Chapter 1

The principles of emergency medicine

People from many different backgrounds, with an enormous variety of problems, present to an emergency department (ED) both by day and by night. Fortunately, certain basic principles are applicable to the care of them all.

Immediate (or primary) assessment and management of the patient

The priorities are as follows. In all cases, swift and accurate assessment must immediately lead to appropriate action.

For cardiac arrest protocols see page 156.
For further details of immediate assessment and management of children see Chapter 18, page 323.

A – Airway

The airway may be:

- patent, partially obstructed or completely obstructed (this results from physical obstruction or loss of muscle tone);
- adequately protected or at-risk (this depends on the protective reflexes of the airway).

Check for responsiveness

Is the patient alert and responsive to questions? A verbal reply confirms that there is:

- a maintained and protected airway;
- temporarily adequate breathing and circulation;
- cerebral functioning.

If responsive, then the patient will usually be able to elaborate on the cause of the sudden deterioration that has brought him or her to an ED.

Failure to respond indicates a significantly lowered level of consciousness and therefore an airway that may be obstructed and is definitely at risk. There may be a need for airway opening manoeuvres and action to protect the airway.

Look, listen and feel for breathing

The absence of breath sounds indicates the need to attempt airway opening manoeuvres (*see below*) and if unsuccessful to consider the possibility of a foreign body obstruction.

> Foreign body obstruction may initially present as a distressed, very agitated, cyanosed patient – 'choking'.

For choking protocols see page 205.
For respiratory arrest see page 208.
For cardiorespiratory arrest see Chapter 11, page 156.

If breathing is present then:

Look for the signs of partial upper airway obstruction

- *Snoring* – the familiar sound of obstruction caused by the soft tissues of the mouth and pharynx. Often it accompanies the reduced muscle tone of a lowered level of consciousness.
- *Rattling or gurgling* – the sound of fluids in the upper airway.
- *Stridor* – a harsh, 'crowing' noise, which is heard best in inspiration. It is thus different from

wheezing, which is usually loudest in expiration. Stridor suggests obstruction at the level of the larynx and upper trachea. General illness and temperature usually indicate an infection causing swelling. Obstruction by a foreign body is the other main cause.

In cases of suspected supraglottic swelling, examination or instrumentation of the throat should not be carried out for fear of causing complete obstruction.

- *Drooling* – the inability to swallow saliva. It suggests blockage at the back of the throat.
- *Hoarseness* – gross voice change. This suggests obstruction at the level of the larynx.

Cyanosis and reduced haemoglobin saturation readings on a pulse oximeter are very late signs of airway obstruction.

For clearance and protection of the airway *see below*.
For laryngotracheal obstruction see page 205.
For allergic reactions see page 295.
For surgical airways see page 23.

Assess the need for cervical spine protection before any airway intervention.

Clearance and maintenance of the airway

A patent airway is a prerequisite for life; a blocked airway is a common harbinger of death in emergency situations. There are two main ways in which the airway becomes blocked.

1 The most common cause of airway obstruction is a depressed level of consciousness. The tone of the muscles controlling the patency of the mouth and the pharynx is under neural control in much the same way as is the activity of the other striated muscles of the body. When this control is lost the soft tissues around the airway prolapse and fail to maintain its patency (simplistically, the tongue falls back). This can be overcome by:

- tightening these tissues (chin lift manoeuvre);
- pushing the jaw and the hyoid bone and their attached soft tissues forward (jaw thrust manoeuvre);
- putting an artificial airway down the anatomical airway (oro- or naso-pharyngeal airways, endotracheal tubes, laryngeal masks, etc., *see Figure 1.1*).

2 The other way that the airway becomes blocked is by physical obstruction. Many things can do this (direct trauma, external or intramural mass, etc.) However, in emergency practice, there is usually

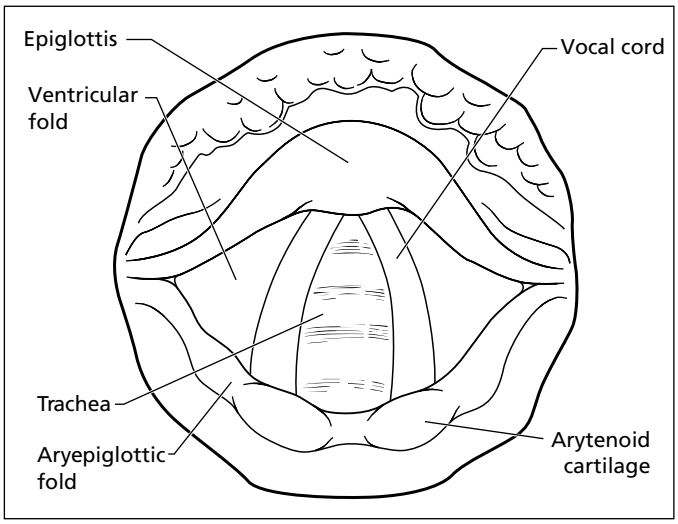

Figure 1.1 Visualisation of the larynx.

either something in the airway (vomitus, blood or foreign body) or there is swelling in the wall of the airway (oedema, haematoma, etc.). This is overcome by:

- removing the cause of the obstruction (suction, manual removal or choking manoeuvres);
- passing an artificial airway (as detailed above) past the obstruction;
- reducing the swelling with vasoconstrictor drugs (adrenaline);
- bypassing the obstruction with a surgical airway.

Protection of the airway

The airway is normally kept clear of foreign matter by the gag, cough and laryngeal reflexes. These may be attenuated by specific palsies, the effects of drugs or a generalised depression of conscious level. They may also be impaired at the extremes of age and in states of general debilitation. Special vigilance is required in all such situations; the recovery position should be used whenever possible.

Paradoxically, these same reflexes may make advanced airway care extremely difficult in situations where they are not completely absent. At such times, the airway should be managed by a person skilled in both its assessment and the use of sedating and paralysing drugs.

> Over 10% of normal subjects have no gag reflex.

Laryngospasm, bleeding, vomiting and consequent hypoxia can result from ill-judged attempts at intubation. It should be noted that the absence of the gag reflex is not a good predictor of the need for (or the ease of) endotracheal intubation.

> In a patient with a reduced level of consciousness, the airway must be assumed to be at-risk until proved otherwise.

On-going protection of the airway requires continual vigilance. The following are also essential:

- The recovery position uses gravity, both to drain fluid matter away from the airway and to allow the soft tissues to be positioned in such a way that they do not cause obstruction. Once the airway is clear, this position can be used to both maintain and protect the airway.
- A high-flow suction catheter must always be near the patient's head.
- The patient's trolley must be capable of tilting "head down" so as to drain vomitus out of the airway.
- If endotracheal intubation is attempted, the airway must be protected by the manoeuvre known as cricoid pressure throughout the period of instrumentation. Pressure is applied to the front of the patient's cricoid cartilage by an assistant using the thumb and two fingers. This compresses the oesophagus against the cervical spine and thus prevents the passive regurgitation of gastric contents. The airway is vulnerable from the start of induced paralysis until the cuff is inflated on a correctly positioned endotracheal tube.

