one third to one half of the infant's chest

Release the pressure, then repeat at a rate of about 100 times a minute

After 5 compressions tilt the head, lift the chin and give 1 effective breath

Return your hands immediately to the correct position on the sternum and give 5 further compressions

Continue compressions and breaths in a ratio of 5:1

For more than one professional rescuer, the following technique is used where practicable. Place both thumbs over the lower half of the sternum one finger's breadth below the inter-nipple line. Encircle the infant's chest with the hands, supporting the infant's back with the fingers. Depress the sternum with the thumbs to one half to one third of the depth of the chest at the rate and ratio given above. A second rescuer manages airway and breathing.

8. Continue resuscitation until:

The victim shows signs of life (spontaneous respiration, pulse)

Qualified help arrives

You become exhausted.

When to go for assistance

It is vital for rescuers to get help as quickly as possible when a child collapses.

When more than one rescuer is available, one should start resuscitation while another rescuer goes for assistance.

If only one rescuer is present, he should perform resuscitation for about 1 minute before going for assistance. It may be possible to take the infant or small child with you whilst summoning help.

If the victim is a child with known heart disease and the collapse was sudden, and not caused by trauma or poisoning, go for help immediately. An arrhythmia is likely.

Recovery position

An unconscious child whose airway is clear, and who is breathing spontaneously, should be turned on his side into the recovery position. This prevents the tongue falling back to obstruct the airway, and reduces the risk of inhalation of stomach contents. There are a number of different recovery positions, each of which has its advocates. The important principles to be followed are:

The child should be in as near a true lateral position as possible with his mouth dependant to allow free drainage of fluid

The position should be stable. In an infant this may require the support of a small pillow or rolled up blanket placed behind the infant's back to maintain the position

Any pressure on the chest that impairs breathing should be avoided

It should be possible to turn the child onto his side and to return him back easily and safely, having particular regard to the possibility of cervical spine injury

Good observation and access to the airway should be possible.

Obstructed airway

If you have difficulty achieving an effective breath:

Recheck the child's mouth and remove any obvious obstruction

Recheck that there is adequate head tilt and chin lift but also that the neck is not over extended

Make up to 5 attempts in all to achieve at least 2 effective breaths

If still unsuccessful, move on to foreign body airway obstruction sequence.

FOREIGN BODY OBSTRUCTION SEQUENCE

There are a number of different foreign body obstruction sequences each of which has its advocates.

If the child is breathing spontaneously his own efforts to clear the obstruction should be encouraged. Intervention is necessary only if these attempts are clearly ineffective and breathing is inadequate.

Do not perform blind finger sweeps of the mouth or upper airway as these may further impact a foreign body or cause soft tissue damage

Use measures intended to create a sharp increase in pressure within the chest cavity, an artificial cough

1. Perform up to FIVE back blows

Hold the child in a prone position and try to position the head lower than the chest with the airway in an open position

Deliver up to five smart blows to the middle of the back between the shoulder blades

If this fails to dislodge the foreign body proceed to chest thrusts.

2. Perform up to FIVE chest thrusts

Turn the child into a supine position, again with the head lower than the chest and the airway in an open position

Give up to five chest thrusts to the sternum:

The technique for chest thrusts is similar to that for chest compressions.

Chest thrusts should be sharper and more vigorous than compressions and carried out at a rate of about 20 per minute.

3. Check mouth

After five back blows and five chest thrusts check the mouth

Carefully remove any visible foreign bodies.

4. Open airway

Reposition the airway by the head tilt and chin lift (jaw thrust) manoeuvre

Reassess breathing.

5A. If the child is breathing

Turn the child on his side

Check for continued breathing

5B. If the child is not breathing:

Attempt up to 5 rescue breaths to achieve 2 effective breaths each of which makes the chest rise and fall.

The child may be apnoeic or the airway partially cleared, in either case the rescuer may be able to achieve effective ventilation at this stage

If the airway is still obstructed repeat the sequence as follows:

For a child

Repeat the cycle (1-5 above) but substitute 5 abdominal thrusts for 5 chest thrusts

Abdominal thrusts are delivered as 5 sharp thrusts directed upwards towards the diaphragm

Use the upright position if the child is conscious; kneel behind a small child

Unconscious children should be laid supine and the heel of one hand placed in the middle of the upper abdomen

Alternate chest thrusts and abdominal thrusts in subsequent cycles

Repeat the cycles until the airway is cleared or the child breathes spontaneously.

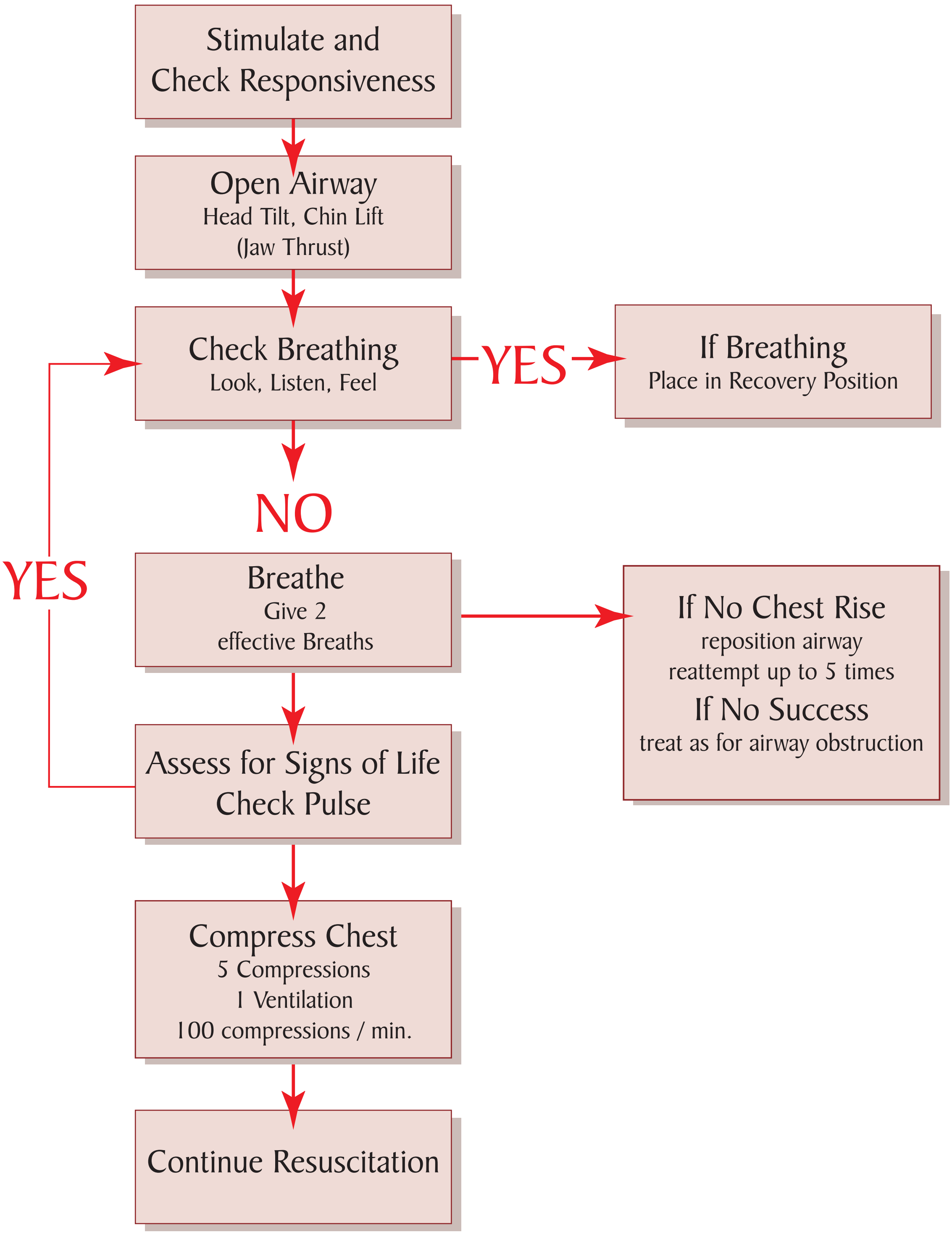
For an infant

Abdominal thrusts are not recommended in infants because they may rupture the abdominal viscera

Perform cycles of 5 back blows and 5 chest thrusts only

Repeat the cycles until the airway is cleared or the infant breathes spontaneously.

PAEDIATRIC BASIC LIFE SUPPORT



PAEDIATRIC ADVANCED LIFE SUPPORT

1. Establish basic life support

2. Oxygenate, Ventilate

Provide positive pressure ventilation with a high inspired oxygen concentration

3. Attach a Defibrillator or Monitor

Monitor the cardiac rhythm:

Place the defibrillator pads or paddles on the chest wall; one just below the right clavicle, the other at the left anterior axillary line

For infants, when using this method of monitoring, it may be more appropriate to apply the pads or paddles to the front and back of the infant's chest

Place monitoring electrodes in the conventional chest positions and monitor with a cardiac monitor.

4. Assess Rhythm (+ check for pulse)

Check the pulse

Child - feel for the carotid pulse in the neck

Infant - feel for the brachial pulse on the inner aspect of the upper arm

Take no more than 10 seconds

Assess the rhythm on the monitor as being:

Non ventricular fibrillation (Non VF) or non pulseless ventricular tachycardia (non VT) (Asystole or Pulseless Electrical Activity)

Ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT)

5A. Non VF/VT - Asystole, Pulseless Electrical Activity

This is more common in children

Administer epinephrine

If direct venous or intraosseous access has been established, give 10 mcg/kg epinephrine (0.1 ml/kg of 1 in 10,000 solution)

If venous access has not been established consider giving 100 mcg/kg epinephrine via the tracheal tube (1 ml/kg of 1 in 10,000 or 0.1 ml/kg of 1 in 1000 solution) if one is already in place

try the intraosseous route first if there is no circulatory access in place

Perform 3 minutes of basic life support and ventilation with oxygen

Repeat the administration of epinephrine

If direct venous or intraosseous access has been established, give a further dose of 10 mcg/kg epinephrine. In cases where intrarterial monitoring is already in place, higher doses such as 100mcg/kg epinephrine (1ml/kg of 1 in 10,000 or 0.1 ml/kg of 1 in 1000 solution) may be used if helpful as the effect can be measured. Higher doses may be considered in other circumstances, for example where extreme vasodilatation contributed to cardiac arrest i.e. septicaemia, anaphylaxis.

Repeat the cycle of 10mcg/kg epinephrine followed by 3 minutes of basic life support and ventilation

Consider the use of other medications such as alkalising agents, and treat reversible causes such as hypolvolaemia.

5B. VF/Pulseless VT

This is less common in paediatric life support but the rescuer must always be aware of the possibility of treating this arrhythmia rapidly and effectively

Defibrillate the heart with three defibrillation shocks:
2J/kg 2J/kg 4J/kg
(Accuracy of dosage may be difficult using defibrillators with stepped energy levels.)

Place the defibrillator pads or paddles on the chest wall; one just below the right clavicle, the other at the left anterior axillary line

For infants, when using this method of monitoring, it may be more appropriate to apply the pads or paddles to the front and back of the infant's chest

If VF/VT persists perform one minute of basic life support and give 10mcg/kg of epinephrine to support coronary perfusion

Defibrillate the heart with three further shocks:

4J/kg 4J/kg 4J/kg

Repeat the cycle of defibrillation and one minute basic life support until defibrillation is achieved. Consider the use of other medications such as antiarrhythmics and treat reversible causes.

