ANAESTHESIA FOR THE PATIENT REQUIRING EMERGENCY ABDOMINAL SURGERY

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Introduction

The principles of anaesthesia for the patient requiring emergency abdominal surgery are common to adults and children, and to the patient and their anaesthetist wherever they are, and whatever resources are available. Within this framework, the article will address the importance of attention to:

- Airway
- Breathing
- Circulation
- Drugs
- Equipment
- Fluids and electrolytes

The major part of the article is about general anaesthesia, with some comments on regional anaesthesia, which may be the only option on some occasions.

The Anaesthetist and the Environment

The anaesthetist has to bear in mind a number of things when preparing to anaesthetise a patient for emergency abdominal surgery. This not only includes the patient's condition, and the nature of the surgery, but also the anaesthetist's own knowledge and experience, the anaesthetic equipment, and the consumables and drugs which are available.

The anaesthetist must take into account issues such as the knowledge and experience of the surgeon, the availability of an anaesthetic assistant, and the reliability of services such as oxygen, suction and power. For emergencies, particularly, there is often no second chance should a crisis occur, and if fall-back plans have not been made before starting the anaesthetic.

Pre-Anaesthetic Check

The operating theatre needs to be always ready for an emergency procedure, so the anaesthetist does not have to waste time cleaning up and finding things used in the previous case. A systematic approach is necessary. An example is to check the following (Table 1).

Table 1 **Pre-Anaesthetic Checklist**

- Fresh Gas Supply
- Gas Delivery System
- Anaesthetic Gases
- Anaesthetic Agents
- Breathing Circuit
- CO_2 Absorber
- Airway Equipment
- Breathing Equipment
- Circulatory Equipment
- Monitors
- Resuscitation Drugs
- Resuscitation Equipment

- **Fresh gas supply** - is it air, or oxygen. If it is oxygen, is it supplied by an oxygen concentrator, a cylinder, or from a wall outlet? What reserves are there in theatre or in the bulk supply?

- **Gas delivery system** - is it draw-over, demand flow, or continuous flow?

- **Anaesthetic delivery** - will nitrous oxide be used? Is the main agent ether, halothane, enflurane, isoflurane, sevoflurane? Is the vaporiser full, and does it work? Is it draw-over or plenum? Is there extra agent available?

- **Breathing circuit** - does it have carbon dioxide absorption or not? If so, is it fresh? Is the circuit intact, and does it work?

- **Airway equipment** (Figure 1, Table 2) - Are there airways of various types and sizes - oropharyngeal, nasopharyngeal, endotracheal tubes, laryngeal masks? Are an endo-tracheal tube introducer and a bougie immediately available? Are there a syringe, clamp, tape, Magill's forceps, catheter mount available? Is there a way to insufflate the trachea with oxygen if the patient cannot be ventilated or intubated? Can an emergency cricothyroidotomy be performed? Is there effective suction with handpieces and catheters?

- **Breathing equipment** - Are there face masks of various types and sizes? What is the main ventilating system? Is there a self-inflating bag in reserve? Is the equipment for emergency decompression of a tension pneumothorax available? Is there a ventilator for long cases?

- **Circulatory equipment** - What intravenous equipment is there? - syringes, needles, catheters, fluids, ability to infuse under pressure, ability to warm intravenous fluids.

- **Other equipment** - What equipment is available to warm or cool the patient? What monitoring equipment is there that works and has been checked. Complete monitoring can be listed as follows, bearing in mind that some hospitals will have all of it, and some will have very little.

- Clinical monitoring by the anaesthetist, of the patient, the surgery and the equipment.

- Pulse, colour, blood pressure, perfusion, skin feel.

- Chest movement, breath sounds.

- Pupil size, lacrimation

- Temperature, urine output.

- Pulse oximetry (the most useful electrical monitor)

- Capnography (the second most useful electrical monitor)

- ECG(the third most useful electrical monitor)

- Airway pressure, tidal and minute volumes

- Blood sugar, haemoglobin level, blood gases
- CVP monitoring equipment
- Nerve stimulator
- Defibrillator