Protection of the cervical spine

If the patient has an injury to the cervical spine, there is a risk of damage to the spinal cord during the procedures needed to maintain the airway. Because of the terrible outcome of such damage, it is mandatory to protect the neck immediately in patients who are:

1 unresponsive with a history of trauma or no clear history;
2 suffering from multiple trauma;
3 difficult to assess;
4 showing any symptoms or signs that might be attributable to the cervical spine.

Adequate protection of the potentially unstable cervical spine consists of a rigid collar and either a purpose-made cervical immobiliser or sandbags and tape.

For exclusion of cervical spine injury see page 57.

B – Breathing

Breathing is the means by which oxygen is delivered to the alveoli and thus made available to the circulating red cells. At the same time carbon dioxide (CO_2) is eliminated.

Look for

- *Difficulty in talking.*
- *An abnormal respiratory rate* – usually fast, laboured breathing. Very slow respiratory rates may occur just before respiratory arrest or as a consequence of poisoning with narcotic drugs, for example, methadone.
- *Recession of the chest wall* – the indrawing of the elastic tissues of a child caused by increased respiratory effort.
- *Nasal flaring and use of the shoulder and neck muscles during breathing.*
- *Paradoxical respiration* – a see-sawing movement of the chest and abdomen, which indicates obstruction of either the upper or lower airways or fatigue of the diaphragm.

All the above suggest that the patient is struggling to achieve normal respiration. Failure to oxygenate the blood adequately and hence the tissues is shown by:

- *Tachycardia* – the nervous system has detected hypoxia and is stimulating the heart.
- *Pallor and sweating* – again caused by sympathetic stimulation.
- *Cyanosis* – a late sign.
- *Irritability, confusion or reduced responsiveness* – the brain is short of oxygen. This is an extremely worrying sign.
- *A low SaO_2 (<95%)* – pulse oximetry should be established as soon as possible.
- *Unequal, diminished or abnormal breath sounds.*
- *Hyper-resonance or dullness to percussion.*
- *Displacement of the trachea or apex beat.*
- *A flail segment.*

For oxygen therapy see below.

For decompression and drainage of the chest see page 77.

For severe allergic reactions see page 295.

For specific treatment of respiratory distress see page 205.

For injuries to the chest see page 75.

Oxygen therapy

The common denominator of all life-threatening illness, regardless of cause, is a failure to deliver adequate amounts of oxygen to the tissues. In normal circumstances, the oxygen content of atmospheric air (21%) is perfectly adequate but when the mechanisms for breathing are diseased or traumatised supplemental oxygen should be given. The physiological compensatory mechanisms for hypoxia and hypovolaemia all consume oxygen themselves; the immediate administration of supplemental oxygen may maintain these reflexes while more definitive measures are put in place.

There are really only two main types of oxygen therapy:

1 high-concentration oxygen (40–100%);
2 low-concentration oxygen (24–30%).

The dangers of high-concentration therapy are known to every medical student. The patient with a chronically raised blood CO_2 level may depend on a hypoxic drive to stimulate breathing – give him or her oxygen and the breathing slows, CO_2 levels rise even higher and the patient becomes comatose with CO_2 narcosis. In practice, these patients are a small group in whom the speed of onset of symptoms can be used to determine treatment – *see pages 215 and 208.*

Hypoxia is a swift killer and so patients in the resuscitation room invariably need a high concentration of oxygen. The use of a mask that has a reservoir bag will improve the effectiveness of oxygen delivery (to perhaps 60–80%) and should be standard. The reservoir bag is needed because a patient's inspiratory flow is always greater than the 15 L per min maximum flow from the oxygen supply.

Blood gases must be obtained at an early stage to monitor the effect of supplemental oxygen. If improvement is not satisfactory, then ventilation may be needed. Continuous positive airway pressure (CPAP) is another method of increasing oxygenation.

Mechanical ventilation

This should always be considered when:

- the patient cannot maintain a clear airway;
- oxygen enrichment of the inspired gases fails to prevent the signs of cerebral hypoxia;
- CO_2 narcosis is present;
- there has been a successful but prolonged resuscitation from cardiac arrest;

- the patient is multiply injured;
- the patient has a severe chest injury (particularly those with multiple rib fractures and/or flail segments);
- the patient is to be transferred and there is a risk of severe deterioration en route.

The emergency induction of anaesthesia for the purpose of intubation and ventilation in a hypoxic patient is a difficult and demanding task. It requires considerable anaesthetic skills.

A pneumothorax is more likely to tension in a ventilated patient. Chest drains must be inserted prior to ventilating patients with chest injuries.

C – Circulation

Check for a central pulse (over 5 s).

The absence of a central pulse (or a rate of less than 60 beats per min in infants) indicates the need to follow procedures for cardiorespiratory arrest (*see page 156*).

The clinical significance of the different arrest rhythms – ventricular fibrillation (VF), asystole and electro-mechanical dissociation (EMD) is discussed on *page 156*.

Look for

- *Pallor and coolness of the skin* – the body diverts blood away from the skin when there are circulatory problems and these signs are thus very useful indicators of shock.
- *Pallor and sweating* – signs of gross sympathetic disturbance.
- *Active bleeding or melaena.*
- *A fast or slow heart rate* – fast heart rates usually mean that either there is a cardiac arrhythmia or more commonly that the sympathetic nervous system has detected a problem with the body (such as hypoxia, hypoglycaemia, pain or fear) and is 'instructing' the heart to beat faster. A slow heart rate usually means that something is wrong with the heart itself. The worst cause of this is severe hypoxia (or hypovolaemia) and, in this case, it means terminal bradycardia and asystole are only seconds away.
- *Abnormal systolic blood pressure (BP).*
- *A raised capillary refill time* – it should be less than 2 s if the circulation is satisfactory. However, peripheral shutdown in a cold, wet patient can easily produce a prolonged refill time.
- *Absent or quiet heart sounds and raised jugular venous pulse (JVP)* – suggestive of tamponade if accompanied by hypotension and tachycardia; JVP will not be raised if there is hypovolaemia also.
- *A precordial wound.*
- *An abnormal electrocardiogram (ECG) trace on the monitor.*
- *Signs of left ventricular failure (dyspnoea, gallop rhythm and crepitations).*
- *Signs of abdominal, pelvic or occult bleeding (may need PR examination and a nasogastric tube or ultrasound scan).*
- *Signs of dehydration (especially in children).*
- *Purpura (meningococcal septicaemia).*

Inadequate circulation will reduce tissue oxygenation and thus may also cause:

- *a raised respiratory rate;*
- *altered mental status.*

Bolus fluid therapy should be calculated at 20 mL per kg and repeated as necessary after further assessment. (Reduced to 10 mL per kg for patients with bleeding following trauma in hospital and no more than 5 mL per kg for patients with trauma in the prehospital setting – *see page 7.*)

For the types of shock and their treatment see page 242.
For blood transfusion see page 26.
For the renal effects of shock (acute tubular necrosis and acute cortical necrosis) see page 252.
For severe allergic reactions see page 295.
For decompression of a cardiac tamponade see page 82.
For emergency thoracotomy see page 83.
For intra-abdominal bleeding see page 84.
For bleeding from the pelvis see page 88.
For cardiac arrhythmias see page 170.
For anaphylaxis see page 233.
For LVF see page 217.