ADVANCED LIFE SUPPORT

PROCEDURES

Establish a definitive airway

- attempt tracheal intubation

- verify the position of the tracheal tube at regular intervals

Establish ventilation

- Ventilate with 100% oxygen using a self inflating resuscitation bag

Establish vascular access

- Gain access to the circulation by:
Direct venous access
Intraosseous access

Give epinephrine every three minutes

Consider giving bicarbonate to correct a severe metabolic acidosis

Consider antiarrhythmics

Correct reversible causes:

Hypoxia
Hypovolaemia
Hyper/hypokalaemia
Hypothermia
Tension pneumothorax
Tamponade
Toxic/therapeutic disturbances
Thromboemboli

6. Drugs in Paediatric Advanced Life Support

Epinephrine (Adrenaline)

Epinephrine is the first line drug for asystole. Its action is to increase aortic diastolic pressure during chest compressions and thus coronary perfusion pressure and the delivery of oxygenated blood to the heart. It also enhances the contractile state of the heart and stimulates spontaneous contractions. The initial intravenous or intraosseous dose is 10 micrograms/kg (0.1 ml of 1:10,000 solution). In the child with no existing intravenous access the intraosseous route is recommended as the route of choice as it is rapid and effective. In each case the epinephrine is followed by a normal saline flush (2-5 mls). If circulatory access cannot be gained, the tracheal tube can be used. Ten times the intravenous dose (100 micrograms/kg) should be given via this route. The drug should be injected quickly down a narrow bore suction catheter beyond the tracheal end of the tube and then flushed in with 1 or 2 mls of normal saline.

When it comes to the second and subsequent doses there is no convincing evidence that a tenfold increase in epinephrine is beneficial in children and in some adult studies a deleterious effect was observed. However, there are some anecdotal cases of return of spontaneous circulation with large doses of epinephrine and therefore it can still be used for second and subsequent doses in patients where cardiac arrest is thought to have been secondary to circulatory collapse. It is clear that patient response to epinephrine is very variable, therefore if the patient has continuous intra-arterial monitoring the epinephrine dose can be titrated to best effect.

Alkalising Agents

Children with cardiac arrest will be acidotic as the arrest has usually been preceded by respiratory arrest or shock. However, the routine use of alkalising agents has not been shown to be of benefit. Sodium bicarbonate therapy increases intra-cellular carbon dioxide levels so administration, if used at all, should follow assisted ventilation with oxygen, and effective BLS. Once ventilation is ensured and epinephrine plus chest compressions are provided to maximize circulation, use of sodium bicarbonate may be considered for the patient with prolonged cardiac arrest or cardiac arrest associated with documented severe metabolic acidosis (1 ml/kg of an 8.4% solution). These agents should be administered only in cases where profound acidosis is likely to adversely affect the action of epinephrine. An alkalising agent is usually considered if spontaneous circulation has not returned after the first or second dose of epinephrine/adrenaline.

Intravenous Fluids

In situations where the cardiac arrest has resulted from circulatory failure, a standard (20 mls/kg) bolus of crystalloid fluid should be given if there is no response to the initial dose of epinephrine.

Anti-arrhythmic drugs

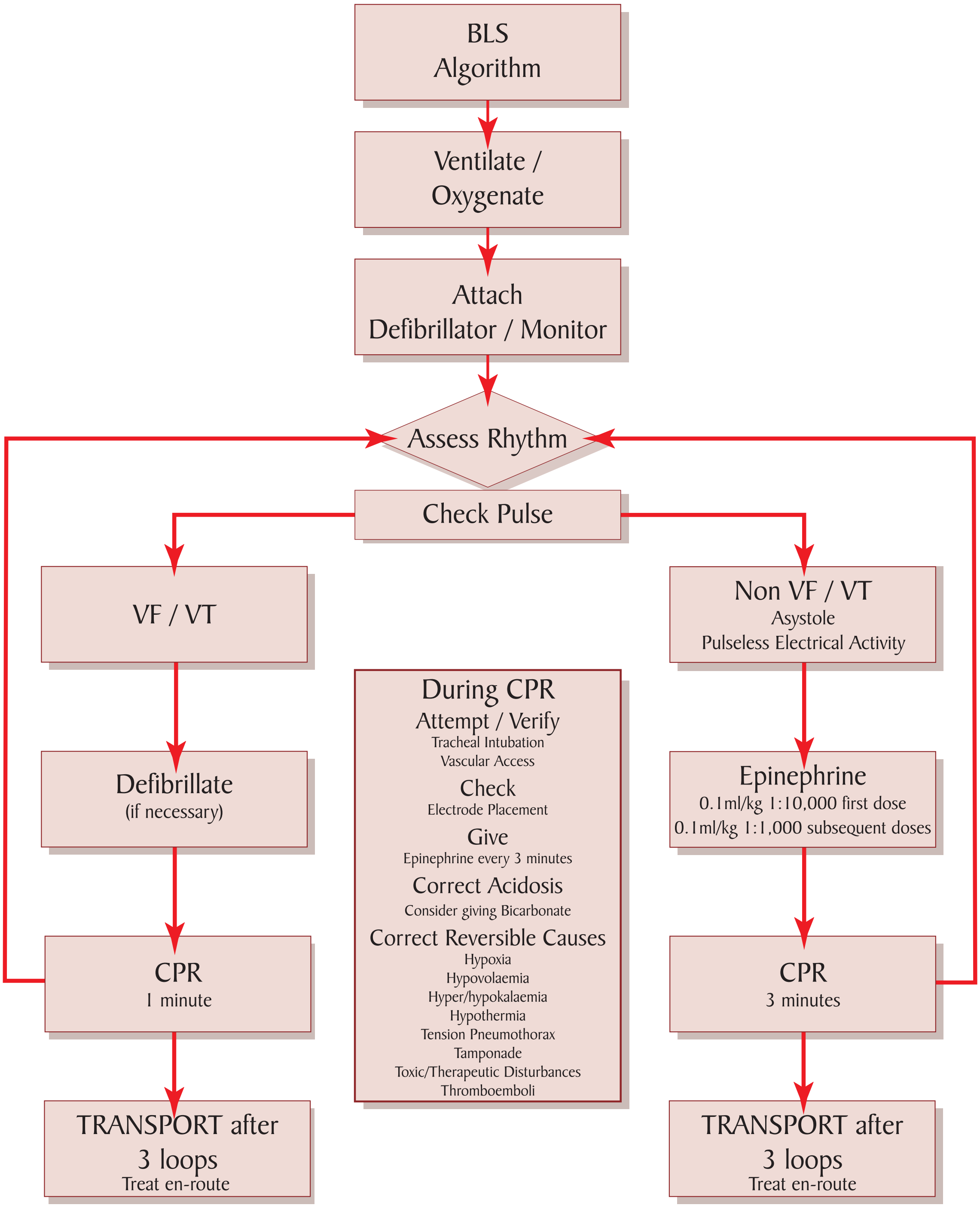
Amiodarone is now the treatment of choice in shock resistant ventricular fibrillation and pulseless ventricular tachycardia. This is based on evidence from adult cardiac arrest and experience with the use of amiodarone in children in the catheterisation laboratory setting. The dose of amiodarone for VF/ pulseless VT is 5 mg/kg via rapid i.v. bolus followed by continued basic life support and a further defibrillation attempt within 60 seconds.

Further doses of epinephrine (usually at low dose unless specifically indicated by the clinical situation) should be given every 3-5 minutes.

Lidocaine (lignocaine) may still be used as an alternative to amiodarone but bretylium is no longer thought to be an appropriate agent in children.

After each drug CPR should continue for upto a minute to allow the drug to reach the heart before a further defibrillation attempt. It is DC shock that converts the heart back to a perfusing rhythm not the drug. The purpose of the anti-arrhythmic drug is to stabilise the converted rhythm and the purpose of epinephrine is to improve myocardial oxygenation by increasing coronary perfusion pressure. Epinephrine also increases the vigour and intensity of ventricular fibrillation which assists effective defibrillation. There should be about a minute of CPR between each set of shocks. Therefore, drugs should be given very promptly after an unsuccessful defibrillation attempt to allow time for the drug's distribution each time before the next shock.

PAEDIATRIC ADVANCED LIFE SUPPORT



Resuscitation of the newborn

There are number of significant differences between an infant during pregnancy, an infant immediately before birth and an infant immediately after birth. These changes are automatic and do not normally give rise to problems. In fact the changes are necessary in order for the baby to adapt to life outside the uterus.

Introduction

Immediately before birth, the blood sup ply via the umbilical cord is considerably reduced due to uterine contractions. The blood supply is completely cut off when the cord is clamped. This leads to hypoxia in the infant. It is this hypoxia that causes the infant to take it's first gasp. The first gasp (usually by crying) raises the pressure in the alveoli and drives the amniotic fluid from the alveoli via the tissue into the lymphatic and circulatory systems. The alveoli are kept open by gas pressure and the presence of surfactant, which reduces the surface tension in the lining of the alveoli, preventing the alveoli walls from sticking together like a wet plastic bag.

Lack of surfactant affects about 10% of all babies below 2.5kg birthweight, and is particularly common when the infant is less than 1.5kg at birth. (Premature is defined as an infant born below 2.5kg).

The reduction in blood flow through the umbilical cord and placenta also affects the infant's circulatory pattern. When the placenta is no longer supplied with blood, the pressure in the vena cava falls, closing the ductus venosus (between the umbilical vein and the vena cava).

As the lungs expand following the first gasp, the vascular resistance in the lungs falls considerably. As the infant's systemic blood pressure rises, the blood flow is reversed through the ductus arteriosus, (between the pulmonary trunk and the aorta, which bypasses the lungs during pregnancy).

As the oxygen concentration in the blood rises, the ductus arteriosus closes and the blood now flows from the heart to the lungs. The pressure in the right atrium falls and, because of the increased blood flow through the lungs, the pressure in the left atrium rises. This causes the foramen ovale (between the left and right atria) to close, completing the changes to the circulation that are required for life breathing air.

The liver becomes well-supplied with blood and the glycogen stores are converted to glucose to help with nourishment in the first few days after birth. However, premature infants have small glycogen stores and are therefore prone to hypoglycaemia.

The blood vessels in the skin constrict immediately after birth, helping to preserve heat. This also gives the impression that the infant is pale. Wrapping the normal infant warmly will normally restore it's healthy pink colour. Premature infants are particularly prone to hypothermia as the immature hypothalamus is unable to provide reliable temperature control.

Assessment

Immediately after delivery, the cord should be clamped and the infant dried and wrapped in a warm towel. The stimulation from drying the child by rubbing gently with a warm, dry towel, together with the lack of oxygen supply from the placenta, will normally provoke the first gasp, if it has not already been taken. Following this, the infant is assessed to decide if resuscitation is required. This assessment is in three parts;

Skin Colour
pink, blue or white
Heart Rate
>100, <100 or nil, by auscultation
Respiratory Effort
>30 <30, regularity and adequacy

The healthy infant will have pink skin, a heart rate over 100 bpm and regular respirations of 30 or more breaths per minute, often with vigorous crying.
The cord should be clamped (but not cut at this stage) and the infant should be dried with a warm towel, warmly wrapped and put on the mothers abdomen or to her breast. It is not necessary to smack the infant.