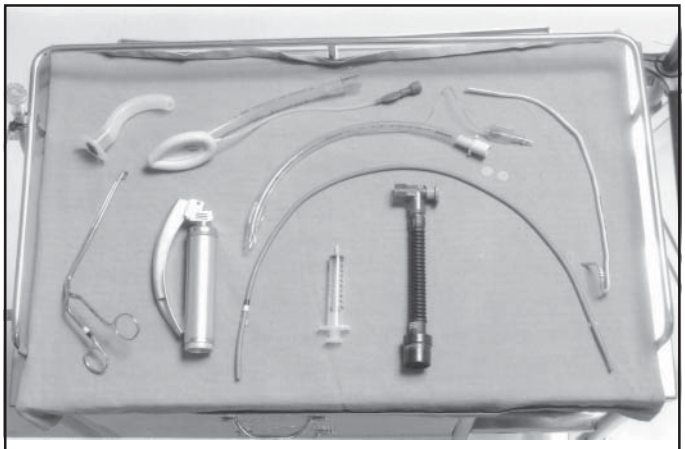

Figure 1: Airway Equipment

Table 2 **Airway Equipment**

- Suction Device
- Oral/Nasal Airways
- Laryngoscopes
- Endotracheal Tubes
- Syringe/clamp/tape
- Introducer/Stylet
- Bougie
- Magill's Forceps
- Laryngeal Mask Airway
- Cricothyroid Insufflation Equipment
- Cricothyroid Equipment

For **children**, is all the equipment of the appropriate type and size?

- Drugs - There are so many, and the choice between them is often based on arguments which may be relevant in some environments and not in others

- Intravenous induction agents (Table 3) - thiopentone is still the commonest agent world-wide, challenged by ketamine in some places, propofol in others.

- Inhalational agents (Table 4) - ether and halothane are common in many parts of the world, enflurane, isoflurane, sevoflurane in others.

- Hypnotics - diazepam remains common, but midazolam is more useful in anaesthesia because of its more rapid onset and shorter duration of action.

- Opioids - morphine is still widely used, and pethidine less frequently. Fentanyl is increasingly used in anaesthesia because of its short duration of action.

- Other analgesics such as paracetamol or indomethacin suppositories.

Table 3 **Intravenous Agents**

Drug	Typical Initial Dose	Clinical Onset	Clinical Duration
Thiopentone	4-5 mg/kg	20-30 sec	5-10 min
Propofol	1.5 – 2.5 mg/kg	1-2 min	5-10 min
Midazolam	0.01-0.1 mg/kg	2-4 min	1-2 hrs
Diazepam	0.02-0.2mg/kg	3-6 min	4-8 hrs
Fentanyl	1-1.5 mcg/kg	1-4 min	2-3 hrs
Morphine	0.05-0.15 mg/kg	3-10 min	2-3 hrs
Pethidine	0.5-1.5 mg/kg	2-5 min	2-3 hrs
Ketamine	1-2 mg/kg	20-30 sec	5-10 min

Table 4 **Inhalation Agents**

Agent	MAC*	Concentration used	Blood/Gas partition coefficient	Oil/Water Solubility
Ether	1.92	2-15%	12	3
Halothane	0.76	0.5-3%	2.3	220
Enflurane	1.68	1-6%	1.9	120
Isoflurane	1.15	1-4%	1.4	120
Sevoflurane	2	1-6%	0.69	53
Nitrous Oxide	104	70%	0.47	2.2

*with 60% nitrous oxide. MAC is higher if no nitrous oxide is used

- Muscle relaxants (Table 5) - Suxamethonium is still the choice for emergencies. Non-depolarising relaxants are now many, and may be short, medium or long acting, with specific advantages and disadvantages. Vecuronium, atracurium and rocuronium are rapidly overtaking pancuronium in many places. d-tubocurarine, alcuronium and gallamine are still used in some countries.

- Other essential drugs include atropine, neostigmine, adrenaline, ephedrine, an anti-hypertensive, a bronchodilator, a diuretic, an anti-emetic, and emergency resuscitation drugs (atropine, calcium, adrenaline, lignocaine) (Table 6).

- Local anaesthetics - lignocaine, bupivacaine, ropivacaine, cinchocaine.

Pre-Operative Assessment and Resuscitation

A systematic approach is best - it avoids overlooking important matters. For the patient requiring emergency abdominal surgery, with few exceptions, there is time to assess properly, and to resuscitate, before induction of anaesthesia. Most sensible surgeons understand this. Even in the few surgical emergencies where time to surgery is critical, the anaesthetist must still have essential information before proceeding.

Bear in mind that patients (and surgeons) do not tolerate unnecessary delays. If the patient needs investigations and/or resuscitation, organise it yourself, then you know it has been done properly. Don't "leave it to someone else". If surgery has to be delayed for resuscitation, agree on a time with the surgeon (see case insert).