Cardiac function

The stroke volume is the amount of blood ejected from the heart with each beat. It is determined by the left-ventricular filling pressure, myocardial contractility and the systemic vascular resistance.

The product of heart rate and stroke volume is the cardiac output – the most important parameter of cardiac function. (Cardiac index is cardiac output divided by body surface area.) An increase in heart rate will directly increase the cardiac output and is the earliest cardiac response to hypoxia. However, the faster the heart beats the less time there is for it to fill and, eventually, a rise in heart rate will no longer be matched by a rise in cardiac output.

Myocardial function is compromised at high pulse rates because coronary blood flow occurs chiefly in diastole. When the heart rate rises above about 130 bpm in an adult, the filling time is so reduced that cardiac output will actually fall.

Pulse and blood pressure

The autonomic response to hypovolaemia is complex. Rapid blood loss produces a reflex bradycardia, but when associated with tissue damage, it produces the more familiar tachycardia. Systolic blood pressure is the product of the cardiac output and the systemic vascular resistance. A high catecholamine response to hypoxia and hypovolaemia will produce a high systemic vascular resistance. This will maintain a 'normal' blood pressure in the presence of a falling cardiac output.

Knowledge of the systemic blood pressure provides only very limited information about cardiac function and is a very late indicator of haemodynamic instability.

Blood pressure when measured by a cuff depends upon the production of Korotkoff sounds by turbulent flow in the artery. When systemic vascular resistance is high and flow through the artery is relatively low (e.g. in the immediate aftermath of cardiac arrest) these sounds may not easily be heard, even when the mean arterial pressure is good. Great care must be taken when deciding if such patients are beyond salvage or in electromechanical dissociation (PEA).

Maintenance of systemic vascular resistance is a vital response to hypovolaemia and hypoxia. (Skin pallor reflects this early on but is an imprecise clinical sign.) Like other compensatory mechanisms to hypoxia, this vasomotor response consumes oxygen and will eventually fail.

Measurements of pulse and blood pressure are very poor indicators of haemodynamic function in critically ill patients. Central venous pressure may not reflect the functioning of the left side of the heart and is thus of limited use in the assessment of overall cardiac performance. Indwelling pulmonary artery flotation and systemic arterial catheters will provide much more useful information and allow measurement of the cardiac output. Critically ill patients should be moved to an intensive care unit where such monitoring facilities are available as soon as possible. Direct ultrasound measurement of cardiac output may soon become routine in emergency departments, but this facility must not delay consultation with intensivists.

Fluid replacement

Left-ventricular filling pressure (and hence cardiac output) is a function of the circulating blood volume. Increases in heart rate, systemic vascular resistance and myocardial contractility can maintain cardiac output and blood pressure in the early stages of hypovolaemia. However, this will be at the expense of increased oxygen demands by the cardiovascular system and reduced tissue perfusion in many other areas. The rapid restoration of circulating volume will prevent a sudden failure of these mechanisms and an often irreversible fall in cardiac output.

Early restoration of blood pressure by transfusion does not necessarily indicate correction of the circulatory deficit.

The delivery of oxygen to the tissues depends not only on the pumping mechanism of the heart but also on the red cells in the circulating blood. A modest fall in haematocrit can reduce viscosity and increase blood flow while maintaining oxygen delivery but will still require an increase in cardiac output to be effective. Maintenance of haemoglobin levels by blood transfusion reduces the impact of hypoxia by increasing the effectiveness of each cardiac cycle and reducing the need for an increase in cardiac output. Transfused blood will also maintain the oncotic pressure of the circulating fluid, thereby increasing the filling pressure. However, adequate levels of 2,3-diphosphoglycerate

(2,3-DPG) are also necessary for satisfactory oxygen delivery – *see page 26*.

Maintenance of adequate tissue perfusion is not synonymous with the return of a normal blood pressure. Indeed, the latter may be contraindicated in the ED in an actively bleeding patient (e.g. with an aortic aneurysm). Resuscitation can be achieved while keeping the blood pressure relatively low. This has been shown to improve survival until definitive surgery can be undertaken. A similar approach is recommended in the prehospital management of injured adults and older children with presumed blood loss. Intravenous (IV) fluids should not be administered if a radial pulse can be felt (or, in the case of penetrating torso injuries, if a central pulse can be felt). In the absence of these pulses, IV crystalloids should be administered, en route to hospital, in boluses of no more than 250 mL until the relevant pulse becomes palpable. The same advice is probably applicable for young children and infants also, in which case boluses of 5 mL per kg should be used. When rapid fluid replacement is required, warmed IV fluids (40°C) should be be used. A ratio of crystalloids to colloids of at least 50 : 50 has been shown to be safe. Many doctors believe that Hartmann's solution is preferable to normal saline if large volumes are to be given. The role of hypertonic saline in resuscitation looks promising but has yet to be fully established.

D – Disability

After A, B and C (airway, breathing and circulation) have been attended to, it is necessary to look at the state of the brain. The term disability is now widely used to describe a brief assessment of neurological functioning.

Look for

1 A reduced level of consciousness – this is the most important sign of any problem affecting the brain. AVPU scoring is useful initially.

A Alert.

V Voice elicits a response.

P Pain elicits a response. [Attending relatives are usually in a highly distressed state so be careful how you elicit this sign. Pressure on a finger nail (with a pencil) is probably the most subtle way.]

U Unresponsive.

Later, the Glasgow Coma Scale (GCS) should be used (*see page 36 for GCS in adults and page 327 for children*).

Always consider hypoglycaemia as a cause for a reduced level of consciousness.

2 Abnormal pupils – look for size, equalness and reactivity. These features can be affected by both drugs and brain disease.

3 Abnormal posture and limb movements.

Severe intracerebral problems may also cause:

- airway obstruction;
- respiratory depression (respiration, unlike the heart beat, requires an intact brainstem);
- bradycardia and hypertension (Cushing's response);
- neurogenic pulmonary oedema (caused by massive sympathetic vasoconstriction).

