

## SELF-ASSESSMENT QUESTIONS

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### Question 1

Epiglottitis

- A. Is commonest in children between six months and three years
- B. There may be no systemic upset in the child
- C. Cannulation is mandatory before attempting to control the airway
- D. Staphylococcus is the usual causative organism
- E. Intubation for 24 hours is usual

### Question 2

When assessing the airway preoperatively

- A. The Mallampati grading accurately predicts difficult intubation
- B. Mallampati grade 4 indicates a view of the soft palate
- C. Wilson grade C accurately predicts difficult intubation
- D. The ability to put chin on chest is a reliable indication of ease of intubation
- E. Vertebro-basilar insufficiency may be detected

### Question 3

Porphyria

- A. Can be induced by alcohol, pregnancy and muscular activity
- B. Is characterised by the induction of the enzyme d-aminolaevulinic acid synthetase
- C. Anaesthesia does not induce the erythropoietic forms of the disease
- D. The use of tourniquets is contraindicated
- E. Barbiturate anaesthesia must be avoided

### Question 4

The American Society of Anesthesiologists (ASA) Physical Status

- A. Predicts postoperative outcome
- B. Was instituted in response to malpractice claims
- C. ASA Class II would include a well-controlled asthmatic
- D. ASA Class IV indicates a condition which impedes activity but does not represent a threat to life
- E. Postscript E indicates an elective case

### Question 5

In ketoacidotic diabetic coma

- A. Large volume administration of dextrose-containing solutions are required in resuscitation
- B. Potassium supplementation will be required
- C. The hourly insulin requirement can be calculated by dividing the daily requirement by 24
- D. Bicarbonate therapy is needed with an arterial pH above 7.0
- E. Artificial ventilation may be required

### Question 6

The Glasgow Coma Scale

- A. Indicates the severity of head injury
- B. May be used as a prognostic guide
- C. A score of 2 is incompatible with survival
- D. If the patient's best motor response is flexion to pain, this scores 3 points
- E. Was first described by Dr Fergus Glasgow in 1973

### Question 7

The following are early signs of inadvertent oesophageal intubation

- A. ST depression on electrocardiogram (ECG)
- B. Bradycardia
- C. Absence of waveform on capnograph
- D. Absence of breath sounds on auscultation of lung apices
- E. Oxyhaemoglobin desaturation detected on pulse oximetry

### Question 8

Postoperative shivering

- A. Is due to the use of volatile anaesthetic agents
- B. May cause hypoxia in recovery
- C. May be arrested by a single dose of 25mg pethidine intravenously
- D. Does not occur after spinal anaesthesia
- E. The incidence of shivering with extradural analgesia is reduced by the concurrent use of an opiate

### Question 9

Intravenous regional anaesthesia (Bier's block)

- A. Can safely be performed using 0.25% bupivacaine without adrenaline
- B. Provides good quality postoperative analgesia
- C. Depends on the use of a double-cuff tourniquet inflated to 50mmHg above systolic pressure
- D. The tourniquet can safely be deflated 20 minutes after injection
- E. An advantage of the technique is that it can be employed by unsupervised casualty officers

### Question 10

The following agents may be used safely in a patient with asthma

- A. Vecuronium
- B. Ketamine
- C. Atracurium
- D. Tubocurarine
- E. Isoflurane

**Question 11**

The following commonly occur in pulmonary embolism

- A. Left bundle branch block
- B. Dyspnoea
- C. Raised systolic blood pressure
- D. Bradycardia
- E. Cannon waves in the JVP

**Question 12**

The following are recognised complications of massive transfusion of stored blood

- A. Hypokalaemia
- B. Hypernatraemia
- C. Tetany
- D. Hypothermia
- E. Thrombocytopenia

**Question 13**

The following tests are useful during acute investigation of a case of suspected anaphylaxis

- A. Serum histamine
- B. Serum N-methylhistamine
- C. Serum tryptase
- D. Serum IgA
- E. Serum complement

**Question 14**

During anaphylaxis

- A. Bronchospasm will occur in more than 75% patients
- B. Bronchospasm may be the only presenting feature
- C. Disseminated intravascular coagulation (DIC) may occur
- D. More than 10% of reactions involve upper airway oedema
- E. Cardiovascular collapse may be the only clinical feature