Table 5 **Muscle Relaxants**

Drug	Initial dose mg/kg	Approximate Duration (min)
d-Tubocurarine	0.5	25-30
Alcuronium	0.3	20-25
Gallamine	1-2	20-30
Pancuronium	0.1	30-45
Vecuronium	0.1	15-20
Atracurium	0.5	20-25
Cisatracurium	0.15	20-25
Mivacurium	0.2	10-20
Rocuronium	0.6	20-30
Suxamethonium	1-1.5	3-5

Table 6 **Resuscitation Drugs**

Drug	Recommended Dose	Average Adult Dose
Adrenaline	0.01-0.05 mg/kg	0.5-1 mg
Atropine	0.02 mg/kg	0.6 – 1.2 mg
Calcium Chloride	0.2 ml/kg (10%)	5 – 10 mL
Lignocaine	1 mg/kg	10 mL 1%

There are some situations where the patient must go to theatre immediately - they include severe foetal distress, uncontrollable internal haemorrhage, rapidly expanding intracranial lesion (e.g. extradural haematoma). In these situations, history, examination, resuscitation have to be done "on the run" and with no delay. In most other situations, a short delay for resuscitation is best for the patient.

A good approach is to divide pre-operative assessment and resuscitation into two phases - initial (rapid), and definitive (when there is more time). In the **history**, essential questions are:

- When did you last eat or drink? (But regard these patients as having a full stomach anyway.)
- Have you any allergies?
- Are you taking any medications, smoking, drinking, using drugs or remedies?
- Have you had any problems with previous anaesthetics?
- Heart problems, chest problems, kidney or liver problems?
- Diabetes?
- Heartburn or reflux?
- Fits, faints, or funny turns?
- Bleeding tendency?
- Pregnancy?
- Infectious disease? - especially HIV/AIDS, Hepatitis, Malaria, TB

In the physical **examination**, look particularly for evidence of

- Difficult airway
- Respiratory abnormalities
- Cardiovascular abnormalities

Investigations may not be available, or not available in the time frame. Haemoglobin, urea, creatinine, electrolytes, Chest X-Ray and ECG are still the most useful.

Investigations may be clinical, or laboratory. Clinical investigations are part of physical examination, and include the "bedside forced expiratory volume", measured with a spirometer, or by listening to rapid exhalation. Laboratory investigations should always be requested if they will help to identify a problem which can be corrected. Once ordered, they must be checked and acted upon. Once again, they may or may not influence a clinical decision to delay the operation, or to proceed.

Of the more commonly available investigations, Haemoglobin value must be interpreted in the context of the usual Hb of the population (which may be 8-9gm/dl in some areas, 12-13gm/dl in others) as well as in the context of bleeding or dehydration. A Hb of 8gm/dl in a bleeding or dehydrated patient may really be 5gm/dl when resuscitation is complete, and vascular volume is expanded, so blood transfusion may be indicated early.

Blood sugar (or urinalysis for glucose) should always be measured to allow correction in the diabetic, and to detect diabetic ketoacidosis masquerading as an abdominal emergency.

Urea and Creatinine and Electrolytes may be helpful, but should be interpreted in the context of the clinical picture, and information about whether the patient has pre-existing renal failure.

Elevation of urea and creatinine may simply indicate dehydration and poor renal blood flow, or it may indicate acute or chronic renal failure. Fluid resuscitation should proceed whatever the cause, to ensure renal blood flow is improved.

Serum sodium, potassium, chloride and bicarbonate may be "normal" or "abnormal". The first step in the acute abdominal emergency is again expansion of intravascular volume and fluid resuscitation. If renal function can be restored, the kidneys will correct the electrolyte disturbance.

Chloride and bicarbonate tend to balance each other - if one goes up the other goes down. Hypochloraemia (as in pyloric stenosis) will correct with normal saline infusion, but be made worse with Hartmann's solution, because of the lactate, which is converted to bicarbonate. A low bicarbonate usually indicates metabolic acidosis due to poor perfusion, and corrects as the circulation improves.

Administration of bicarbonate is not often advisable, because it combines with hydrogen ions and results in formation of carbon dioxide which must be excreted by increased ventilation. Its acidosis-correcting effect is thus short-lived.