The infant in primary apnoea will be blue, have a heart rate of 60-100 bpm and gasping or absent respirations.
These babies should be stimulated by gently rubbing with the towel. Check that the airway is not obstructed with mucus or meconium and, if necessary, suction very gently. Oxygen should be administered by holding the oxygen tubing near the mouth and nose.

These stimulants will normally bring about normal, regular respirations or crying. If this fails, begin bag and mask ventilation with oxygen at a rate of 30 breaths per minute and if the heart rate falls below 60bpm, begin chest compressions at a rate of 100/minute.

The infant will normally become pink and can then be classified in the first group, ready to be put on the mothers abdomen or breast. However, if it does not become pink, the cord should be cut and the infant transported to an Accident and Emergency Department, with resuscitation carried out en-route, as required. Alert the receiving hospital.

The infant in terminal apnoea will have white skin, a heart rate of less than 60 bpm and no respirations.
Check that the mouth and nose are not obstructed and suction gently, if required. Begin bag and mask ventilation with oxygen at a rate of 30 breaths per minute. Begin chest compressions at a rate of 100 bpm. The cord should be cut and the infant transported to an Accident and Emergency Department, with resuscitation carried out en-route, as required. If there is no response within a few minutes, intubate and ventilate at 30-40 breaths per minute. Alert the receiving hospital.

The still-born infant will have white skin, no pulse and no respirations.
Check that the mouth and nose are not obstructed and suction gently, if required. The full BLS/ALS resuscitation protocols should begin immediately. Begin bag and mask ventilation with oxygen and intubate. Ventilate at 30-40 breaths per minute. Begin chest compressions at a rate of 100 bpm. Give resuscitation drugs in accordance with protocols (usually asystole). The cord should be cut and the infant transported to hospital, with resuscitation carried out en-route. Alert the receiving hospital.

Bearing in mind the above information, if the newborn infant appears normal and healthy, an Apgar Score is assessed after one minute and five minutes. Healthy babies have, and keep, an APGAR score of 7-10. Babies in primary apnoea have an APGAR score of 4-6 and will usually improve to 7-10 with minimal treatment. Babies in terminal apnoea or still-born will have an APGAR score of <4 and will require aggressive resuscitation. This is summarised in the APGAR score and resuscitation flowchart on page 83.

NOTE:

The primary cause of cardiac arrest in babies and children is hypoxia, lead ing to asystole. Babies with any respiratory insufficiency must receive supplemental oxygen and will usually benefit from ventilation.

Airway

Babies have a large occiput, which tends to close the airway by flexion of the neck. Place a folded towel under the shoulders, but do not overextend the neck as this will tend to kink the airway.

Do not grip the jaw tightly when using chin lift, as the soft tissue in the mouth is easily damaged.

When clearing the airway, do not use finger sweeps as the soft tissue in the mouth and pharynx is easily damaged. Instead, use a mouth-powered suction device. (see picture page 30). Do not suction for too long or too far into the airway, as stimulation may cause the vagus nerve to provoke bradycardia, and touching the larynx may provoke laryngospasm.

Bag and Mask Ventilation

When ventilating with a bag and mask, always use supplemental oxygen at a high flow rate. Oxygenation of newborn babies will only cause blindness after some considerable time and there is much more immediate danger from hypoxia. Only ventilate with enough pressure to make the chest begin to rise. Any overinflation will damage the delicate tissues of the immature lungs. Always use the correct type of mask, which is soft and circular, if it is available. If not, use the smallest size available, but take care to maintain an adequate seal. Use of a paediatric bag is important, to avoid overinflation.

If the newborn is apnoeic, the first five breaths will only displace the fluid in the lungs and true ventilation will only begin when the chest has started to rise and fall. Once the chest has started to rise, check the heart rate again, by auscultation, as the relief from hypoxia may stimulate proper heart activity.

If the airway appears to be blocked after the first few inflations, check carefully that the head is in the correct position, as the small airway is very easily obstructed by kinking.

Intubation

Should the airway be clogged with meconium, gentle suction of the mouth and nose will not usually provide a clear airway and the infant may remain hypoxic. Intubation will usually be required in the case of prolonged resuscitation of terminal apnoeic babies and where meconium is found. The meconium will normally have to be removed from the lower airways by suctioning through the endotracheal tube. Take care not to suction for more than 5 seconds and removing the air from the lungs will not only cause hypoxia, but may also lead to collapse of the alveoli (atelectasis).

Chest Compressions

Following inflation of the lungs, the heart rate should be reassessed by auscultation. If it is still below 60, chest compressions should begin over the lower third of the sternum, just below the nipple line. The rate should be 100 compressions per minute, taking into account the time lost for inflations, if there is only one operator. This will mean that the compressions should be carried out at about 2 per second to achieve the optimum rate. Only compress the chest with one or two fingers and only enough to move the sternum approximately 2-3 cm. If there are two operators, the combined rate is one inflation to three compressions.

Clamping the Cord

Immediately following birth, the umbilical cord should be clamped. This will assist the first gasp. The cord need not be cut by the paramedic unless the infant is to be transported immediately. Otherwise, leave it for the midwife to cut. Cutting the cord with inadequate clamping will lead to catastrophic bleeding unless the cord has stopped pulsating, which takes several minutes.

The Mother

Whilst busy with resuscitating the infant, do not forget that the mother may be in need of medical assistance, as well as reassurance about her newborn child. If the infant is to be transported without the mother, remember to call for a second ambulance.

APGAR SCORING

Appearance, Pulse, Gasp, Activity, Reflex

Sign	0	1	2
Colour	Blue, white	Body pink, Extremities blue	Completely pink
Heart Rate	Absent	Slow <100	Fast >100
Respiratory Effort	Absent	Weak cry, Hypoventilation	Good; strong cry
Muscle tone	Limp	Some flexion of extremities	Active motion; extremities well flexed
Reflex irritability	No response	Grimace	Cry

An Apgar Score of 7-10 is considered normal and the infant will probably require no treatment, except perhaps suctioning the mouth of mucus. The infant should be dried and handed to the mother.

An Apgar Score of 4-6 implies that the breathing is impaired and the infant will probably require suctioning and tactile stimulation to help it take it's first gasp. Oxygen should be given.

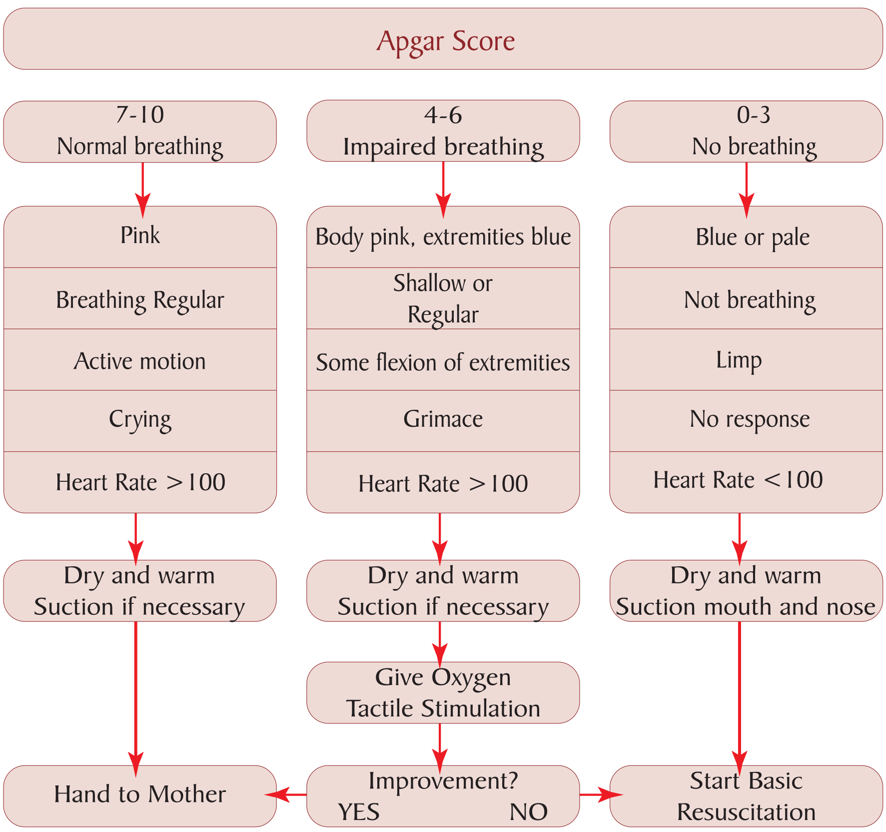
If the infant improves, it should be handed to the mother.

If the drying, stimulation and oxygen do not lead to an improvement, basic resuscitation should be started.

An Apgar Score of 0-3 implies that the child is not breathing and does not take it's first gasp. Basic resuscitation should begin immediately.

It should be noted that a pulse rate of less than 60 is considered to be cardiac arrest and chest compressions should be started.

Resuscitation of the Newborn



8

Practical Procedures

Endotracheal Intubation

Intubation should be carried out when;

- The airway cannot be kept open by manual methods or oropharyngeal airways.
- There is risk of aspiration of vomit or secretions or blood.
- The child needs to be ventilated and other procedures need to be carried out.
- Drugs need to be given during cardiac arrest and IV access is not available

Tube Selection

The tubes used for adults have an inflatable cuff near the tip. This is used because the narrowest part of the adult airway is at the vocal cords. The tube is passed through the cords and the cuff inflates against the wall of the substantially larger trachea.

Tubes for children under the age of 10 are uncuffed. The narrowest part of the airway is the trachea just below the vocal cords. The correct size tube will pass through the vocal cords and form a good fit with the trachea below, just compressing the soft lining to form a seal.

The correct diameter endotracheal tube can be calculated using the formula :
Internal diameter in mm = (age/4) + 4

The correct length for the tube can be calculated using the formula:

Length in cm = (age/2) + 12cm

So the correct tube for a three year old child would be calculated as follows:
Diameter = (3/4) + 4 = 0.75 + 4 = 4.75mm
Length = (3/2) + 12 = 1.5 + 12 = 13.5cm

As tubes come in 0.5mm graduations, either a 4.5mm or a 5.0mm diameter tube should be used.

A guide to help in this situation is that the tube should just fit the nostril.

These formulae work for children over the age of 1 year up to the age of 10 years. Children under one year should need a tube of 3.0 - 3.5mm diameter, with premature babies possibly needing a tube of 2.5mm diameter. Once again, the guide at this size is that the tube should comfortably fit the nostril.

Children over the age of ten years should have an adult cuffed tube somewhere in the range 6.5mm - 9.0mm, using the nostril size as a guide when in doubt.

It should be remembered that when the tubes are this small, the actual diameter of the lumen is smaller in proportion to an adult tube, due to the thickness of the tube wall. This will lead to increased resistance to airflow.

Laryngoscope Blade Selection

The straight (Millar) and curved (Macintosh) blades are used differently. The straight blade is better for children up to about the age of four or five, whilst the curved blade is better for all others.

Various blade sizes are available and the correct length is that which fits from the vallecula (or epiglottis) with the blade protruding about 1cm out of the mouth. However, if the blade selected proves to be too large, simply do not insert it into the mouth as far. The width of the blade is not generally found to be a problem, except in the case of neonates and babies, who have very small mouths.