For hypoglycaemia see page 9.
For poisoning see Chapter 15 on page 267.
For head injury see Chapter 3 on page 34.
For intracranial pathology see Chapter 14 on page 226.
For brainstem death see page 381.

Depression of consciousness

A decreased level of consciousness indicates that something is wrong with the brain or its fuel supply – *see Box 1.1*. There is a continuum of consciousness that ranges from an alert and orientated patient to one with brainstem death.

Box 1.1 Causes of Impaired Consciousness

Hypoxia, hypovolaemia or cerebral ischaemia
Hypoglycaemia
Hypothermia
Poisoning or gross metabolic disturbance (including CO_2 narcosis)
Injury to the brain
Intracranial pathology (bleeding, thrombosis, embolism, infection, swelling, tumour, fits, etc.)

If prolonged, many of the above problems (including hypoxia, ischaemia, hypoglycaemia and status epilepticus) will lead to a remarkably similar outcome – selective neuronal necrosis and permanent brain damage.

Coma is defined as a Glasgow Coma Score of 8 or less.

Unconsciousness is an imprecise term usually describing a condition of an unaware patient with whom verbal communication is not possible; unresponsive is thus a better description. Such patients will usually be amnesic for the duration of the unresponsiveness.

The ability to maintain the airway decreases as the coma score falls and finally the ability to protect the airway is also lost. Breathing indicates a functioning brainstem; in an arrested patient it often returns quickly after cerebral circulation is restored. Sudden cerebral trauma may cause transitory apnoea and all of the causes of impaired consciousness listed in Box 1.1 may lead to terminal apnoea. The heart beat is less immediately dependent on an intact brain but asystole is inevitable within hours of brainstem death.

E – Environment and exposure

Control of the body temperature is increasingly recognised as important to a successful outcome in resuscitation. Wet clothes should be removed and consideration given to the use of warm IV fluids. In cases of trauma, collapse and depressed conscious level, the whole body must be exposed so that nothing important is missed. Even at this early stage care must be taken to avoid extrinsic factors that may harm the patient.

Look for

- Cold extremities.
- Shivering.
- Wet clothing.
- Pyrexia and clamminess.
- The position in which the patient is most comfortable.
- Uncomfortable splints (including collars and spinal boards).
- Loss of the protective reflexes of the eyes.
- Areas where pressure sores might form (*see page 229*).
- The proximity of the next of kin.

Attention to these details early on can radically change the well being (and demeanour) of a patient.

If a patient cannot blink, then the eyes should be covered to protect them.

For hypothermia see page 248.
For hyperpyrexia and hyperthermia see pages 250 and 270.

F – Fits

It is very difficult to assess adequately or manage a patient with convulsions. Hence termination of the convulsion must be an immediate aim and often precedes satisfactory care of the airway or breathing.

Look for

- Frank tonic or clonic activity.
- Spasmodic twitching.
- Post-ictal drowsiness.
- Gurgling, rattling or other signs of post-ictal airway obstruction.
- Cyanosis. There is increased demand for oxygen and also respiratory distress.
- Signs of head injury.
- Signs of other injury caused by a convulsion (e.g. a bitten tongue and intra-oral bleeding).
- Reasons to consider hypoglycaemia.
- Pyrexia or other signs of infection (especially in children).

Convulsions must be terminated before any further action can be effective. Meanwhile, the patient must be prevented from harming himself or herself.

For hypoglycaemia see pages 246 and 327.
For treatment of convulsions see page 237.
For treatment of convulsions in childhood see page 339.

Fitting indicates that something is wrong with the brain or its fuel supply. The list of possibilities is almost the same as that for causes of reduced consciousness – *see Box 1.2*. Convulsive activity causes a dramatic increase in cerebral and muscle oxygen demand; a post-ictal acidosis is inevitable. The uncoordinated muscle action that occurs during the tonic or clonic stages of a fit makes control of the airway extremely difficult; some regurgitation may also occur. Ventilation of the lungs is usually reduced for the same reason. Alveolar oxygenation is thus poor at a time of high oxygen

Box 1.2 Causes of Fits

Hypoxia or shock
Hypoglycaemia
Poisoning or gross metabolic disturbance
Injury to the brain
Intracranial pathology (bleeding, thrombosis, embolism, infection, swelling, tumour, epilepsy, etc.)

demand. This combination probably explains why prolonged fitting is associated with permanent neurological damage.

G – Glucose

The human body can be compared to an engine that needs an oxygen supply (airway and breathing) delivered in the blood stream (circulation). However, we should not forget that the oxygen is required to burn fuel (glucose). Fat and protein are, of course, also important but the brain uses glucose almost exclusively.

Look for

- Restlessness, agitation or other mental change ('jitteriness' in a neonate).
- Inappropriate lack of cooperation or aggression.
- A reduced level of consciousness.
- Convulsions.
- Signs of insulin usage.
- A low blood sugar level on testing with a reagent strip.

A reagent-strip measurement of blood glucose should be performed in all patients who have depression of consciousness. If hypoglycaemia is found it should be immediately treated with IV glucose solution (50 mL of 50% glucose for a normal adult; 0.2 g per kg for a child). If no venous access can be found, then glucagon 1 mg by IM injection is a useful standby.

For hypoglycaemia see also pages 246 and 327.

Hypoglycaemia is always waiting to catch you out. A comatose patient with profuse sweating should always make you think of a low blood sugar.

H – History

At this juncture a brief history becomes a necessity and brief is AMPLE:

A Allergies.
M Medication.
P Past and present illnesses of significance.
L Last food and drink.
E Events leading up to the patient's presentation.

The people who accompany the patient to the department are a vital source of this information; hence the need to collect facts before the paramedical staff leave the ED.

Patients who are undergoing prolonged treatment with steroids (i.e. for more than 3 weeks) may develop adrenocortical suppression. This can also occur for up to a year after stopping long-term steroid therapy. During a medical crisis, such patients should be given supplementary corticosteroids (e.g. hydrocortisone 200 mg IV in the ED).

I – Immediate analgesia and investigations

This is the point (if you have not already done it) to call for help. There should be no hesitation in seeking another pair of hands or a more experienced opinion.

In many patients who are not in extremis, the above will only take a matter of seconds. Once life-threatening problems have been identified and treated, it is necessary to perform the tasks that are at the very heart of emergency medicine – the immediate relief of suffering. This will include:

- administration of analgesia *(for the assessment of pain see Box 1.3)*;
- provision of splintage and support for injuries;
- further relief of dyspnoea;
- reassurance.

This is not just a matter of humanity. The trust of the patient (and their relatives and friends) is

Box 1.3 Assessment of Pain

Pain is a subjective experience. Clinical assessment of a patient's level of pain depends upon:

- the patient's description of the pain;
- the patient's behaviour;
- the known injuries or condition;
- any observed signs of pain (sweating, etc.);
- the use of visual pain scales – analogue or image type (pain ladders and faces, etc.).

more easily gained by staff who are seen to 'do something'. This trust leads to the provision of more information and better compliance with treatment. Conversely, nothing agitates relatives more than the sight of a doctor or nurse asking endless questions while the patient continues to suffer. It is always better to overestimate pain rather than to underestimate it.