Arterial blood gases are the only accurate way of obtaining:

- PaO_2 (Oximetry is a substitute provided perfusion is good)
- $PaCO_2$ (End tidal CO_2 is a substitute but in the critically ill patient, there may be a wide gap between the $ETCO_2$ and the higher $PaCO_2$, not the normal 6mmHg)

- pH
- HCO_3 (which may differ from that measured with serum electrolytes)
- Identification of whether an acid-base disturbance is an acidosis or alkalosis, whether either is primarily metabolic or respiratory, and whether there is secondary compensation for the primary disturbance.

Chest X-Ray is often useful in patients with abdominal emergencies when history and examination are not clear cut, particularly in obese patients. Look carefully for pneumothorax, haemothorax, effusion, evidence of stomach or bowel in the chest, abnormalities in the lung fields (basal atelectasis is common), size and outline of the cardiac shadow.

ECG may indicate ischaemia, atrial or ventricular enlargement, abnormalities of electrolytes (as in the peaked T waves of hyperkalaemia), arrhythmias.

Assess the risk for this patient. Were they perfectly healthy before the emergency, or did they have mild systemic disease, significant systemic disease, or life-threatening systemic disease now complicated by an emergency?

Be aware of common conditions in the population which will influence resuscitation and anaesthesia, as well as postoperative care. These may include:

- Diabetes
- Ischaemic heart disease, cardiac failure, hypertension
- Valvular heart disease
- Asthma, chronic respiratory disease
- TB - especially of pleura and pericardium
- HIV/AIDS
- Malaria
- Anaemia
- Liver disease, renal disease

Identify, pre-operatively if possible, those patients who will benefit from close observation and care post-operatively in the High Dependency or Intensive Care Unit. You may be responsible for care of the patient there. If not, make sure the handover is good, and that you are available to help if there are problems.

Resuscitation goes hand in hand with assessment

- Airway problems such as in severe facial injury must be managed before induction of anaesthesia.
- Oxygen should always be given to the critically ill patient.
- Breathing problems such as asthma or pneumothorax must be treated before induction of anaesthesia.
- Circulation problems such as hypovolaemia, or cardiac tamponade must be treated before induction of anaesthesia.
- Other emergencies, such as hyperglycaemia and electrolyte or acid-base abnormalities must have treatment commenced before induction of anaesthesia.
- Consider the need for a nasogastric tube. Decide when to insert the urinary catheter.

Resuscitation must be aggressive before and during anaesthesia. The only excuse for induction prior to resuscitation is if the patient has a condition which cannot improve without surgery. This may include massive intra-abdominal haemorrhage. Even then, resuscitation must begin before anaesthesia is induced.

Which fluids should be used in resuscitation depends on the cause of the problem, and what is available. (Table 7). In an adult with intra-abdominal bleeding, the choice is clearly blood and plasma expanders such as Haemaccel or Gelafundin or Gelafusin or Dextran, supported by crystalloids - normal saline or Ringer lactate (Hartmann's) solution. In a patient with intra-abdominal sepsis, the same approach may be needed, but blood transfusion will depend on the haemoglobin level once vascular volume has been restored. In an adult with bowel obstruction who is not shocked, saline or Hartmann's solution may be adequate. In an infant with pyloric stenosis, saline is required initially, and Hartmann's solution will make the hypochloraemic metabolic alkalosis worse.

What fluids to give, and how much, depends on the cause of the emergency. Every patient with shock is an opportunity to revise your cardiovascular pathophysiology.

Table 7 **Intravenous Fluids**

Fluid	Na^+ mmol/L	K^+ mmol/L	Cl^- mmol/L	HCO_3^- mmol/L	Ca^{++} mmol/L	Mg^{++} mmol/L
N/Saline	154	-	154	-	-	-
Hartmann's	131	5	111	29*	2	-
4% Dextrose in $^N/_5$ Saline	31	-	31	-	-	-
5% Dextrose	-	-	-	-	-	-

** as lactate*

Tissue perfusion of the whole body depends on an adequate cardiac output. Cardiac output depends on:

- Myocardial contractility, which is influenced by
  - End diastolic ventricular volume
  - End systolic ventricular volume
  - Myocardial integrity
- End diastolic volume, or the volume of each ventricle before it contracts, is influenced by
  - End systolic volume
  - Preload
- End systolic volume, or the volume of each ventricle at the end of contraction, is influenced by
  - End diastolic volume
  - Afterload
- Preload - venous return to the atria depends on blood volume, vascular capacitance (matching of blood volume to vascular capacity), posture, venous valves, limb muscle activity, intrathoracic pressure changes, functioning cardiac valves, normal atrial contraction, and a reasonable heart rate to allow time for ventricular filling.
- Afterload - ejection of the stroke volume into the aorta is influenced by the ability of the arterial bed to receive the volume, so that vasoconstriction requires extra cardiac work to generate the pressure required to eject the blood.