**Question 15**

In the patient with an ejection systolic murmur

- A. The patient with aortic stenosis has an increased risk of perioperative mortality
- B. Two dimensional echocardiography is used to assess gradient across the valve
- C. Aortic gradients greater than 25mmHg are regarded as significant
- D. The patient will require antibiotic cover perioperatively
- E. An aortic gradient less than 50mmHg excludes severe aortic stenosis

**Question 16**

The following clinical associations are correct

- A. Plasma potassium 2.6mmol/l - ST depression on ECG
- B. Plasma sodium 114mmol/l - bronchial carcinoma
- C. Plasma calcium (corrected) 3mmol/l - prolonged QT interval on ECG
- D. CSF glucose 1mmol/l with plasma glucose 6mmol/l - bacterial meningitis
- E. Serum albumin 60g/l - trauma

**Question 17**

Considering malignant hyperthermia during anaesthesia

- A. Sevoflurane is a precipitant
- B. The incidence is about 1 in 50,000 anaesthetics
- C. Inheritance is by an autosomal dominant mechanism
- D. Mannitol is added to vials of dantrolene to aid management of haemoglobinuria
- E. Profound muscle weakness can result from the effect of dantrolene on calcium transport

**Question 18**

In a patient with sickle cell anaemia

- A. About 50% of their haemoglobin will be in the HbS form
- B. Exchange transfusion is appropriate prior to major vascular surgery
- C. Folate is contra-indicated perioperatively as it may provoke an aplastic crisis
- D. The Hb-O<sub>2</sub> dissociation curve is shifted to the right aiding tissue O<sub>2</sub> unloading
- E. The use of any tourniquet is absolutely contraindicated

**Question 19**

During anaesthesia for a patient with severe mitral stenosis

- A. Sinus rhythm is critical since atrial contraction contributes 60% of ventricular filling
- B. If a-v pacing is required a long P-R interval is appropriate
- C. Afterload reduction is appropriate even if systemic blood pressure is normal
- D. Increased pulmonary vascular resistance is not a likely problem
- E. There will often be a marked discrepancy between PA diastolic and PA wedge pressures

**Question 20**

In a patient with severe aortic stenosis undergoing a general anaesthetic

- A. There is a direct relationship between calculated aortic valve area and blood flow across the valve
- B. A peak aortic valve gradient of 30mmHg is not compatible with the diagnosis
- C. A faster heart rate will be important to help left ventricular filling
- D. A reduction in systemic vascular resistance has little effect on ventricular emptying
- E. Episodes of myocardial ischaemia should be treated with GTN

**Question 1.**

You are the anaesthetist covering an obstetric unit. You and the obstetrician are called urgently to a patient. A primigravida woman with an antenatal diagnosis of intra-uterine growth retardation is being induced at 35 weeks gestation. She has received prostin pessaries overnight, and after starting the syntocinon infusion, develops prolonged late decelerations on the cardiotocograph (CTG) trace. Her cervix is 3cm dilated, she is contracting strongly and has received only intramuscular pethidine as analgesia.

- Describe the significance of the tracing
- How would you manage this patient?
- Outline the physiology of fetal oxygenation

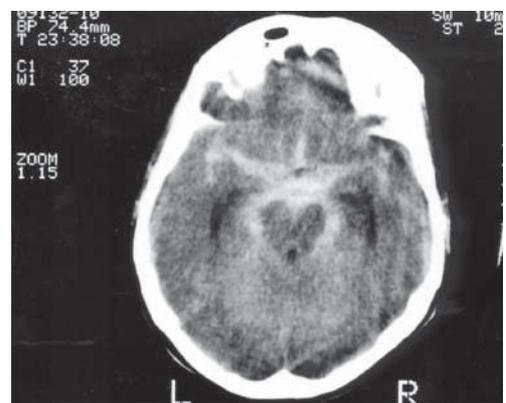
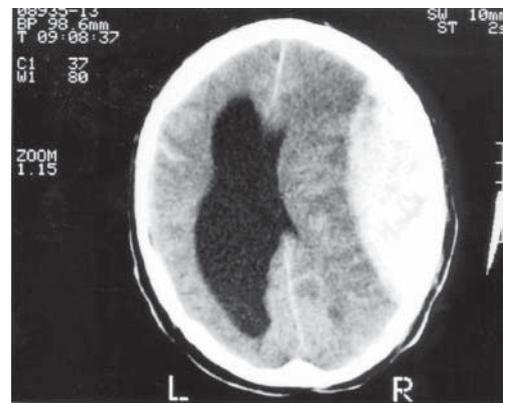
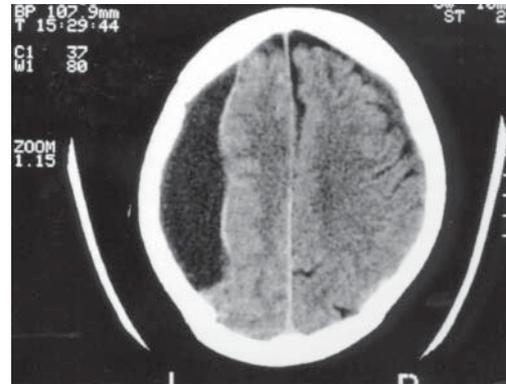
**Question 2.**