The straight Millar blade fits over the epiglottis and lifts it out of the way directly.

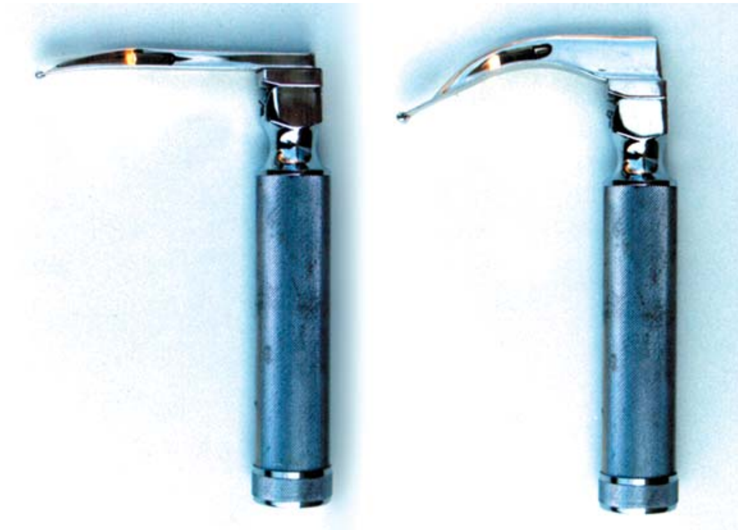
The curved Macintosh blade fits in the vallecula next to the epiglottis and lifts it indirectly. There are advantages and disadvantages to both approaches.

Babies and very small children have a relatively large epiglottis. Lifting the epiglottis directly removes it completely from the line of view, but makes laryngospasm more likely if the blade is advanced too far and it touches the vocal cords.

If the vallecula is used, there is more likelihood of trauma to the mouth, but less likelihood of laryngospasm and a poorer view. Taking the necessary care and time when visualising the cords should reduce these hazards to acceptable levels and make the use of the straight blade for babies and very small children, and the curved blade for all other patients the best overall choice.

Intubation

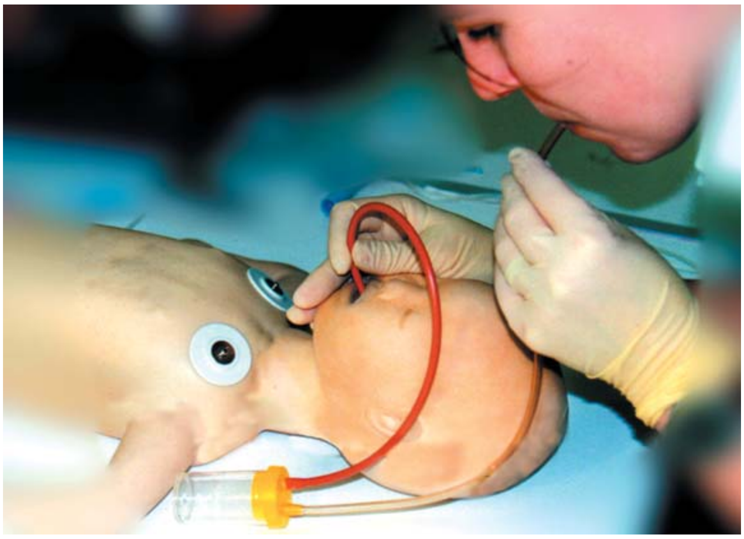
Intubation takes time. During this time the child is not being ventilated and is not receiving any oxygen. Before attempting intubation the child must be hyperventilated by bag and mask with 100% oxygen for at least one minute. This will buy time for the procedure. If the intubation attempt takes longer than 30 seconds, stop and again ventilate the child for one minute before starting again.

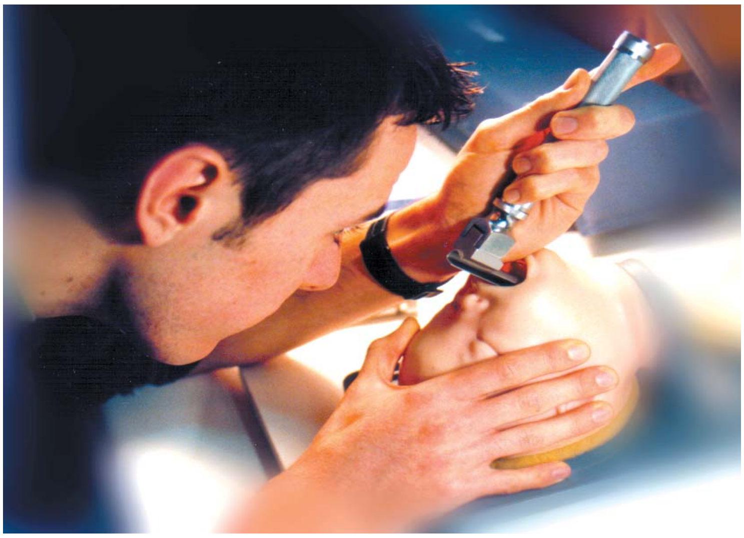


Have all the correct size equipment you require, and also one size smaller and larger, ready and immediately to hand. The equipment required is as follows:

- Bag and mask with oxygen supply
- Oropharyngeal or nasopharyngeal airways
- Suction equipment and suction catheter
- Magill forceps
- Spencer Wells forceps
- Stethoscope
- Laryngoscope and blades
- Endotracheal tubes
- 50ml syringe for cuff inflation (if cuffed tube is used)
- Catheter mount
- Securing tape or ribbon

Select the type of blade and size of tube to suit the child in front of you. The size of the child is more important than its age in determining blade selection and tube size.





The head must be positioned correctly to allow visualisation of the cords. A baby has a relatively large head, which will prevent proper neck extension when laid on a flat surface. A pad of material approximately 2-3cm thick should be placed under the shoulders to achieve the correct position.

If there is a possibility of cervical spine injury, neck extension and movement should be kept to a minimum. Cricoid pressure (Sellick's manoeuvre) will usually help with cord visualisation.

With the mouth open and the airway in this line, gastric regurgitation and aspiration of vomit or blood or secretions is a great danger. Check that the airway and mouth are clear and, if necessary, clear them with suction.

Position the head into the "sniffing" position and introduce the laryngoscope blade into the right hand side of the mouth. Laryngoscopes are left-handed instruments, with the flange of the blade designed to keep the tongue out of the line of sight. Advance the blade into the correct position (past the epiglottis for children up to 5 years, into the vallecula for other children), displace the tongue to the left and lift the blade upwards and forwards in the direction that the handle is pointing. Do not lift vertically. Do not lever the blade against the teeth or gums. The vocal cords should come into view.

At this point it can be advantageous to depress the larynx by pressing on the cricoid cartilage (Sellick's manoeuvre). This should achieve two things. It should improve the view of the vocal cords, particularly if the head extension is limited by head positioning or the need to keep the extension to a minimum due to possible cervical injury. It should also close off the oesophagus, thereby preventing gastric regurgitation.

When placing the blade tip under the epiglottis in small children, care should be taken not to touch the vocal cords, as this may result in laryngospasm and a completely closed airway.
When placing the blade tip in the vallecula in larger children, care should be taken not to injure the soft palate and tongue, both of which are delicate. Once the cords have been visualised, check that the tube is going to be the correct size. If there is significant oedema around the larynx or upper trachea, a smaller size tube may be required.

Insert the tube past the vocal cords into the trachea. Some tubes have a mark, which should line up with the vocal cords when the tube is inserted the correct distance into the trachea. In any case, the tip of the tube should end up 2-4 cm past the cords, depending on the size of the child.

The tube should slide easily into the trachea. If significant pressure is required at or past the cords, it could be that the tube is too large and a smaller tube should be used. If there is significant clearance at or past the cords, a larger tube should be used. If a different tube size is needed, take care not to spend more than 30 seconds on the intubation attempt as hypoxia develops very quickly.

Once the tube is in place, keep hold of the tube and connect the catheter mount. Three or four inflations should be given whilst the chest is checked for symmetrical movement. Check for equal breath sounds both sides by using a stethoscope under both axillae and at the base of each lung. Remember that if the child is newborn, significant inflation pressure may be required to fully open the alveoli. Check for gastric distension. If the tube is correctly placed, secure it with tape and insert an oropharyngeal airway to both stabilise the tube and the tongue and to protect the tube from being bitten.

Significant fluid in the lungs can be aspirated via the tube. Insert the soft catheter into the tube until you feel it stop. As the catheter is slowly withdrawn, apply suction, but for no longer than 5 seconds and at low pressure.

The child should be hyperventilated for one minute following intubation as significant hypoxia may have developed. Normal ventilation should continue after this.

Intravenous Infusion

Small children have small peripheral veins and the size of cannula to be used is generally smaller. However, it should be borne in mind that a smaller cannula will allow a very much smaller fluid flow. If the cannula bore is doubled, the possible flow rate rises by sixteen-fold. It should also be remembered that Dextrose solution is much thicker than Normal Saline and this will slow down any infusion. You should therefore use as large a cannula as possible. Careful cannulation will allow a larger cannula to be used than seems obvious. The veins in the hand of a three year old child will probably allow a 1.0mm internal diameter 20G cannula to be used instead of the obvious 0.8mm 22G. This will increase the possible flow rate from 31ml/min to 54ml/min. If a 1.2mm internal diameter 18G cannula can be used, up to 80ml/min can be infused. Infusion amounts for children are smaller than for adults, so a close watch must be kept on the amount of fluid being used. The desired amount will be achieved within a short space of time, particularly if the cannula is relatively large.

The actual procedure for cannulation in children is the same as for adults. Care should be taken to ensure that the limb is firmly held, as children are more likely to pull away from the needle. A great deal of reassurance must be given, not only to the child, but also to any relatives present. The limb should be splinted after cannulation to help prevent the cannula being dislodged if the child is restless or agitated.

The choice of cannulation site is slightly different than with adults. The veins in the antecubital fossa and forearm can be well-hidden by subcutaneous fat and the hand veins are more easily found. However, if the child is seriously shocked, neither will be easily visible. In this case, the reliable anatomy of the antecubital fossa should guide you to a suitable vein.

Following the application of the tourniquet, a minute spent waiting for the vein to fill is usually well spent. Children's veins will be small and difficult to see or feel, so it is worth warming the site and tapping the vein to make it stand out. The pressure of the tourniquet need only be slight to fill the vein. The small arteries in the arm, with their relatively low blood pressure, are easily closed.

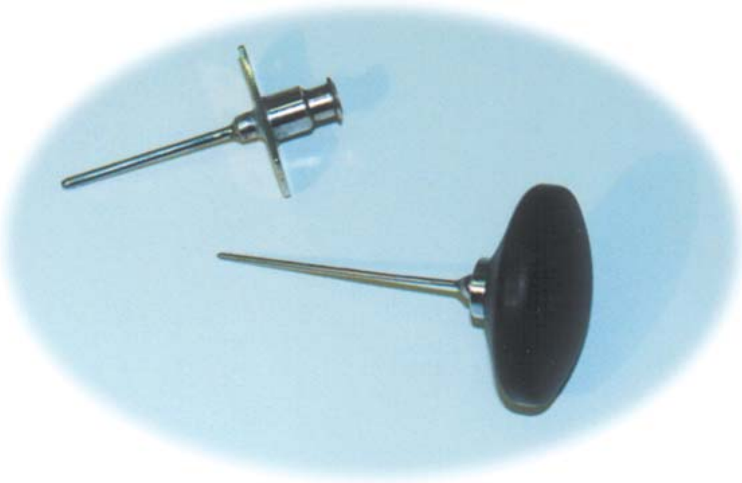
Stretch the skin at the site with a finger and thumb either side and insert the cannula. Children's skin is usually easily penetrated and there is a danger of passing through the vein to the other side. Careful alignment of the cannula in the vein should avoid this. There may not be a normal "flash-back" into the cannula, as the blood pressure is much lower, but there should be some sign. Once you are sure the cannula is in the vein, pull the needle back slightly, advance the cannula fully and remove the needle and place the cap. Do not advance the cannula more than 3 or 4 millimetres without pulling the needle back as there is a danger of the tip of the needle penetrating the vein. Flushing with normal saline should be restricted to 1 or 2 ml and this should be taken into account when calculating fluid therapy.