- Myocardial integrity depends on the cardiac muscle having glucose and oxygen to allow it to function properly. It will be impaired if there is myocardial ischaemia, some electrolyte imbalances, or if there are toxins (from sepsis) affecting it, or if it is exposed to high concentrations of some anaesthetic agents (intravenous or inhalational).

In an abdominal emergency, the main problem resulting in poor tissue perfusion may be

- Hypovolaemia (as in haemorrhage)
- Hypovolaemia plus vasodilatation (as in sepsis)
- Hypovolaemia plus vasodilatation plus myocardial depression (as in sepsis).

In all cases, apart from giving oxygen, the most important thing to do is to correct the hypovolaemia, start antibiotics, then review and rethink. In sepsis, use of a "vasopressor" may be wise after correction of the volume deficit. Although there are several available, the cheapest and most useful is the catecholamine adrenaline. If the patient is moribund, intermittent doses of 0.1-0.5mL of 1:10,000 adrenaline may buy time until an infusion of 3-12mcg/minute can be set up (3mg adrenaline in 50mL normal saline run at 3-12mL/hour).

Note that in a resuscitated patient, it may take several hours for urine output to improve, even though the perfusion, blood pressure and pulse rate improve rapidly. In every patient, monitor the effects of the drug used to check that the desired effects are being achieved.

How fast fluids should be administered depends on the estimated deficit and the time available to ensure the circulatory volume is adequate before induction of anaesthesia. Always use large bore IV cannulae - more than one if necessary. The aim is to have a patient who is conscious, pink, well perfused, with a reasonable pulse and blood pressure prior to induction. Particular care is required in the very young and the very old.

Case Insert

A 30 year old male has been admitted with peritonitis, thought to be due to bowel perforation from typhoid, present for 3 days. He is shocked, with a temperature of 38°C, a pulse of 120/minute, BP 70 mmHg systolic, poor nail bed capillary return, respiratory rate 30/minute, confused. There are no facilities for immediate investigations of any sort. Urinary catheterisation results in 20mL of concentrated urine. The surgeon wants to operate immediately. The anaesthetist **does not** say "Yes", or "call me when the patient is resuscitated". The anaesthetist **does** ask the surgeon to assist in resuscitation following the ABC sequence, planning to resuscitate with oxygen, IV fluids, and administer antibiotics.

This patient could be deficient in fluids to the extent of at least 8-10 litres or more, (2 litres per day x 3 days of maintenance fluids plus fluid lost by vomiting/diarrhoea, plus fluid pooled in the bowel and peritoneal cavity). Induction of general anaesthesia in this state will probably cause death. The first priority is restoration of intravascular volume with a colloid such as Haemaccel/Gelofundin/Gelofusin or Dextran given rapidly, until the pulse rate is down, the blood pressure is up, nail bed perfusion has improved, and the patient's mental state has improved.

If colloids are not available, use a crystalloid such as normal saline or Hartmann's solution. Higher volumes of crystalloids will be required because of their rapid distribution throughout the extracellular fluid space. Once the patient has acceptable vital signs and looks better, run saline or Hartmann's solution rapidly while getting ready for theatre. If **you do the resuscitation**, the patient may be ready for induction of anaesthesia in 1-2hours. **If you delegate the resuscitation** and wait for a phone call, the patient may never survive to get to theatre.

Preparation of the Patient for Theatre

Two questions which arise after assessment of the patient has been completed, and resuscitation is underway, are what about fasting and what about premedication?

In an abdominal emergency it is always assumed that the stomach is full, and that an emergency rapid sequence ("crash") induction and intubation of the trachea will be carried out. There is no need to fast, but there is a need to decide whether emptying the stomach by nasogastic tube is advisable - as in bowel obstruction, when vomiting or regurgitation of large amounts of fluid may result in aspiration or hypoxia.

Pre-medication should be restricted to use of opioids intravenously for analgesia, and atropine if ether or ketamine are to be used. Hypnotics should not be given, because they increase the risk of regurgitation and aspiration in these patients. Antiemetics will not be effective. Antacids and H_2 antagonists are most effective for the emergency patient with an empty stomach, which is rare.