You are asked to anaesthetise a 25 year old man for an appendicectomy. He is a smoker who has recently had a chest infection that has been treated with antibiotics by his general practitioner. He still has a productive cough but is not short of breath and on examination he has some coarse crepitations in both lung fields. His pre-operative chest X-ray is entirely normal. After an uneventful procedure under general anaesthesia you extubate him and transfer him to the recovery ward. You are called back to recovery because his oxygen saturations are only 87% despite a high inspired oxygen concentration and he is complaining that he is having difficulty breathing. You examine him and order a chest X-ray (shown). What is the diagnosis and how would you treat it?



**Question 3.**

What pathology is demonstrated in each of these three CT scans?



## ANSWERS TO MCQ QUESTIONS

### Question 1

A. false B. false C. false D. false E. true

Epiglottitis causes a severe systemic upset with fever and drooling, which contrasts with croup where the child may otherwise be well. Croup is seen between six months and three years. Over this age epiglottitis is more likely to be responsible. Cannulation, direct examination and X-rays should not be attempted as laryngospasm may occur. Short term intubation, initially facilitated with sedation but not paralysis, is usually required and the causative organism is *Haemophilus*; bacterial tracheitis, which is a differential diagnosis, is caused by *Staphylococcus*.

*Reference: Johnston D, Hull D. Essential Paediatrics, 3rd edn. Churchill Livingstone, 1994*

### Question 2

A. false B. false C. true D. false E. true

The Mallampati system detects only 50% of difficult intubations. Grade 1 allows a full view down to the tip of the uvula, grade 2 the base of the uvula, grade 3 the soft palate only and grade 4 is where the soft palate cannot be seen. The Wilson test is of ability to protrude the mandible below the maxilla, where A is the mandible beyond the maxilla, B is where they can be aligned, and C is where the mandible cannot be brought in line with the maxilla. Neck extension is more important than flexion, and may reveal vertebro-basilar insufficiency in the susceptible.

*Reference: Recognition and management of difficult airway problems. Copley M, Vaughan R. British Journal of Anaesthesia 1992;68:90-97. Also Update in Anaesthesia Issue 9.*

### Question 3

A. false B. true C. true D. false E. true

Acute porphyric attacks are induced by alcohol, diet, pregnancy and in the case of the hepatic forms of the condition by barbiturates and steroids. Induction of d-aminolaevulinic acid synthetase with a deficiency of an enzyme further down the pathway of haem synthesis underlies all forms. Tourniquets, hypoxia and acidosis induce sickle crises not porphyria. Safe anaesthesia includes propofol, vecuronium, opiates and domperidone. Volatiles are probably not safe, and the use of local anaesthetic agents is contentious.

*Reference: Harrison et al. Anaesthesia for the porphyric patient. Anaesthesia 1993;48:417*

### Question 4

A. false B. false C. true D. false E. false

The ASA classification does not predict outcome; it indicates preoperative status and suggests the degree of skill required to deal with the case. It is widely used in audit to indicate the severity of disease and in research to standardise patients. The Harvard Minimum Monitoring Standards were developed as a result of escalating malpractice premiums. E indicates emergency, but has a different definition from that used in the Confidential Enquiries into Perioperative Death.

The ASA classes are, briefly:

- I: Fit and well
- II: Mild systemic disease
- III: Disease restricting activity
- IV: Severe systemic disease which is a constant threat to life
- V: Moribund and not expected to survive 24 hours.