Secure the cannula with a suitable dressing and proceed with the infusion. If only a small amount of fluid is required, it may be preferable to use a syringe to give several bolus doses, as this is more accurate than measuring the fluid in a soft bag. The three-way tap technique detailed in the intraosseous infusion section should be used.

Fluids should only be given where there is clear clinical need, including the early signs of shock dehydration and hypoglycaemia.

Intraosseous infusion

In 80% of paediatric cardiac arrests, intravenous access cannot be gained within a reasonable time and repeated attempts at gaining intravenous access take up more valuable time. The alternative route for drugs, the trachea and bronchial tree, is not as efficient as the intravenous route and can cause problems because of the large amounts of fluid introduced into the lungs.



Although we are richly endowed with a system of veins, they seem to all but disappear in conditions of shock and cardiac arrest. Due to the additional subcutaneous fat found in children and babies, the veins that are normally used are all but invisible and impossible to feel. It is for this reason that ways have been sought to achieve intravascular access in any patient within 60 seconds of arrival at their side. One very rapid method is by intraosseous infusion. (IO) It should be noted that intraosseous infusion is the second line of intravenous access and should only be carried out after attempts at normal intravenous access have failed.

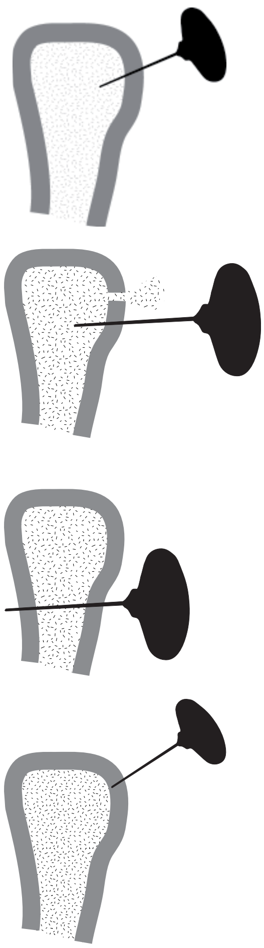
IO access is not only rapid, but it is also easy to carry out and very effective. The bones have a rich structure of veins that communicate directly with deep veins in the limbs. Studies have shown that an IO infusion has similar cardiovascular effects to a central line.

IO has more contraindications and cautions than cannulating a vein. If the chosen bone has been fractured, or there has been a previous attempt at IO access, the integrity of the bone will be compromised and leakage of fluid into the tissues could result. The IO site should be carefully cleaned with several alcohol swabs as infection in the bone can be a problem.

The needle should be placed in a large flat area of the bone, not immediately on the end. However, there have been no reports of epiphyseal growth-plate injury. Fat embolism has not been reported.

Intraosseous infusion is possible, but not usual, at several sites, including the sternum, the ribs, the femur, the pelvis and the calcaneus bone in the foot. The recommended site for Paramedic use is the proximal medial tibia.

Inserting the needle relies on the twisting motion of the sharp tip and does not require heavy pressure. Entry into the bone cortex produces a sudden loss of resistance, but there is no flashback. A check is made on correct placement by aspirating marrow through the needle. A final test is to infuse a small amount of fluid, when no tissuing should be detected. When correctly inserted, the needle will stand alone like a nail.



Correct placement

Correct placement achieves the positioning of the needle in the main medullary canal of the bone.

Incorrect placement

Incorrect placement can include

- Failure to penetrate the medulla.
- Penetration of both sides of the bone and into the tissue by using excessive force.
- Penetration of the side of the bone without penetration of the medulla

Tissuing

Tissuing can be caused by

- Passing through the bone and out the other side.
- Passing through the edge of the bone without entering the medulla.
- An unsteady technique, resulting in the needle passing though a large hole giving leakage at the side.
- Placing the needle near a previous placement attempt, with leakage though the previous hole.

Failure to infuse

Failure to infuse can be caused by

- Failure to penetrate the medulla
- Blockage of the needle by bone and tissue fragments

(these can be cleared by pressure)

Intraosseous Needle Placement Technique

The site is located by palpating two finger-breadths below the knee on the medial aspect of the proximal tibia. Clean the site carefully with alcohol swabs.

Grasp the needle with the butt in the palm of the hand and the fingertips at the tip of the needle. Use moderate pressure to penetrate the skin and subcutaneous tissue. When the bone is felt, change to a smooth back and forth twisting movement with moderate pressure. Penetration may take some time, the older the patient the thicker and therefore the more resistant the bone, so be patient and only use moderate pressure.

As soon as the loss of resistance is felt, remove the pressure and check that the needle stands on its own. If it does not, apply further twisting pressure. If it does, unscrew the stylette and remove the needle. Attach the primed IV line, syringe and three-way tap and check that marrow can be aspirated or that fluid can be infused using the syringe. Immediately you know you are successful, give the IV bolus as required in accordance with the patients condition.

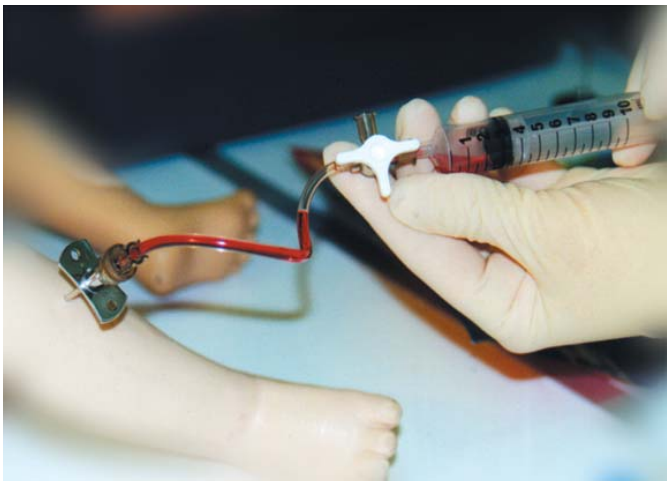
Once the needle is placed and running correctly, the fluid lines should be carefully secured to avoid displacement. As the needle stands proud of the skin, the lines should be secured using the hinge-tape technique. The limb should be splinted to avoid unnecessary movement, which may lead to displacement, particularly in a conscious patient.

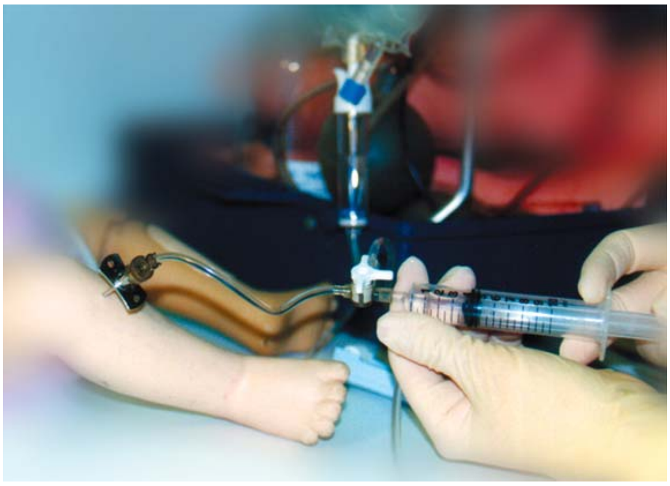
Management of the infusion

The fluid is infused via a three-way tap and a syringe, to enable accurate measurement and control of the amount infused. The use of the three-way tap to infuse fluids is relatively simple once the technique has been learnt. The amounts to be administered are shown in separate chapters dealing with various conditions.

The three-way tap is connected as shown in the picture. The tap is turned to close off the cannula and to open the way between the bag of fluid and the syringe. As the syringe is drawn, fluid passes from the bag, via the giving set, into the syringe, where an accurate measurement of the fluid can be made. The tap is then turned to close the bag of fluid off and open the way from the syringe to the cannula. The syringe is depressed and the fluid passes from the syringe through the tap to the cannula and into the patient. This can be repeated as necessary to give the correct amount of fluid.

You must be on the way to hospital as the patient that needs IO needs to be in hospital. The vehicle must be stationary for actual needle insertion. The site of the infusion should be carefully monitored for tissuing and swelling.





Determine the side of the chest that has the tension. The chest will be hyperresonant on the affected side. The trachea may be deviated towards the unaffected side. There will be decreased movement of the chest wall on the affected side. The chest wall on the affected side may become distinctly prominent when compared with the unaffected side.

Palpate the chest on the affected side and find the clavicle. Move your fingers down the chest wall until you reach the second intercostal space. Find the mid-clavicular line. The cannula must be inserted over top of the rib as the intercostal nerve and artery run in the groove inside the lower edge.

Insert a large-bore cannula until you feel the "pop" as it passes through the chest muscle wall. Air should be vented through the cannula under pressure from the pleural cavity. If it is not, adjust the depth of the cannula, in and out. Attach a syringe and withdraw approximately 50ml of air. If no air still comes though, check again whether there is actually a tension pneumothorax. If air is vented, remove the needle completely and replace the cap on the cannula. Secure the cannula with tape.

Once the cannula is in place, there should be a rapid improvement in the respiratory status of the child. Keep a check on the chest and vent the air again, if necessary, by simply removing the cap from the cannula.

Needle Cricothyroidotomy

When repeated attempts at ventilation by other means have failed, total airway obstruction is best treated with tracheostomy or surgical cricothyroidotomy. However, these procedures are fraught with dangers and complications and are not currently available to Paramedics. They involve opening the trachea with a scalpel and inserting a metal tube to act as a substitute airway. The area alongside and in front of the larynx is rich with blood vessels and nerves, and is flanked by the thyroid gland. A great deal of damage can be caused with the scalpel. Needle cricothyroidotomy, on the other hand, is very much safer. It involves making an opening in the cricothyroid membrane with a large-bore cannula, which will act as a substitute patent airway.

There are still potential hazards which could cause complications when carrying out the procedure. There may be significant bleeding into the airway if a vein or artery is punctured with the cannula. This is unlikely, as no large blood vessels normally cross the area to be punctured, although a small lobe of the thyroid gland may be punctured, usually with little effect. The cannula may be placed into the soft tissue of the trachea instead of the lumen, causing surgical emphysema. If the child is still conscious, this can be a hazardous procedure as the child will be struggling because of the airway obstruction and the larynx will also be very mobile due to gasping and swallowing.

The airflow through the cannula bore is quite small, compared with the normal trachea, but with oxygen, it can be sufficient for emergency needs until emergency tracheotomy can be performed by a doctor or the condition that caused the blockage has been resolved.