Make sure that any resuscitation measures commenced are continued up to the time of induction of anaesthesia.

Induction of Anaesthesia

There are two phases, the "countdown" to induction, and induction itself. The "countdown" is the short period of checking that everything is ready, and nothing has been missed. (Table 8). This is when the patient is on the operating table, the assistant is ready to do anything required, including hand you the sucker, apply cricoid pressure reliably and effectively, and tilt the table head down on request. The anaesthetic machine, equipment and drugs have been prepared and checked. The intravenous line(s) is running well. The surgeon is scrubbed and the nurses waiting. The monitors are checked, and readings noted. 100% oxygen has been administered for 5 minutes. Now it is time to start the induction sequence, informing the patient that they will feel sleepy shortly, and that pressure will be applied to their throat (Table 9).

The intravenous induction agent is given slowly until the patient does not respond, bearing in mind that the circulation time may be slow in these patients. Cricoid pressure is applied suxamethonium is given, and tracheal intubation performed as soon as the fasciculations start to fade. The cuff is inflated, and the patient ventilated with a few breaths of 100% oxygen while checking the position of the tube. The tube is then secured.

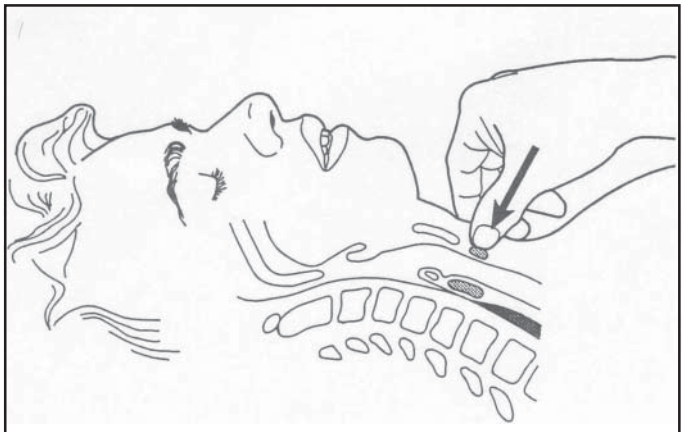

Figure 2: Cricoid pressure

How do you know the tube is in the trachea? (Table 10). Because you saw it pass through the vocal cords, heard bilateral breath sounds, with no noise over the epigastrium, and the chest moved uniformly up and down. What else is useful? Capnography is the gold standard, disposable colour-change discs are the next best. Without either of these, aspiration of the endo-tracheal tube with a large syringe will reveal easy aspiration of air if the tube is in the trachea, with a vacuum if it is in the oesophagus.

Table 8 **Pre-Induction 'Countdown'**

- Patient
- Surgeon
- Assistant to Anaesthetist
- Machine Check
- Airway Management
- Breathing Equipment
- Circulation Equipment
- Anaesthetic drugs are drawn up
- Resuscitation drugs are available
- Intravenous
- Pre-Oxygenation
- Vital Signs
- Monitors

Table 9 **Induction Sequence**

- Give 100% oxygen
- Complete pre-induction 'Countdown'
- Assistant ready
- Thiopentone +/- fentanyl
- Suxamethonium
- Cricoid pressure
- Endotracheal tube insertion
  - Cuff up
  - Check position
  - secure tube
- Non-depolarising relaxant
- O_2/gas/vapour
- Check vital signs/monitors
- Check patient safety

If at this stage you are unable to intubate or ventilate the patient, tell the surgeon, and start the protocol you worked out before you started. Maintain oxygenation, maintain cricoid pressure and follow the sequence shown in Table 11.

Table 10 **Is the Tube in the Trachea**

- See it pass through the cords
- Chest moves uniformly
- Hear bilateral breath sounds
- No noise over epigastrium
- Capnography trace
- Free air on aspiration of ETT
- O_2 saturation/colour maintained

Table 11 **Failed Initial Intubation**

- Call for help
- Maintain cricoid pressure
- Ventilate with 100% O_2
- If you can ventilate
  - Reposition head
  - Manipulate larynx
  - Suction larynx
  - Use introducer or bougie
  - Reintubate with smaller ETT
- If you can't ventilate
  - Consider LMA
  - Consider cricoid insufflation
  - Consider cricothyroidotomy
  - Consider waking patient up

Maintenance of Anaesthesia

Maintenance of anaesthesia (Table 12) may be achieved with nitrous oxide, oxygen and a volatile agent. If there is no nitrous oxide or it is contra-indicated, an air/oxygen mixture and volatile agent can be used. If there is no oxygen, just air and volatile agent, bearing in mind that the amount of the anaesthetic agent required will be higher than if it is used with nitrous oxide. If there is no air, oxygen and volatile agent can be used. A non-depolarising muscle relaxant and intermittent positive pressure ventilation allows the best conditions for the surgeon. If there are no relaxants, controlled or assisted ventilation will still assist the surgeon.