*Reference: Update in Anaesthesia No 14*

### Question 5

A. false B. true C. false D. false E. true

Severe cases require intensive care management and frequently require intubation and ventilation. The condition may be insidious in onset, caused by infection, infarction or insufficient insulin. It is characterised by hypovolaemia (osmotic diuresis) and acidosis (ketone body production); large volumes of fluid are needed in resuscitation, but should be dextrose-free until serum glucose has fallen to below 15mmol/l. There is insulin resistance, and the normal daily requirement will be increased by at least 20%. Insulin therapy causes intracellular uptake of potassium and potassium supplementation is always required. Bicarbonate will only be required in extreme cases with severe systemic acidosis, and rarely with a pH over 7.0. Despite initial high plasma sodium levels, these patients are both salt and water depleted. Initial resuscitation should be with normal saline. Half normal saline may be used with caution.

*Reference: Update in Anaesthesia No 11*

### Question 6

A. true B. true C. false D. true E. false

First described for the assessment of head injury, it is now used for all types of coma. It is most usefully broken down into the components of:

- best motor response (1-6)
- best verbal response (1-5)
- eye opening (1-4)

change over time is a more useful guide to progress than is a single measurement. A score of 2 is not possible as 3 is the lowest score.

*Reference: Update in Anaesthesia No 6*

### Question 7

A. false B. false C. true D. false E. false

Especially if preceded by preoxygenation, signs of hypoxia such as desaturation, bradycardia and ECG changes are late warnings. Capnography is the gold standard but careful auscultation is also helpful in confirming correct placement, although it cannot reliably detect oesophageal placement.

### Question 8

A. false B. true C. true D. false E. true

The aetiology of shivering remains unknown but is certainly not due to volatile agents. Perioperative cooling and selective transmission of cold sensation because of a differential neural block are possible contributing factors. A small dose of pethidine may abolish it. Doxapram has also been used. Basal metabolic rate can increase 10-fold and hypoxia is common due to increased oxygen requirements for heat production.

*Reference: Crossley AWA. Anaesthesia 1992;47:193*

### Question 9

A. false B. false C. false D. true E. false

The technique is an anaesthetic technique and regardless of local practice it should be conducted by suitable qualified anaesthetists with appropriate resuscitation facilities available. Prilocaine 0.5%, without preservative or vasoconstrictor, is the only agent used in contemporary practice, bupivacaine being discarded because of toxicity. The tourniquet should be inflated to twice systolic blood pressure. The quality of postoperative analgesia is disappointing. There is a recognised risk of methaemoglobinemia with doses of prilocaine in excess of 600mg.

*Reference: page 000 this issue*

### Question 10

A. true B. true C. false D. false E. true

Agents which provoke histamine release should be avoided because of risk of provoking bronchospasm which may be life threatening. These include atracurium, thiopentone and tubocurarine. Ketamine will cause bronchodilation, as do volatile anaesthetic agents despite the respiratory irritant effects of isoflurane when used for the induction of anaesthesia. Non steroidal should be used with caution in patients known to have asthma.

*Reference: Update in Anaesthesia No 12*

### Question 11

A. false B. true C. false D. false E. false

Pulmonary embolism is the most common cause of death in the first ten days post op. Massive PE is associated with cardiorespiratory collapse and a high mortality. Small PE may cause very few symptoms.

Pleuritic chest pain, dyspnoea and haemoptysis are the common features. Cyanosis, tachypnoea and tachycardia may also occur. Hypotension is the more common feature associated with obstruction of the pulmonary circulation. Cannon waves are seen in complete heart block and not pulmonary embolic disease. The common ECG findings include signs of right ventricular strain; right axis deviation, right bundle branch block, T wave inversion in the right chest leads. The pathognomonic sign is the S1 Q3 T3 pattern. This is rarely seen.

*Ref: Yentis, Hirsch and Smith. Anaesthesia A to Z. Butterworth.*

### Question 12

A. false B. false C. true D. true E. true

The complications of massive blood transfusion can be classified into those that are related to the volume of blood given and those related to the storage of blood:

Volume related:

- Transfusion reactions
- Transmission of infection
- Alloimmunisation
- Immunological disturbance

Storage related:

- Hyperkalaemia
- Acidosis
- Hypothermia
- Citrate toxicity
- Hypocalcaemia
- Platelet and clotting factor deficiency
- Microaggregate formation and acute lung injury
- Reduced oxygen delivery due to reduced 2,3 DPG levels