The larynx is made up of cartilage, held together with membranous ligaments. The largest cartilage is the thyroid cartilage, or Adam's Apple, and it's prominence can be felt as a "V"-shaped notch ending in a blunted point. It is more prominent in boys than girls, except in the very young, where there is little difference and is difficult to palpate.

The cricoid cartilage is also known as the cricoid ring and can be felt roughly 1cm below the thyroid cartilage, with a small depression in between. It is through the cricothyroid membrane, in the small dip, that the opening is made in cricothyroidotomy.

The area in front of the larynx should be thoroughly cleaned with alcohol swabs and then the position of the thyroid cartilage determined by palpation. Find the cricoid ring and place finger and thumb either side of the larynx, alongside the cricothyroid membrane, to stabilise the structures. The palm of the hand should be below the larynx the keep the top clear in order to correctly place the cannula pointing down the trachea.

Select a large bore intravenous cannula of at least 16G (brown Venflon). Insert the cannula through the skin and advance it through the membrane. You will feel it "pop" as it passes through. Do not advance too far at this stage as you may puncture the soft tissue at the back of the larynx.

When the point of the cannula is felt to be within the larynx, gradually advance the cannula over the needle, stopping if there is resistance from the rear wall of the larynx. Withdraw the needle and attach a 5ml syringe to the end of the cannula. Aspirate through the cannula with the syringe. If no resistance is felt, turn the cannula towards the child's feet and advance it as far as possible or until any resistance is felt.

The amount of oxygen that can be passed through the cannula is small, but is the only delivery method possible in the case of complete airway obstruction. Manual ventilation by bag and mask is not practical due to the small airflow.

One method of connecting the cannula to an oxygen line is to use a 2.0ml syringe and a yankauer suction catheter. First, remove the plunger from the syringe. The oxygen line is connected to the patient end of the yankauer sucker tube. The yankauer is then pushed into the end of the syringe. The syringe is then fitted to the cannula. Place one finger over the hole in the side of the yankauer and apply high-flow oxygen to the line for one second. The chest should rise, if only slightly. Remove the finger from the hole in the yankauer for three seconds and the pressure in the line will drop, allowing expiration. Continue this one second on - three seconds off cycle for as long as necessary.

Even with a cricothyroidotomy, the child will rapidly develop severe hypoxia and needs to be hospitalised or treated with a surgical airway by a doctor as soon as possible.

Defibrillation

Virtually all children that suffer a cardiac arrest will be found to be in asystole subsequent to respiratory arrest. Defibrillation will rarely be needed.

Many defibrillators in use by Ambulance Services are not supplied with paediatric paddles. This is not a problem with most children, unless they are under the age of about 9 years.

In older children, the normal paddle size and position (sternum and apex) are used. It is the shock level that changes. Also, care must be taken to ensure that the electrode gel does not meet across the chest.

In smaller children, as the chest area is so small, there is a danger that the paddles will be too close together and arcing of the current and subsequent burning may take place. This arcing will also reduce the energy passed through the chest wall to the heart. In this case, the paddles should be placed in the anterior/posterior position, with the sternum paddle on the front of the chest wall and the apex paddle on the back.

Great care must be taken to assess the correct energy level for defibrillation, as a shock suitable for an adult would cause widespread damage to a child.

The correct energy level is calculated thus:

First shock
2Joules per kilogram of bodyweight. (2J/kg)

Second shock
2Joules per kilogram of bodyweight. (2J/kg)

Subsequent shocks
4 Joules per kilogram of bodyweight. (4J/kg)

Most modern manual defibrillators are selectable down to 50 Joules, which would suit a child of 25kg, or approximately 9 years of age.-

If the defibrillator you are using does not have selectable energy levels, or does not go low enough, do not defibrillate the child. Severe, irreversible damage will be caused. You will have to rely on chest compressions to maintain the circulation until a suitable defibrillator can be used.

9

Child Abuse

Child Protection

Professional staff, including Paramedics, who are routinely in contact with children and those who are called in when concerns about individual children arise or an incident occurs, should be skilled and have sensitivity to abuse of a high order so that children at risk are protected. Staff at a hospital Accident and Emergency Department will not have seen the home circumstances of the child and will rely on the report of the Paramedic to gain an insight into the possible causes of any suspicious injuries or conditions. The Paramedic may be the only professional health care worker to have come into contact with the child in the hours surrounding the event and a report of suspicion may enable the hospital staff to begin the process of protecting the child and prevent further abuse.

The protection of the child takes precedence over the responsibilities to the parents and the welfare of the child must be the paramount concern. It must be remembered, however, that treatment of a child requires the consent of the person with parental responsibility, if they are present. Treatment can be refused, but this refusal should be carefully noted. If you consider that the refusal of consent will endanger the child, it must be reported at once to the appropriate authorities. Recognising children who have been the subject of abuse and intervening effectively to protect them ranks as a high priority. Children are entitled to intervention that protects them from neglect, abuse and exploitation. Such intervention will be often be open to challenge.

This does not mean that any child that may possibly have been the subject of abuse must be snatched from the arms of the mother. Instead, any concerns about the welfare of the child must be passed on to the relevant professional person, usually, in the case of Paramedics, the staff at the hospital that the child is taken to. Every Accident and Emergency Department has a person responsible for the issue of child abuse and they will make the necessary enquiries and contacts with Social Services.

It must be remembered that expressions of concern about the welfare of a child are an extremely sensitive matter and great care should be taken to ensure that the information is only passed to those that have a direct concern. It would be very unusual for a Paramedic to have direct conclusive evidence of abuse. Instead, there may be just a suspicion. It is usual not to inform the person who is suspected of carrying out the abuse as this may provoke a reaction that will make management of the case very difficult. A discreet conversation with another professional out of earshot of the parent and child would be the normal course of action for the Paramedic. Absolute confidentiality must be maintained at all times, as allegations of abuse are very damaging, especially if they turn out to be untrue.

It is important that the child should not be questioned too closely at this stage, if at all. In the case of Paramedics called to the scene of an accident or injury, it will normally be sufficient to ask the child what has happened. The Social Services and Police have specialist officers who will investigate the case and any interference at an early stage may well prejudice the interviews and any evidence gained from them. Any prosecution may fail because of concerns about "prompting" of the child.

Definition of Abuse

Child abuse is defined as any deliberate action or omission that causes, or is likely to cause, the child to suffer significant harm. The Children's Act 1989 does not actually use the term "abuse", but does use the term "significant harm". Significant harm is defined in the Act as:

- Ill-treatment
- The impairment of health
- The impairment of development.

Ill-treatment includes sexual abuse and other forms of ill-treatment which are not physical. Health means physical or mental health. Development means physical, intellectual, emotional, social or behavioural development.

The harm must be significant. With impairment of health or impairment of development, the significance of harm will turn on a comparison of the child's health or development with a standard of health or development that could be reasonably expected of a similar child.

The definition of abuse by the term "significant harm" acknowledges that few of us get through childhood without suffering some harm and that parents are not perfect. The question to be considered for any child is how significant the harm may be and how reasonable is the care of the child.

As far as Paramedics are concerned, the abuse recognised and reported will normally be physical harm to the child, although the possibility of other types of abuse should be borne in mind.

The Child Protection Register

A child may be placed on the Child Protection Register (also known as the "At Risk Register") if the Social Services Department, after due consideration and consultation, consider that the child is at risk of abuse. For the purposes of the Register, a child is defined as a person under the age of eighteen. Although the Paramedic will not have access to the Register, it is helpful to know the registration categories.

Neglect

The persistent or severe neglect of a child, or the failure to protect a child from any kind of exposure to danger, including cold or starvation, or extreme failure to carry out important aspects of care, resulting in the significant impairment of the child's health or development, including non-organic failure to thrive.

Physical Injury

Actual or likely physical injury to a child, or failure to prevent physical injury (or suffering) to a child including deliberate injury, poisoning, suffocation and Munchausen's Syndrome by proxy. Munchausen's Syndrome by proxy is exhibited by repeated fabrication of clinically convincing simulations of disease for the purpose of gaining medical attention for a child. It is a term referring to patients or parents who wander from hospital to hospital or repeatedly call for an ambulance, feigning acute medical or surgical illness in the child and giving false and fanciful information about the medical and social background for no apparent reasons other than to gain attention.

Note: Diagnosis of Munchausen's Syndrome cannot be made on scene. If the child is displaying signs and symptoms of a condition, the appropriate treatment must be given. It may be that the condition is being induced by the parent, but treatment is still required if the condition exists.

Sexual Abuse

Actual or likely sexual exploitation of a child or adolescent. This includes acts such as fondling of genitals of or by the child as well as actual penetration of the genitals, anus or mouth.

Emotional Abuse

Actual or likely severe adverse effect on the emotional and behavioural development of a child caused by persistent or severe emotional ill-treatment or rejection. All abuse involves some emotional ill-treatment but this category is used where it is the main or sole form of abuse.

Recognition of Abuse

The first indication that a child is being abused is not necessarily the presence of a severe injury, although this is the category of abuse most likely to be recognised by the Paramedic. Concerns that a child is being abused may be aroused by the sight of bruises or marks on a child's body or by remarks made by the child, his or her parents or friends, or the observation of a child's behaviour or reactions, from an awareness that a family is under stress and may need help with caring for the children or from a number of other factors. While the situation may not seem initially to be serious, it is worth remembering that prompt help to a family in trouble may prevent minor abuse escalating into something more serious. It is therefore worth reporting any suspicion that you have that the child may be subject to any form of abuse.

Signs and Symptoms

There are some signs that are common in physical abuse. These include unexplained injuries such as bruises, bites, fingernail marks, welts, lacerations or abrasions, particularly to the face, lips and mouth, the torso, back, buttocks and thighs. The injuries may be in various stages of healing and come in clusters forming regular patterns. They may reflect the shape of the article used, such as a belt, a buckle or electrical flex. It should be remembered that small children at play often suffer from minor injuries to the shins, knees, elbows and other prominences as they fall over. It is not unusual for small children to have grazed knees.

Unexplained burns may raise suspicion if they are cigarette or cigar burns, especially on the soles of the feet, the buttocks, the palms of the hands or the back. Rope burns to the arms, legs, neck or torso are usually significant. Immersion in hot water causes burns, but these can easily be caused by accident. Burns from an iron or other hot implement should be considered in the light of the likelihood of the child being accidentally burnt in the manner found. Fractures to the skull, nose and facial structure may be significant. However, the presence of fractures in various stages of healing or multiple of spiral fractures are only diagnosed by x-rays in hospital.

It has been noted that almost all sub-dural haemorrhages in infants are due to abuse, but abuse is usually not recognised. (BMJ 1998).

Neglect can be shown by a very dirty child that has dirty clothing beyond what could be expected in a child of that age. The clothing may be inappropriate for the time of year, such as summer clothes in the middle of winter. A neglected child may appear to be pale, listless and underweight. It should be remembered, however, that poverty is not abuse and account should be taken of the family circumstances.

Sexual abuse is extremely difficult to discover in the field as an abused child may deny abuse or cover up the signs due to fear, shame or guilt. They may also have been sworn to secrecy by the abuser. The child may be sore or bleeding in the genital area or anus and may be reluctant to be examined in this area. They may say that somebody has done something "bad" to them and that it is a secret. They may display an awareness of sexual matters that is beyond what can be expected from a child of that age. Children under the age of five usually know nothing about sex. The child may shown signs of withdrawal or signs of neglect.