Major radiographs can now be requested. In patients who have suffered multiple trauma, these are views of the chest, lateral cervical spine and pelvis. In other instances a chest X-ray is usually sufficient. Twelve-lead ECG and blood gas analysis are also helpful early on.

Box 1.4 Summary of Immediate Assessment and Management

Airway
- Establish and maintain a clear airway.
- Ensure airway protection.
- Consider the need for cervical protection.

Breathing
- Give high-concentration oxygen.
- Ensure adequate ventilation of the lungs.
- Decompress pneumothoraces.
- Begin to correct severe respiratory problems.

Circulation
- Restore the circulating blood volume.
- Ensure adequate cardiac function.
- Commence monitoring.

Disability
- Assess cerebral functioning.
- Consider causes of depression of consciousness.

Environment/exposure of the whole body
- Check the body temperature and positioning.
- Ensure protection from further harm.
- Expose the whole body for examination.

Fits
- Control convulsive activity.

Glucose
- Correct hypoglycaemia.

History
- Take brief but AMPLE details.

Immediate analgesia and investigations
- Provide analgesia and splintage.
- Relieve remaining dyspnoea.
- Give reassurance.
- Request major investigations.

Analgesia

The administration of analgesia does not mask significant clinical signs. Conscious level is not greatly depressed by the judicious administration of small doses of IV opioids and abdominal signs also remain unchanged. Tenderness can still be located and guarding is an involuntary mechanism, which is unaffected. The biggest change will be in the ease of examining a trusting, cooperative patient who was previously distressed and agitated.

> The immediate relief of suffering, in all its forms, is the most important function of an ED.

For a summary of this section on immediate assessment and management of emergency patients see Box 1.4.

Further (or secondary) assessment and management of the patient

The needs of the relatives and friends

The needs of the carers cannot be ignored. These may vary from simple reassurance to medical treatment. As soon as practicable, the relatives must be informed of the patient's current situation and what is going to happen next.

History and examination

History-taking in emergencies should be guided by the presenting complaint. The familial medical history will rarely be relevant in a patient with a dog bite; it might be vital in a haemophiliac with a swollen joint. The art of adjusting the acquisition of information is a difficult one. Most new ED staff take an over-long history for the first few days; they then record less than a bare minimum for the next few months. Mechanism of injury is particularly important in trauma; events leading to presentation are essential in medical cases.

The examination must also be tailored to the patient. At times it can be limited; often it must be thorough. Experience teaches the relative uselessness of some physical signs and the enormous value of others. The examination in trauma patients is usually performed from top to toe

rather than in systems and is called the secondary survey. The back of the patient and the perineum are the parts that are often missed.

Investigations

Investigations should only be requested if the results could have an impact on immediate care or disposal. Specific tests have been described above. Other tests should be performed for precise indications rather than as a general screen. The exception to this is in elderly patients who present with non-specific events such as collapse. They can be very difficult to evaluate clinically. Consequently, before considering sending them home, it is best to carry out a brief screen including Chest X-ray, ECG, haemoglobin, white cell count and blood urea level.

Definitive care

This may involve:

- accurate liaison with other specialists in the hospital or the community;
- safe transport to another facility;
- careful follow-up arrangements;
- rehabilitation.

For observation wards see page 15.
For review clinics see page 15.

The patient and his problem

For ED attendance figures in the United Kingdom see Box 1.5.

Box 1.5 Patients Attending EDs in the United Kingdom

Over 15 million patients attended EDs in the United Kingdom in 2004. Of these patients, around:

- 25% were children;
- 20% arrived by emergency ambulance;
- 20% were admitted to hospital.

Attendance figures are increasing by 6% per annum (2005).

The sorting of patients (triage)

The word triage originally referred to the sorting of coffee beans. Later the term was used to describe the way in which an army divided the mass casualties of war into three categories, depending on their likelihood of returning to the front line. In normal civilian practice, triage means the prioritising of patients such that those with the most urgent or life-threatening conditions are seen and treated first; immediate assessment is a more easily understood description of this process.

Different departments use varying terms and labels for their assessment categories but there is increasing acceptance of the definitions in *Box 1.6*.

Box 1.6 Categorisation of Patients

Category	Label colour	Condition
Category 1	Red	Immediate resuscitation required
Category 2	Orange	Very urgent, major illness or injury
Category 3	Yellow	Urgent, serious problem but apparently stable
Category 4	Green	Standard, routine case without immediate danger or distress
Category 5	Blue	Non-urgent problem, which may be redirected to a more appropriate facility

Patients with pain should be placed in a category that reflects their need for analgesia. This may be higher than that dictated by the apparent severity of their injury. Category blue is often best determined in retrospect (*see inappropriate attenders on page 12*).

The process of immediate assessment is usually undertaken by experienced nursing staff and should logically take place before registration and documentation. The provision of immediate therapies such as analgesia, splintage and ice-packs increases the usefulness of this early clinical contact with the patient.

Management rather than diagnosis

Accurate diagnosis is a skill that every doctor strives to acquire but we can only diagnose conditions

that we know exist. Outside of these, a whole gamut of uncertainty remains to be explored. In the meantime, the patient still needs help. This requires flexibility of mind and a good knowledge of basic principles.

Management of a condition is possible without a firm diagnosis: you may not know what the underlying cause of the problem is, but you must know what to do about it. This approach is life-saving in the primary phase of resuscitation. As each problem presents, immediate action is taken to resolve it – long before the whole clinical picture becomes apparent.

Inappropriate attenders and minor problems

The label inappropriate attender is often given to patients whose problems are thought to be trivial or that are more suitably managed in general practice. However, the perception of trained health providers may not be shared by the lay public. This is because it takes a considerable amount of knowledge to differentiate confidently between major and minor conditions. Moreover, small injuries can be disproportionately distressing and help can seem difficult to find in the complex healthcare systems of today. Whatever your view of the apparent inappropriateness of the patient's attendance, it is best to examine first and criticise later.

Social problems

It is the nature of the work of an ED to take all-comers. Most of these patients will fall into standard medical and surgical categories. However, many people are unaware that suffering must be classified before they can gain relief. For ED staff to complain that many of the problems that they see are vague, ill-defined or social is on a par with a geriatrician complaining that most of his or her patients are elderly.

Homelessness

The standardised mortality rate for homeless people is three times higher than that of the United Kingdom population as a whole.

Many patients who come to an ED have nowhere to sleep or to shelter. People suffering from psychiatric disease often become homeless and there are many other illnesses (such as tuberculosis and alcohol abuse), which are associated with homelessness.