*Reference: Update in Anaesthesia No 14*

### Question 13

A. false B. false C. true D. false E. true

**Anaphylaxis** = An exaggerated response to a substance which the subject has previously been sensitized to, associated with the liberation of histamine. Sensitization may have occurred by exposure to a related substance. Histamine release is the hallmark of anaphylaxis but cannot practically be measured. Instead more durable markers of histamine release should be sought. Tryptase is a neutral protease released during mast cell degranulation. It is

normally undetectable in the serum but levels remain elevated for up to 16 hours following anaphylaxis. N-methyl-histamine, the major URINARY metabolite histamine may also be detectable for prolonged periods. Type 1 hypersensitivity reactions involve IgE (50% of thiopentone reactions) Classical complement mediated activation involves IgG or IgM Alternative complement activation does not involve antibodies

*Reference: McKinnon & Wildsmith. Histaminoid reactions in Anaesthesia. British Journal of Anaesthesia 1995;74:217. Update in Anaesthesia No 12*

#### Question 14

A. false B. true C. true D. true E. true

Anaphylaxis = An exaggerated response to a substance which the subject has previously been sensitized to, associated with the liberation of histamine. Sensitization may have occurred by exposure to a related substance.

- 90% of reactions involve cardiovascular collapse
- 10% involve only cardiovascular collapse as a presenting feature
- 80% get an SVT
- 11% of patients arrest
- 3% get pulmonary oedema
- 50% get bronchospasm
- 3% get only bronchospasm as a presenting feature
- 12% get upper airway oedema

*Reference: McKinnon & Wildsmith. Histaminoid reactions in Anaesthesia. British Journal of Anaesthesia 1995;74:217. Update in Anaesthesia No 12*

#### Question 15

A. true B. false C. false D. false E. false

An ejection systolic murmur may be due to a valvular lesion or may be functional, innocent, and not related to a structural cardiac lesion. Antibiotic cover is recommended for patients with congenital heart disease or acquired valve disease receiving dental or operative treatment. 2D echocardiography will demonstrate calcification or valvular thickening and LVH secondary to aortic stenosis. Doppler echocardiography works out pressures from the velocity of blood within the heart and can be used to determine gradient across the valve. Values over 50mmHg are considered significant, although a poor left ventricle may contract so weakly against a severely stenosed valve that a large gradient is not achieved. Goldmann noted no increase in perioperative mortality with mitral valve disease but a 13% mortality in patients with important aortic stenosis.

*Reference: Kaufman L. Anaesthesia Review 10 (Butterworths). Ch1. Also Update in Anaesthesia No 14*

#### Question 16

A. true B. true C. false D. true E. false

Hypokalaemia (potassium less than 3.6mmol/l) may lead to arrhythmias, ST depression, T wave inversion and a prominent U wave on the ECG. Hyponatraemia to the extent of 114mmol/l is abnormal. The serum sodium is frequently 5mmol/l less than normal in hospital patients and is a result of sick cell syndrome. Bronchial carcinoma is associated with inappropriate ADH secretion which can cause severe hyponatraemia. Hypercalcaemia over 2.6mmol/l may lead to a shortened QT interval on ECG as well as other cardiac arrhythmias and hypertension. The normal plasma CSF glucose is approximately 65% of the blood glucose. A lower CSF glucose than this, as shown, is indicative of bacterial meningitis. The normal plasma albumin is 35-50g/l. Catabolic states such as severe sepsis, trauma, fever and malignancy lead to hypoalbuminaemia.

*Reference: Marshall. Clinical Chemistry. J.B. Lippincott Company.*

#### Question 17

A. true B. false C. true D. false E. false

Human malignant hyperthermia is inherited as an autosomal dominant with links to gene loci on chromosomes 17 and 19. Triggering agents include suxamethonium, (which can produce a very rapid onset) halothane, enflurane, isoflurane, desflurane, sevoflurane, methoxyflurane, ether and cyclopropane. The incidence is approximately 1/15,000 anaesthetics. Mannitol is present in bottles of Dantrolene to make the solution isotonic. Miller suggests that 3-4 people will be needed to get a dose of 2mg/kg into solution for an adult. Even in high dose, dantrolene will only produce mild muscle weakness.