Behavioural signs are extremely difficult to interpret in the field and great care must be taken to observe the child whilst a physical examination is being carried out. The child may flinch when approached or touched, although this is common in small children that have been injured in any way, accidental or not.

The child may appear to be frightened of their parent or carer or may look accusingly at them when asked about the injury. The child may regress to behaviour that would be normal for a much younger child. "Frozen watchfulness" is a rarely-seen sign that the child is being seriously abused.

Any behaviour that is abnormal for a child of that age should be noted and taken into consideration in your findings as a whole.

REPORTING SUSPECTED ABUSE

Any suspicion that a child is being abused must be reported as soon as possible to the appropriate authority. For Paramedics, this will normally be the staff at the Accident and Emergency Department, who will make the necessary arrangements for contacting the Social Services Department or Police.

The report should initially be made verbally and in absolute confidence. However, a record should be kept of your suspicions. It should be remembered that any remarks made on a patient report form may be read by the parent or carer and should therefore be confined to the facts. A confidential report should be written as soon as possible after the event, and should include your suspicions as well as your absolute findings. This report should be submitted to your line manager for urgent forwarding to the appropriate authorities.

If the child is not taken to hospital for any reason, concerns should be made known to Control, who will be able to contact the Social Services Department or even the Police in cases of serious danger for the child. This report should be made by telephone, if possible, to ensure confidentiality and to avoid the possibility of misunderstanding, which is common in radio conversations. If you consider that the child is in imminent and serious danger, the attendance of the Police should be requested, via radio to Control.

SUMMARY

- The child's welfare and interests must be paramount, taking precedence over all other considerations.

- If a child discloses abuse to you, always acknowledge how difficult and painful it must have been for them to do so.

- Tell and show a child that you are taking them seriously.

- Always think before you act, keep an open mind and take an objective view of the situation.

- Consider the long-term future of the child and not necessarily the option which is least painful or troublesome for you.

- Do not take inappropriate action, as it could put the child at further risk. Follow the procedures.

- Do not ignore the child's race, gender, culture or ability.

- Do not make promises to the child that you cannot keep.

- Do not take sole responsibility. If you are concerned, consult with other professionals.

If you are reluctant to report your findings in case somebody is wrongly accused of abuse, bear in mind that it may be your report, although unproven and not totally clear-cut, that is the final piece of a jigsaw of reports and suspicions that finally provides enough evidence for the child to be given complete protection from an abuser. The child may already be on the Child Protection Register, in which case your report will be added to the information held on the child and family. You will probably not know the overall picture. The protection of the child is paramount and they are entitled to your help and protection.

10

Calculations & Drugs

Calculations

Note:

The weights, sizes etc. of children given in this book and in these tables and calculations are based on average values. If the child seems above or below average size or if you know the actual weight or size of a child, drug therapy and equipment should be adjusted to suit the child in question.

The average values are summarised in the table at the end of this chapter.

Weight

The drug dosages for a child are dependent on the child's weight. The average weight of children of different ages can be determined by the formula:

Weight (kg) = (age + 4) x 2

ET Tube size

The size of endotracheal tube to use is determined by the formula:

Internal diameter (mm) = (age/4)+4

As a rough guide, the tube diameter should be the same as the child's little finger, or of such a size that will just fit into the nostril.

Defibrillation

It should be noted that defibrillation is rarely required for children, nearly all paediatric cardiac arrests will be asystole.

Paediatric paddles should be used when they are available. If not available, use a chest/back paddle position. In babies and very small children, adult paddles are too big and should not be used.

1st shock 2J/kg of bodyweight

2nd shock 2J/kg of bodyweight

Subsequent shocks 4J/kg of bodyweight

Drug Dosages

The indications, mode of action, contraindications, cautions and side effects of each drug are given below, but they must be read in conjunction with the relevant section of the book dealing with the actual condition. These are the Paediatric uses of the drugs and do not necessarily relate to the adult uses of the drug.

All the drugs detailed here are suitable for use up to the age of 12 years, qualified as necessary in the text. Over the age of 12, patients are considered to be adults as far as drug administration is concerned, (except for epinephrine in anaphylaxis,where half the dose is given in pre-pubertal children even if they are over 12 years of age) although some paramedic drugs have other age limits.

Aspirin

Owing to an association with Reye's syndrome, aspirin-containing preparations should not be given to children under 12 years, unless specifically indicated, e.g. for juvenile arthritis(Still's disease) which is outside the remit of paramedics.

Reyes Syndrome is a disorder of young children following an acute febrile illness, usually influenza or varicella infection, characterized by recurrent vomiting beginning within a week after onset of the infection and from which the child either recovers within a day or two or lapses into a coma with intracranial hypertension; serum transaminases are elevated; death may result from oedema of the brain and resulting cerebral herniation.

Reye's syndrome has also been reported very rarely in children over 12 years and aspirin should preferably be avoided during fever or viral infection in children and adolescents over 12 years. The alternative ani-pyretic is Paracetamol Elixir (Calpol) as noted below.

Atropine

Indications and dosage

Cardiac Arrest

Atropine is not included in the algorithm for cardiac arrest in children. The only drug for use by paramedics in paediatric arrest is epinephrine (adrenaline) see below.

Bradycardia

It should be noted that bradycardia in children is most often the result of hypoxia and therefore the correction of the hypoxia should be sought first.

If the cause is subsequently found to be other than hypoxia, (such as vagal stimulation from suctioning or intubation or organophosphate poisoning) atropine IV should be given at a dose of 20mcg/kg bodyweight, with a minimum dose of 100mcg (200mcg in the case of organophosphate poisoning) and a maximum dose of 600mcg.

BENZYLPENICILLIN G

Indications & Dosage:

Meningococcal septicaemia.
<1 year 300mg in IV/IO: 5ml water for injections IM: 1ml water for injections
1 - 9 years 600mg in IV/IO: 10ml water for injections IM: 2ml water for injections
> 9 years 1200mg in IV: 20ml water for injections IM: 4ml water for injections

Actions

Penicillin is an antibiotic and operates against a large range of bacteria.

Cautions

Many patients or their relatives think they have had an allergic reaction to penicillin when in fact all that has happened is that they have suffered expected side-effects (see below). If this is clearly the case, penicillin should be given. However, if there is doubt, penicillin should be witheld in favour of rapid transport to hospital.

Contra-indications

If the patient has had a genuine allergy reaction in the past, i.e. unconsciousness, collapse, swelling, difficulty in breathing etc. penicillin must not be given. See cautions above.

Side effects

Administration of penicillin IV or IO may provoke sudden hypotension and a feeling of deep malaise, due to the sudden release of toxins.
Gastro-intestinal problems such as diarrhoea and vomiting are normal side-effects.
Hypersensitivity reactions associated with anaphylaxis may occur.
Extremely rarely, an anaphylactoid reaction may take place if this is the first administration of penicillin, or an anaphylactic reaction if they patient has been sensitised previously.

CHLORPHENAMINE (PIRITON)

Indications & Dosage:

Severe anaphylactic reactions.
Less severe allergic reactions with distressing symptoms.

1-6 years 2.5mg
6-12 years 5mg
> 12 years 10mg
Each by slow IV/IO injection over 1 minute

Actions

Chlorphanamine is an anti-histamine, but also has anticholinergic properties (antagonistic to the parasympathetic system and it's effects).

Cautions

Existing hypotension
Epilepsy
Known hepatic disase

Contra-indications

Known hypersensitivity (very rare)
Children <1 year

Side effects

Chlorphanamine is likely to cause some sedation and transient hypotension, with a headache. The anticholinergic effetcs may cause dry mouth, blurred vison, GI disturbances and psychomotor impairmant. However, these side effects are more often found in the elderly, so are relatively uncommon in children.

Diazepam (Stesolid and Diazemuls)

Indications & Dosage:

Indications:

Continuing fitting for more than five minutes due to epilepsy or febrile convulsions. IV administration is more reliable and therefore is the preferred route. IV access should be gained as early as possible. However, if IV access is difficult, as in small children and those fitting violently, rectal diazepam should be used. If a rectal dose enables you to gain IV or IO access, the second (single) dose of diazepam should preferably be given by that route instead of rectally, as it is more effective.

Rectal diazepam (Stesolid)

Age <1 year 2.5mg rectally (which may be repeated once only)
Age 1-5 years 5mg rectally (which may be repeated once only)
Age 6-12 years 10mg rectally (which may be repeated once only)

IV diazepam (Diazemuls)

IV diazepam is given in the same dosage by weight for all ages up to 12 years
300mcg/kg IV ONCE ONLY

Action:

Anti-convulsive, sedative and muscle relaxant.

Cautions:

May cause respiratory depression.
Many children who are prone to epileptic fits and febrile convulsions are issued with rectal diazepam for administration by their parents or carers in an emergency. Any doses given before the arrival of the paramedic should be taken into account in the maximum cumulative dose.

Contraindications:

Liver disease. (May precipitate coma).
Known sensitivity to Diazepam
Previous apnoea following administration.

Side Effects:

Drowsiness.
Ataxia.
Respiratory depression.

ENTONOX

Indications & Dosage:

Moderate to severe pain.

Action

Thought to act on the perception of pain. Entonox normally takes 3-5 minutes continuous use before any effect is felt, with maximum effect being achieved only after 5-10 minutes. However, susceptibility and reaction to Entonox varies considerably and some patients may find no relief at all. In these cases, IV analgesia should be given. The effects of Entonox wear off as quickly as they come on, so almost continuous self-administration may be required.

Cautions

Entonox is 50% oxygen and 50% nitrous oxide. If more than 50% oxygen is required, such as in severe trauma, IV analgesia should be given.
Very young children may not understand the instructions for self-administration. Care should be taken that paramedics or parents helping the child to take the gas do not give so much Entonox that unconsciousness ensues.
Where pain in hollow organs, such as the bowel, are involved, Entonox may increase the pressure and therefore increase the pain. Should this occur, IV analgesia should be substituted.

Contraindications

Severe chest injuries which may involve a pneumothorax (simple or tension)
Severe head injuries (not simple head wounds) with impaired consciousness.
Decompression sickness.
Violent psychiatric patients

Side effects

May cause the patient to “feel strange” or dizzy, leading to vomiting.