The average life expectancy for someone on the streets is just 47 years.

Efforts should always be made to find temporary accommodation for these patients. The most likely sources of help are:

- the social services;
- the Salvation Army;
- Shelter Nightline (in London).

Health inequalities in the United Kingdom are increasing. The differences in life expectancy between rich and poor areas of the country are at their greatest since the Victorian era.

Placebo therapy

Do not be afraid to acknowledge this very important aspect of medical practice. Human health is inextricably linked with mental functioning and fear and worry play a large part in many consultations. Improvement rates of up to 40% may be obtained with placebo therapy. The doctor's reassurance is the greatest placebo and his or her apparent casual dismissal of a problem has the reverse effect.

Communication

Good communication is the hallmark of the good doctor, the good nurse and the good ED. In addition to the obvious patience and direct verbal skills required, this may encompass:

- information cards to take out;
- telephone advice help-lines;
- translation facilities;
- good quality records and letters.

It is not just the patient who is concerned with communication. Special care is also needed with:

- relatives;
- other health professionals in the hospital;
- paramedics;

- GPs, health visitors and district nurses;
- police officers.

Dealing with complaints properly is a further example of good communication – *see page 382*.

National alert systems. MedicAlert® is a UK-registered charity that provides an identification system for individuals with hidden medical conditions and allergies. This takes the form of bracelets or necklets (known as 'Emblems') that are engraved with the wearer's main medical condition(s) or vital details, a personal ID number and a 24-h emergency telephone number. Medical and emergency personnel can telephone the alert service and, by quoting the patient's ID number (and after clearing security checks), they can receive details of the person's name, address, general practitioner, current medication, next of kin and other medical information.

Record-keeping and letters in an ED

Medical records must be concise and relevant but at the same time sufficiently comprehensive and legible to allow other doctors to understand what happened during the consultation. With increasing litigation (and emergency medicine is a high-risk area for claims), the notes have taken on a new importance as the major source of information for medical defence. Moreover, police statements and other legal reports are impossible to prepare from illegible, inadequate notes. The records should be in a problem-orientated form but must also contain:

- the name of the practitioner (in capitals) and the date and time;
- an adequate history (including mechanism of injury or events leading to presentation);
- a relevant examination (with drawings and measurements as required);
- a list of investigations and the results of them;
- a treatment plan;
- details of any follow-up and instructions given; any factors complicating discharge must be given written consideration.

For medicolegal aspects of record-keeping see page 365.

General practitioners should receive a notification of their patient's attendance at the ED which, as a minimum, tells them:

- who the patient is (the name and address as a minimum);
- on what date he or she attended the ED;
- the diagnosis;
- the results of any investigations;
- treatment and medications given;
- details of any follow-up arranged or required.

Health promotion

The ED is an ideal situation for giving information and advice about health. Patients in the department are in a receptive state and form a captive audience while in the waiting areas. Health information may address:

- accident prevention, home and road safety;
- the importance of routine immunisations;
- healthy eating and lifestyles (*see Box 1.7*);
- domestic and other violence;
- the problems of alcohol, drug and substance abuse;
- hygiene and dental care;
- venereal disease;
- access to local facilities;
- other areas of perceived local and national importance.

Leaflets, films and advice may all have a part to play. There should be a liaison with the local agencies for health education and with the local area child accident prevention group. Some departments will be involved with campaigns in neighbourhood schools.

Box 1.7 Common Health Problems in the United Kingdom in 2005

66% of men and 50% of women are overweight.
25% of children are overweight; 14% are obese.
70% of men and 80% of women take insufficient exercise.
31% of men and 28% of women smoke.
28% of men and 11% of women drink more than the UK recommended limit.

Detection of osteoporosis

Fractures occurring in patients who are over 45–50 years old may be related to bone fragility caused by osteoporosis. This is not visible on plain radiographs until the disease is well advanced. Those patients with fractures that have resulted from relatively minor trauma, should be referred to their GP for further investigation. Treatment may include exercise, diet, hormone replacement therapy and specific drugs.

> More than 1 in 3 women and 1 in 12 men are at risk from osteoporosis. It causes 200,000 fractures every year in the United Kingdom.

The staff and their surroundings

Learning and teaching

A good department of emergency medicine is a forum for ideas and discussion, which should help with personal and professional advancement as well as benefiting the department. Research is just one aspect of this progression. All staff should participate in learning and teaching.

Clothing, appearance and cleanliness

Unlike the GP or ward-based staff, the emergency practitioner has only a few minutes in which to form a relationship with the patient and his or her relatives. This means that first impressions are extremely important. Some factors can be predicted to create a caring but professional image:

- a smart, clean and appropriate appearance (greatly enhanced by a white coat or a uniform and a name badge);
- pleasant body and breath odours;
- courtesy;
- a concerned and attentive attitude.

The reaction of the patient to other factors (such as the sex, age and race of the doctor) is less predictable; some patients may also have a preconceived view of a doctor's attitudes. Personal and intimate problems may sometimes justify a request for a doctor of another sex and it is certainly true that age is often assumed to be synonymous with wisdom. Racial prejudice, however, is always totally unacceptable. If it occurs it must not be tolerated. Senior staff must be informed without delay.

Clean hands. Healthcare-associated infection leads to the deaths of many patients every year in the United Kingdom and costs the NHS millions of pounds. Studies have shown that infection rates can be reduced by 10–50% if hospital staff clean their hands regularly. Unfortunately, handwashing is often performed infrequently and inadequately. The ED is an ideal place to learn and practise good habits in all aspects of cleanliness.

For the prevention of the spread of infectious pathogens see SARS on page 222.

For the prevention of nosocomial respiratory infections see hospital-acquired pneumonia on page 219.

Health and safety at work

Health and safety legislation. The Health and Safety at Work Act 1974 places a legal duty on employers to provide for the health and safety of their employees. NHS trusts have been subject to the full requirements of this legislation since 1991. These obligations were extended further under the Management of Health and Safety at Work Regulations 1992, which require employers to assess risks to their employees and implement a comprehensive system of safety management. There are several additional UK regulations and three EU Council Directives that are relevant to the health and safety of workers.

Departmental facilities. A suitable working environment is a prerequisite for good practice in emergency medicine. Some of the less subtle aspects of this are:

- adequate and well-maintained equipment (this is the responsibility of all staff, not just a few);
- good support from departmental and other hospital staff;
- reasonable working rotas for all members of the team;

- streamlined and clear procedures for most eventualities;
- measures to ensure the health and safety of staff (e.g. security procedures and hepatitis B immunisation).