The maintenance phase requires observation and monitoring of the patient, and of the surgery, with particular attention to fluid and blood loss. If major surgery is proposed, or if the patient was dehydrated or hypovolaemic, measurement of urine output is a good guide to renal perfusion. Keep a careful record of anaesthetic agents, monitored variables, fluid and electrolyte balance.

Potential anaesthetic problems that may occur are the development of high or low airway pressure, desaturation of haemoglobin, abnormalities in the capnometry trace, hypotension, hypertension or arrhythmias. For each scenario, have a plan of how to find the cause of the problem in a logical way. (Table 13).

Table 12 **Maintenance of Anaesthesia**

- Maintain Anaesthesia
  - Agents/gas mixture
  - Opioids
  - Relaxants
  - Monitor
  - Vital Signs
- Monitor
  - Blood loss
  - Fluid/blood replacement
  - Urine output

Monitoring

The most important monitoring of the patient is clinical, including pulse, blood pressure, colour, respiration, pupil size, lacrimation, in addition to monitoring the surgical field, blood loss, urine output, fluid input. Heart sounds are useful to monitor particularly in children.

Table 13 **Checking Problems**

- High Airway Pressure
  - Misplaced airway/ETT
  - Blocked airway/ETT
  - Kinked airway/ETT
  - Bronchospasm
  - Tension pneumothorax
  - Sticking valve
- Low airway pressure
  - Where is the leak ?

  Desaturation of Haemoglobin
  - Oxygen supply failure
  - Oxygen delivery failure
  - Poor ventilation
  - Poor perfusion
  - Artefact
- Abnormal CO_2 trace
  - Ventilator problem
  - Circuit problem
  - Circulatory problem
  - Air embolism
  - Artefact
- Hypotension - identify cause and treat
- Hypertension - identify cause and treat
- Arrhythmias - identify cause and treat

The next important set of instrument monitors are pulse oximetry, end tidal CO_2 monitoring, ECG and temperature.

If available, CVP monitoring may be a useful guide, particularly in the patient who you think has had adequate fluid/blood replacement, but who remains hypotensive. Supported by a high CVP reading, this may be an indication for adrenaline infusion rather than more fluid, provided all other causes of hypotension have been looked for (e.g. pneumothorax, excess anaesthetic agent).

Other forms of monitoring in the critically ill patient might include an arterial line for BP and blood gas sampling, and occasionally a pulmonary artery catheter, which may show that despite a high CVP, the left atrial pressure, as reflected by the pulmonary capillary wedge pressure, is low.

Neuromuscular function monitoring is helpful in those patients who do not breathe well after reversal of muscle relaxants.

In situations where they are available, monitoring of inspired and expired oxygen, nitrous oxide and volatile agent should be used. Airway pressure, tidal and minute volume measurements likewise should be used if available.

Reversal of Anaesthesia

The end of surgery is the beginning of the next challenging period for the anaesthetist. It requires planning, like it did before induction. A "countdown" (Table 14) ensures that the sequence of timing of cessation of the volatile agent, reversal of the muscle relaxant with atropine and neostigmine, return of spontaneous ventilation, suction of the mouth and pharynx, and extubation of the patient occur smoothly (Table 15). Again, the assistant must be ready to start suction, and tilt the table if required.

Table 14 **Reversal 'Countdown'**

- Check Equipment
- Check drugs
- Assistant ready
- Turn off agents
- Give 100% oxygen
- Suction
- Reverse relaxant
- Check Observations
- Wait for adequate breathing
- Wait until patient wakes up
- Extubate
- Give 100% O_2 by mask
- **DO NOT LET THE PATIENT MISS A BREATH**

Table 15 **Reversal Sequence**

- Check
  - Vital signs/monitor
  - Surgeon is finishing
  - Assistant ready
  - Time of last dose of relaxant
  - Signs of reversal
- Check "Countdown" complete
- Extubate
- Turn patient on side
- Check airway is clear
- 100% O_2
- **DO NOT LET THE PATIENT MISS A BREATH**
- Check vital signs/monitors
- **ALL HANDS** to move patient
- Transfer to recovery