Epinephrine (adrenaline)

Indications & Dosage:

1:10,000 - First dose in cardiac arrest - IV or IO 10mcg/kg (0.1ml/kg)
If IV or IO access is not possible, for first dose use ET 100mcg/kg (1ml/kg)
1:10,000 - 2nd+ doses if arrest is secondary to circulatory collapse 100mcg/kg (1ml/kg)

1:10,000 - Subsequent doses in cardiac arrest - IV or IO or ET 10mcg/kg (0.1ml/kg)
1:1,000 - Subsequent doses in cardiac arrest - IV or IO or ET 10mcg/kg (1ml/kg)

1:1,000 - Anaphylaxis - Intramuscular (repeat all these doses after 5 minutes if required)
<6 months 50mcg (0.25ml)
6m-5 years 120mcg (0.12ml)
6-11 years 250mcg (0.25ml)

1:1,000 - Asthma - Subcutaneous 10mcg/kg (last resort option only)

Action:

Adrenaline is a sympathomimetic, stimulating the sympathetic nervous system.
The rate and strength of cardiac contraction is raised, tending to increase blood pressure and general perfusion.
The spleen contracts to force blood into the general circulation.
The coronary arterioles are dilated, giving increased blood supply to the myocardium.
The pupils dilate.
The salivary glands are inhibited, giving a dry mouth.
The arterioles in the skin and mucosa constrict, causing the blood to be forced back into the central circulation. It thereby also causes pallor and dry mucosae.
The sweat glands are stimulated to produce large amounts of sweat.
The arterioles in the abdominal viscera are constricted and the smooth muscle of the gut is constricted, which stops the action of the gut (and also stops diarrhoea).
The blood vessels in the kidneys constrict, reducing the production of urine.
The pancreas is inhibited from producing enzymes and insulin.
Glucagon production is raised, resulting in an increase in blood glucose levels.
The smooth muscles in the bronchioles are relaxed, causing bronchodilation.
Fat cells are broken up chemically, ready for use as fuel.
The liver is stimulated to produce glycogen, a carbohydrate readily converted to glucose. (It should be noted, however, that small children have small stores of glycogen and are therefore prone to hypoglycaemia when ill or injured).

Cautions:

May exacerbate tachycardia.

Contraindications:

None when condition indicates use of adrenaline.

Side Effects:

See above.

Glucagon (Glucagen)

Indications & Dosage:

Hypoglycaemia due to diabetes, trauma or illness, with blood glucose of less than 3mmols/l.
Unconscious patients where hypoglycaemia may be a cause.

Age <1 month 100mcg (1/10 ampoule) IM only
Below 20kg (6 years) 0.5mg (½ ampoule) IM only
Above 20kg (6 years) 1.0mg (1 ampoule) IM only

Action:

Stimulates the conversion of glycogen in the liver to glucose in the blood.

Cautions:

The use of glucagen in children, especially in illness, may not be ideal as children have relatively small glycogen stores. IV or IO 10% glucose would be preferable (see below). However, if venous access is not possible, glucagen may be used to correct hypoglycaemia.

Contraindications:

Known allergy to Glucagon.
Able to treat with oral glucose.

Side Effects:

Diarrhoea, nausea and vomiting may be experienced.
Glucagon may cause a hypersensitivity reaction, but this is a rare event as glucagon is a natural hormone.

Glucose Solution - 10% (Dextrose)

Indications & Dosage:

Hypoglycaemia due to diabetes, illness or injury. (BM <3mmmol/l)
Unconsciousness from an unknown cause accompanied by hypoglycaemia <3mmol/l
In both cases, oral glucose should be given instead, where possible.

5ml/kg of bodyweight IV or IO - single dose.
If this results in a dose of >100ml, restrict to 100ml in one dose, followed by the remainer after 5 minutes.

NOTE: 20% dextrose should not be used for children.

Action:

Directly raises the blood glucose level, thereby aiding metabolism and energy production (especially in conjunction with natural or injected adrenaline)
Aids cerebral metabolism.
Corrects dehydration.

Cautions:

Danger of overinfusion when given at the same time as crystalloids. A clinical decision has to be made as to which is more important in each particular case.

Always use the largest bore cannula possible and flush the cannula before administration to ensure correct placement in the vein, as infiltration into the tissues will cause necrois. The vein should be flushed afterwards to prevent phlebitis from local high-concentration glucose.

Hartmann's Solution (Sodium lactate solution)

Indications & Dosage:

Significant blood or fluid loss from trauma or dehydration.

Children up to the age of 12 years up to 20ml/kg bodyweight IV or IO bolus, according to physiological response.
This may be repeated if no improvement is noted.

Action

Increases cerebral blood flow and reduces hypoxia by raising the blood pressure.

Cautions

Large infusions of Hartmanns solution should be avoided in cases of isolated head injuries (with no other major trauma or major blood loss) as it may cause a rise in intra-cranial pressure.

Contraindications

Do not use for rehydration in hyperglycaemia as the additional ingredients may cause haematological problems.

Side effects

Large volumes may precipitate heart failure, respiratory distress and hypertension. .

Hydrocortisone

Indications & Dosage:

Secondary treatment in severe, life-threatening asthma with a journey to hospital of more than 30 minutes. (Primary treatment is salbutamol and adrenaline (epinephrine))
Secondary treatment in Anaphylaxis (Primary treatment is adrenaline (epinephrine)).

Children <1 year 2.5mg/kg bodyweight
Children < 12 years 4mg/kg bodyweight
Administer over 30 seconds to 1 minute.

Action

Supresses the immune response, reducing inflammation.

Cautions

None

Contraindications

Known allergy

Side effects

May cause burning or itching of the groin if administered too quickly.

Hypostop

Indications & Dosage:

Hypoglycaemia caused by diabetes where the patient is conscious and able to swallow and control their own airway.
1 ampoule (23g of 40% glucose gel) smeared around the gums.
Although hypostop may be repeated as necessary, failure to raise the blood glucose level significantly indicates that glucagon or 10% IV glucose should be used.

Action

Raises the blood glucose level by rapid absorption through the oral mucosa.

Cautions

None

Contraindications

Patient must be conscious and able to swallow and control their own airway.

Side effects

None

Ipratropium Bromide (Atrovent)

Indications & Dosage:

Acute severe or life-threatening asthma. (To be given with the first dose of salbutamol)
Acute asthma unresponsive to salbutamol.

6-11 years 0.5mg once only Nebulised.
12 months - 5 years 0.25mg once only Nebulised.
<12 months 0.125mg once only. Nebulised.

Action

Ipratropium is an anticholniergic bronchodilator which works dircetly on the smooth muscles of the bronchioles by antagonising acetylcholine, the nerve transmitter of the vagus nerve. Ipratropium works slightly more slowly than salbutamol, but as it works in a different way, the effects of the two drugs are additive, making it useful in acute severe or life threatening asthma and also asthma that is unresponsive to salbutamol.

Cautions

None

Contraindications

None in a life-threatening emergency.

Side effects

None

Metoclopramide (Maxolon)

Metoclopramide is contraindicated under the age of 20 years.

Morphine Sulphate

Indications & Dosage:

Severe pain. If the pain is obviously very severe, Entonox need not be used beforehand.

1ml morphine should be diluted with 9ml normal saline (0.9%) to a concentration of 10mg in 10ml

0.05mg/kg (0.05ml/kg when diluted) as a slow IV or IO bolus over 2-3 minutes. If this is ineffective, further doses of 0.05mg/kg may be given, up to a maximum total dose of 0.2mg/kg (0.2ml/kg when diluted).

Action:

Thought to simulate endorphins, which are neurotransmitters at inhibitory synapses in the central nervous system.

Cautions:

May cause respiratory depression.

Contraindications:

Infants <1 year of age.
Hypotension (<80mmHg in schoolchildren, <70mmHg in pre-school children)
Head injury with lowered level of consciousness (GCS <12)
Respiratory depression
Concomitant use of other strong analgesics.

Side Effects:

Respiratory depression.
Confusion.
Nausea.
Sedation.
Headache.

Nalbuphine Hydrochloride (Nubain)

Indications:

Moderate to severe pain not relieved by Entonox.
150mcg/kg of bodyweight (up to 5mg) which may be repeated once only, if necessary.

Action:

Thought to simulate endorphins, which are neurotransmitters at inhibitory synapses in the central nervous system.

Cautions:

May cause respiratory depression.

Contraindications:

Where morphine is available, as morphine is the drug of choice for strong analgesia.
Infants <1 year of age.
Hypotension (<80mmHg in schoolchildren, <70mmHg in pre-school children)
Head injury with lowered level of consciousness (GCS <12)
Respiratory depression
Concomitant use of other strong analgesics.

Side Effects:

Respiratory depression.
Confusion.
Nausea.
Sedation.
Headache.

Naloxone (Narcan)

Indications:

Respiratory depression or apnoea from opiate overdose or from an unknown cause.

Children First dose 10mcg/kg of bodyweight IV IO or IM, as available.
Children may require a subsequent dose 100mcg/kg of bodyweight IV. after 3 minutes if required.

Neonates 100mcg, IM only, single dose only.

Note if IV route is unavailable, IM dose may be given, but the action may be slower.

Action:

Blocks the opiate receptors in the central nervous system.

Cautions:

Has a shorter half-life than opiates. Naloxone may become ineffective before the opiate has been metabolised. A second dose may be necessary after 20-30 minutes
Very small children of drug abusers may be addicts and suffer acute withdrawal reactions.

Contraindication:

None

Side Effects:

Reverses legitimate opioid analgesia.

Normal Saline Solution (0.9% Sodium Chloride)

Indications & Dosage:

Intravenous fluid replacement in suspected or proven loss of fluid from the systemic circulation. (Blood, vomit, diarrhoea or displacement of fluid due to anaphylaxis etc.).
Crystalloid is the first choice of fluid.

In fluid loss, give a fluid challenge of up to 20ml/kg of body weight, IV or IO, titrated carefully to physiological response. Stop once the desired blood pressure is achieved. (80mmHg in schoolchildren and 70mmHg in pre-school children). The dose may be repeated once if necessary.

In hyperglycaemia, give up to 20ml/kg, IV or IO, whilst monitoring physiological response. This may be repeated once if necessary.

Action:

Raises blood pressure temporarily (½ -2 hours half-life)
Corrects dehydration.

Cautions:

Overinfusion can cause, heart failure, respiratory distress and hypertension.

Contraindications:

Small fluid loss that is compensated for by the body.

Side Effects:

Haemodilution in large doses, leading to clotting disorders and lack of oxygen-carrying capacity in the blood.

Paracetamol (Calpol)

Indications & Dosage:

Relief of mild to moderate pain and pyrexia.
3m - 1 year 120/125mg oral, via an oral syringe. Repeated in not less than 4 hours.
1 - 5 years 240/250mg oral, via an oral syringe. Repeated in not less than 4 hours.
6-12 years 480-500mg oral. Repeated in not less than 4 hours.

In all cases, the maximum dose in 24 hours is 4 age-related doses, which must be taken into account when administering paracetamol.

Action

Analgesic and anti-pyretic

Cautions

Previous doses given by parents or carers

Contraindications

Known allergy
Previous dose in the last 4 hours
Maximum dose in 24 hours already given.

Side effects

Extremely rare.

Salbutamol (Ventolin)

Indications:

Bronchoconstriction due to asthma, allergy, anaphylaxis, smoke inhalation or any other cause.
<12 months 2.5mg nebulised with oxygen ONCE ONLY
1-5 years 2.5mg nebulised with oxygen, which may be repeated every 15-30 minutes as necessary
6-12 years 5mg nebulised with oxygen, which may be repeated as necessary.
In all cases, if tachycardia becomes a problem, repeat doses should be stopped.

In the case of acute severe life-threatening asthma, atrovent should be added to the first nebuliser. If severe asthma is unresponsive to salbutamol, atrovent should be used instead. See above for dosages etc.

Action:

Stimulation of the Beta cells in the smooth muscles of the bronchioles, relaxing the muscles. This brings about bronchodilation where bronchconstriction has been caused by an allergic response.

Cautions:

Likely to cause tachycardia due to the effects on the beta-receptors in the heart.
Children under he age of 1 year rarely have asthma and another cause of wheezing should be sought.

Contraindications:

None in an emergency

Side Effects:

Tachycardia.
Changes in the focusing ability of the eyes.
Tremors.