Prevention of blood-borne infections. There are more than 20 dangerous transmittable blood-borne diseases. The three main infections are hepatitis B, hepatitis C and HIV/AIDS, of which hepatitis B is by far the greatest danger. However, other blood-borne pathogens include:

- Human T lymphotrophic retroviruses (HTLV I and II).
- Hepatitis D and hepatitis G viruses (HDV and GBV-C).
- Cytomegalovirus (CMV).
- Epstein Barr virus (EBV).
- Parvovirus B19.
- Transfusion-transmitted virus (TTV).
- West Nile virus (WNV).
- Malarial parasites and prion agents.

These organisms may be transmitted through contact with blood or any other body fluid from an infected person. This can be via a 'needlestick' injury, a human bite, a splash into the eyes or directly into an open wound or cut.

> The high-risk patient cannot be confidently detected and so precautions must be taken to avoid transmission of infection at all times.

Every effort should be made to avoid exposure to blood and body fluids through safe systems of practice. The principle of following standard ('Universal') precautions means never assuming that there is no risk. The same precautions to prevent transmission of infection should be used for every single procedure:

1 Cuts and grazes should always be covered with a waterproof dressing.

2 Gloves should be worn when dealing with blood or other body fluids. (Although a needle or other sharp instrument can easily penetrate latex, it is said that a surgical glove will remove 80% of the blood on the offending instrument before it reaches the underlying hand.)

3 Eye protection should be worn when there is a high risk of splashing of body fluids.

4 Needles should not be re-sheathed.

5 Needles and other sharp objects should be disposed of carefully into an appropriate bin in the room where they are used and not carried around.

For the identification of high-risk patients see Box 21.7 on page 398.

For the management of blood and body-fluid exposure incidents see page 397.

Observation wards

The College of Emergency Medicine recommends that there is one ED-managed 'short stay' or observation bed per 5000 new emergency patients. The exact case-mix of the patients admitted to this ward will vary between departments but might include those with:

- head injuries;
- chest injuries;
- soft-tissue injuries;
- soft-tissue infections;
- acute alcohol intoxication;
- some other poisonings;
- alcohol withdrawal;
- social problems.

The acceptable level of severity of some of the above conditions will depend on unit policy, as will maximum length of stay on the ward. To make the best use of the available bed space, ward rounds are required at least twice a day with interventions and investigations as necessary.

Review clinics

Some patients (but certainly less than 10%) may be best managed by follow-up in a review clinic, which is run under the auspices of the ED. This clinic can provide:

- specialised dressings and other wound care;
- reassessment of burns and certain other wounds;
- review of cellulitis and other infections;
- reassessment of soft-tissue injuries where complete resolution is not inevitable (e.g. some joint sprains);

- follow-up of particular conditions (e.g. scaphoid injuries, chest injuries, some head injuries, minor fractures).

> Neither the review clinic nor the short stay ward should be used as a substitute for proper examination, investigation and treatment at first presentation.

Organisation – the team approach

To carry out the rapid assessment of patients with almost simultaneous treatment of life-threatening conditions requires a team effort. The team must have an acknowledged leader and a clear line of command. The team should be identified beforehand and should practise and prepare for an emergency. Horizontal integration with concurrent actions that are undertaken by team members who are allocated to specific tasks is the most effective system. The ED staff will form the nucleus. Other specialists called to the department must know beforehand that they will be required to function as part of this team under the supervision of the team leader. Training according to the tenets of Advanced Life Support for trauma, cardiac and paediatric emergencies is recommended.

Prehospital care

Outside of the hospital situation, there is a clear organisational hierarchy.

- The police are in overall control of the scene.
- The fire service is in charge of rescue and extrication, and scene safety for the other personnel.
- The ambulance service is responsible for the evacuation of casualties.
- The medical team is present at the request of the ambulance service.

Entrapment of casualties is now the most common reason for paramedics to request the assistance of a hospital team – either prolonged entrapment (more than 20 min) or situations where release requires analgesia.

An on-site medical team must be formed from experienced, regularly trained staff who have:

- high-visibility protective clothing;
- adequate equipment;
- insurance cover for this type of work.

Furthermore, the parent department must be left adequately staffed.

The only measures which have been shown conclusively to save lives in the prehospital situation are ABC:

Airway	Clearance, maintenance and protection
Breathing	Oxygen and ventilation
Circulation	Chest compression and defibrillation

> In cardiac arrest, the time taken to initiate the above interventions is crucial to survival – *see page 157*.

Extensive clinical examination and the establishment of IV infusions are of no proven benefit. Nevertheless, other prehospital treatments may contribute greatly to the relief of pain and suffering.

> Time at the scene must not be extended by anything other than essential treatment. The priority is to get the patient to hospital as soon as possible.

The basic principles of prehospital care are the same as those for in-hospital care. Specific resuscitation courses are now available where the applied skills may be mastered.

Major incidents

A discussion of the management of major incidents is outside the scope of this book. However, all departments should have a written policy for dealing with events that have the potential to overwhelm the standard facilities of the hospital. Action cards for all personnel should be available together with a special supply of equipment and drugs. Regular practice sessions are a necessity. (NB. This is a legal obligation under the Civil Contingencies Act 2004. The Act is divided into

two parts – Civil Protection (Part I) and Emergency Powers (Part II). For the purposes of Civil Protection, local responders are divided into two categories. The Category 1 responders (which include hospitals, primary care trusts and ambulance services) have a duty to make and execute effective plans for major incidents. Category 2 organisations (such as utility and transport companies) are obliged to co-operate with other responders.)

For contamination and irradiation see page 297.

The administration of sedation or general anaesthesia in the ED

The unique circumstances of the ED lead to special problems with the safe administration of sedative drugs. However, a unit that treats comatose patients as part of its daily workload must inevitably have the personnel and facilities available for the care of sedated patients.

The techniques used for assessment and monitoring of pathological coma are also applicable to depression of consciousness during sedation. The safety of the patient is paramount; emergency situations do not obviate the need for standard precautions. Consideration must be given to the medical preparedness and fasting state of all patients. If in doubt, senior staff should be consulted.

Special problems associated with sedation in an ED

Most ED patients are self-referred and many will return to their homes or workplaces within a matter of hours. Moreover, the very nature of accidents and emergencies is that they are unplanned. This combination of circumstances leads to special problems with the safe administration of sedative drugs.

- Most patients are not fasted; in addition, painful conditions delay gastric emptying.
- Many patients will have ingested alcohol in the preceding few hours.
- There is no opportunity for preplanned assessment of fitness or review of case notes.
- The need for sedation is invariably immediate.
- The fitness of patients for discharge and the circumstances to which they depart require very careful consideration.

Preparation for sedation and selection of patients

The immediacy of the situation does not obviate the need for a concise but adequate work-up of the patient. Most patients will not require investigations to assess their fitness for the procedure; those that do are generally not suitable for sedation in the ED. Pulse oximetry (while breathing air) is a useful screening test – a fit patient will invariably have an SaO_2 of above 94%.