A final check of observations, and the patient's ability to maintain their airway, ventilation and oxygenation, and movement to the bed or trolley and transfer to Recovery can proceed. But a number of things can go wrong at this stage. There may be inadequate muscle relaxant reversal, and more reversal agent may be required, or extubation may have to be delayed; extubation may be followed by regurgitation or vomiting and aspiration; there may be laryngeal spasm. On the circulatory side, hypotension may occur while attention is concentrated on airway and breathing. A plan for each of these events must have been made, so that no time is lost in detecting and correcting the problem.

Recovery Room Care

Care in the Recovery Room must equal that during anaesthesia until the patient is capable of looking after their own airway and breathing, and is fully conscious. Again, use a systematic approach (Table 16). Any problems must be identified and treated rapidly (Table 17).

Table 16 **Recovery Care**

- Check vital signs/monitors
- Check level of consciousness
- Continue oxygen
- Check wound
- Check urine output
- Check respiratory rate, sedation, pain score
- Check temperature
- Give analgesics as required IV
- Check fluids and IV sites

Table 17 **Some recovery Problems**

- Inadequate breathing
- Regurgitation/vomiting/aspiration
- Laryngeal spasm
- Hypotension
- Not waking up

The patient in Recovery should continue to receive oxygen, have continuous monitoring of airway, breathing and circulation, and be given analgesia as required. Specific problems require a plan. If the patient fails to breathe adequately, is it due to inadequate reversal of relaxants, to the persistence of anaesthetic agents and opioids? Have they continued to bleed or lose fluid since the anaesthetic finished, and become hypovolaemic? If the patient fails to wake up, is it because of the drugs given, hypoxia, carbon dioxide retention, hypoglycaemia, hypothermia, or a medical complication?

Postoperative Care

The anaesthetist is often the best resource a surgeon has to advise on post-operative problems such as pain relief (Table 18), management of nausea and vomiting, fluid and electrolyte replacement. Get in the habit of visiting all emergency patients in the ward. You may be able to help, and you can make a note of any problems recorded on your anaesthetic record or the recovery record, as well as picking up anything that developed later which the surgeon believes may be due to the anaesthetic. You can also encourage early mobilisation and chest physiotherapy to minimise postoperative complications such as atelectasis, pneumonia, and deep venous thrombosis.

Table 18 **Post Operative Pain relief**

- Opioids
  - Titrate intravenously to start
  - Continue SCI or IMI regularly or IV infusion
  - Wean to simple analgesics
- Regional - epidural
- Monitor pain on a 0-10 scale
- Top-up before mobilisation
- Check for side effects
  - Respiratory depression
  - Sedation
  - Nausea/vomiting/itching
  - Confusion/hypotension
  - Urinary retention

Regional Anaesthesia

Occasionally, there may be a surgeon, an anaesthetist with only facilities for regional anaesthesia, and a patient requiring emergency abdominal surgery who cannot be moved to another hospital. Can anything be done with regional anaesthesia?

The options available are not ideal forms of anaesthesia for emergency abdominal surgery, but if resuscitation is carried out and the same principles followed as have been described above, possibilities include:

- Spinal anaesthesia
- Epidural anaesthesia
- Abdominal field block
- Para-vertebral block
- Splanchnic block

Spinal and epidural blocks have been described superbly in previous issues of Update (see Further Reading). They must not be used in patients who have not been fully resuscitated. Abdominal field block is best carried out by paravertebral intercostal block, first described by Sellheim in 1906, or paravertebral block, described by Kappis in 1912. Abdominal field block was first carried out by Schleich in 1899. Posterior splanchnic block was described by Kappis in 1919. These blocks have significant complications, and should only be attempted by those with excellent anatomical knowledge and technical skills.

Further Reading

Dobson MB Anaesthesia at the District Hospital 2nd. Edition, WHO Geneva 2000 ISBN 9241545275

Oberoi G, Phillips G Anaesthesia and Emergency Situations - A Management Guide, McGraw Hill Sydney 2000 ISBN 0074707671

Casey WF Spinal Anaesthesia - A practical guide, *Update in Anaesthesia* 2000:12

Visser L Epidural Anaesthesia, *Update in Anaesthesia* 2001:13

Mackenzie I, Wilson I The Management of Sepsis, *Update in Anaesthesia* 2001:13