Some patients will be found to be unsuitable for sedation in the department. They include those who:

- are severely intoxicated;
- have a full stomach;
- have had previous problems with sedation;
- have chronic illnesses, which may complicate sedation or aftercare;
- have other severe injuries;
- have a co-existent significant head injury;
- are at the extremes of age;
- have inadequate circumstances for discharge.

Patients who are deemed unsuitable for sedation but whose condition does not allow delay (e.g. vascular compromise distal to a dislocation) must be discussed with a senior colleague immediately.

The urgency of most of the conditions that present to an ED, does not allow for the conventional period of preoperative fasting. However, in all but the most pressing circumstances, a period of 2 h should separate sedation from the last ingestion of food or drink to allow for gastric emptying. No further food or drink must be allowed from the moment of entering the department.

Painful conditions, such as dislocations, must be alleviated with parenteral analgesia (before X-ray) and the subsequent doses of sedative drugs then adjusted accordingly.

> Sedation is not the same as analgesia.

Facilities for the administration of sedation or general anaesthesia

The minimum requirements include:

- medical and nursing staff trained in the management of patients with a depressed level of consciousness;
- areas suitable for high-dependency observation;
- a full range of resuscitation and monitoring equipment;
- all necessary drugs for resuscitation, including the specific benzodiazepine antagonist flumazenil and the opioid antagonist naloxone.

When a doctor is performing a procedure on a sedated patient, a separate member of staff must be responsible for the overall care of that patient. The operator should never try to monitor the patient at the same time.

Conditions during the period of sedation

During sedation, and until recovery is complete, all patients should:

- be accompanied by a responsible member of staff;
- be on a trolley with side rails, which can be tipped head-down;
- have an IV cannula *in situ*;
- be given a high concentration of oxygen by mask;
- be monitored by pulse oximetry as a minimum standard (respiratory rate, ECG and BP recording are also highly desirable);
- have a high-volume suction catheter in place under their pillow.

The protective reflexes of the airway are depressed by all sedative and narcotic drugs to an unpredictable degree. Even at a high GCS there may be enough impairment of airway protection to allow aspiration of gastric contents. Therefore, all sedated patients must be placed in the recovery position as soon as is practically possible.

Effective sedation is greatly facilitated by pleasant, quiet surroundings and the presence of attentive, reassuring and obviously competent staff.

Assessment of the level of sedation

The scores for measuring coma (AVPU and GCS) are understood and practised by all staff in an ED. They are thus ideal for use in assessing the level of sedation.

General anaesthesia and sedation are both induced states of depression of consciousness. Sedation is characterised by the fact that verbal contact should be maintained with the patient throughout – V on the AVPU scale. (This does not mean that the patient either speaks sensibly or remembers the conversation afterwards.) In the language of an ED, sedation is equivalent to a GCS of 10 or above and is certainly not the same as a GCS of 8 (coma). Full general anaesthesia is characterised by a GCS of 3. Gentle stroking of the upper eyelashes usually causes blinking (the eyelash reflex) and the loss of this reflex (at a GCS of around 8) is a good guide as to the imminent onset of general anaesthesia.

Drugs for sedation in the ED

All drugs that are used for sedation are capable of inducing general anaesthesia and vice versa. The main difference between the two groups of agents is the speed of onset of action and thus the ability to control the level of consciousness. (Thiopental acts in 20 seconds whereas diazepam takes several minutes to work.)

Sedation should always be accompanied by adequate analgesia, both before, during and after the procedure. Anti-emetics may be given as required but there is little evidence that their routine use reduces the risk of aspiration.

For sedation and analgesia for children see page 347.
For sedation of the disturbed patient see Chapter 19 on page 352.

Intravenous benzodiazepines

Intravenous benzodiazepines such as midazolam or diazepam emulsion are the standard drugs for ED sedation.

- Initial adult dose of IV midazolam = 1–2 mg.
- Initial adult dose of IV diazepam = 2.5–5 mg.

The correct initial dose can be estimated from the age, weight and general health of the patient. The elderly may need only very small amounts. Subsequent doses, given after a delay of a few minutes, should be titrated against apparent effect. The muscle relaxation that is a feature of sedation with benzodiazepines makes these drugs ideal for use in the reduction of dislocations.

Short-acting opioids

Short-acting opioids such as fentanyl can provide an excellent combination of sedation and analgesia:

- IV dose of fentanyl = 1–3 μg per kg.

This should be titrated slowly at a rate of no more than 1 μg per kg per min up to a maximum dose of 5 μg per kg in 1 h. The onset of action is within 3 min and the effects of a single dose wear off in less than 1 h. Opioids may cause some muscular rigidity.

Low-dose inhaled nitrous oxide

Low-dose inhaled nitrous oxide is useful as a supplement to other drugs or to give background sedation. It is often administered, for the purpose of analgesia rather than sedation, in a fixed concentration (50%) from a cylinder premixed with oxygen (e.g. Entonox) via a demand valve. Such valves require a negative pressure to open them (which varies greatly with the make of the demand apparatus). The generation of this pressure may be beyond the ability of younger children and some adults.

Proper sedation with nitrous oxide requires a constant flow of gas and this is best achieved with a purpose-built system such as the Quantiflex machine. Using this apparatus, nitrous oxide may be administered in sub-anaesthetic concentrations of 30–70% via a non-rebreathing circuit with a guaranteed minimum of 30% oxygen.

Ketamine

Ketamine is a derivative of phencyclidine and is often recommended as an anaesthetic for prehospital use. This is because it has both sedative and analgesic effects and does not compromise the airway or the circulation as much as other comparable drugs. In a lower range of doses, it is also an excellent and safe sedative for use in the ED:

- IV dose of ketamine for sedation = 0.5–1 mg per kg. The sedation starts within less than 60 s and lasts for 5–10 min.
- IM dose of ketamine for sedation = 2–4 mg per kg. When 2 mg per kg is given IM (as recommended by the authors), the onset of sedation is around 5 min with an effective duration of up to 35 min. A top-up dose of a further 1 mg per kg can be given if either the first dose proves to be inadequate or there is a requirement to prolong the duration of the sedation. The effects of ketamine are surprisingly predictable and reliable when it is administered by the IM route.

In these low doses, dysphoria is uncommon and excess salivation is not a problem. Consequently, emergence from sedation is usually uneventful and prior administration of atropine is unnecessary.

Discharge of patients who have received sedative drugs in the ED

The patient who is fit for discharge after sedation must fulfil all of the following criteria:

- alert and orientated;
- able to walk steadily and unaided;
- able to drink liquids;
- not suffering from any disabling condition such as vomiting, dizziness, shortness of breath or severe pain;
- accompanied by a responsible adult;
- suitable for available transport; and
- returning to adequate home circumstances.

For aftercare advice to be given to a patient who has received sedative or narcotic drugs in the ED see page 385.