*Reference: Miller. Anesthesia. Churchill Livingstone. Chapter 31.*

#### Question 18

A. false B. true C. false D. true E. false

Sickle cell disease is commonest in people originating in west and central Africa and also from around the Mediterranean. Sickle cell trait is present in 10% of African Americans in whom 40% of their Hb is as HbS. Sickle cell anaemia is found in 1% of African Americans and their Hb is very predominantly HbS. On desaturation of their Hb the HbS is 50 times less soluble than HbA and tactoids of rigid Hb chains are formed altering the function of the red blood cells. Haemolytic anaemia occurs along with organ damage due to vascular obstruction in the spleen, kidneys, gut, and brain. Aplastic crises can occur when the bone marrow fails as a result of intercurrent infection or folate deficiency. Exchange transfusion is appropriate prior to major vascular surgery as O<sub>2</sub> carriage is increased and the risk of sickling is decreased. Folate therapy is appropriate as it may help marrow function at a time of additional stress. Esmarch tourniquets have been described as used without problems in some patients although overall the use of tourniquets would be considered contra-indicated.

*Reference: Katz J. Anaesthesia and uncommon diseases. Saunders. Sickle cell anaemia. p391-397.*

**Question 19**

A. false B. true C. false D. false E. true

Mitral stenosis is usually the result of rheumatic fever with a distorted and partly fused valve secondarily calcifying. Slow deterioration with dyspnoea, pulmonary oedema, chest pain, palpitations and haemoptysis occurs. Left atrial pressure is chronically raised and pulmonary hypertension occurs. Atrial contraction will contribute 30% of ventricular filling and if atrio-ventricular pacing is needed a long P-R interval will help filling of the ventricle. Cardiac output will usually not be helped by afterload reduction in the setting of a normal blood pressure since the obstruction is at mitral valve level. Pulmonary vascular resistance is a serious problem with right ventricular failure being a risk. If pulmonary vascular resistance increases the right ventricle may further distend and the inter-ventricular septum intrude on left ventricular function. Due to the pulmonary hypertension the pulmonary diastolic pressure will often be considerably above the pulmonary wedge pressure.

*Reference: Hensley. The practice of cardiac anaesthesia. Little, Brown. Anaesthetic management for the treatment of valvular heart disease. Also Update in Anaesthesia No 14*

**Question 20**

A. true B. false C. false D. true E. true

In aortic stenosis the normal aortic valve area decreases from 3cm<sup>2</sup> to less than 1cm<sup>2</sup>. Without increased left ventricular systolic pressures the blood flow across the valve is dependent on the pressure gradient. With compensatory hypertrophy of the left ventricle the aortic valve gradient will increase. However later in the disease as the left ventricle dilates and further fails the left ventricular valve gradient will fall as cardiac output falls. A relatively slower heart rate is important to allow adequate time for left ventricular filling and emptying. The increased impedance to left ventricular emptying is at valve level and so changes in systemic vascular resistance will not significantly affect left ventricular emptying. However a decrease in systemic vascular resistance may lead to critical reductions in myocardial perfusion. Episodes of myocardial ischaemia should be treated by firstly increasing systemic perfusion pressure. Vasodilators such as nitrates should be used with extreme caution if at all.

*Reference: Hensley. The practice of cardiac anaesthesia. Little, Brown. Anaesthetic management for the treatment of valvular heart disease.*

*Also Update in Anaesthesia No 14*

**Answers to Self Assessment Questions****Question 1 - Answer**

Prolonged late decelerations on the CTG are abnormal and signify probable fetal distress. This is progressive fetal asphyxia that if uncorrected will lead to permanent central nervous system damage or death. Fetal acidosis should be confirmed by performing a fetal scalp pH. This procedure should not, however, delay the institution of intra-uterine fetal resuscitation (IUF) which should begin immediately. IUF consists of specific measures aimed to increase the delivery of oxygen to the placenta and the umbilical blood flow, in order to reverse fetal hypoxia and acidosis. The mother should be examined quickly to exclude maternal hypoxia or shock or placental separation (placental abruption) which would require additional specific therapy. The following management should then be instituted immediately:

- Turn the syntocinon off.
- Turn the mother into the left lateral position and if there is no improvement try the right lateral position or the knee chest position in case cord compression is the cause.
- Administer high flow oxygen via a tight fitting Hudson mask with a reservoir bag.
- Infuse 1000mls Hartmann's solution or normal saline rapidly.
- Treat a low blood pressure if it exists. Fluids and vasopressors may be required after epidural analgesia.
- Tocolysis (stopping uterine contractions). Terbutaline 250 micrograms subcutaneously or GTN spray sublingually (2 puffs repeated up to 3 times). [not if placental abruption or antepartum haemorrhage]

If fetal acidosis is confirmed and the fetal heart rate trace does not improve with the above measures a caesarian section will be necessary.

**The Physiology of Normal Oxygen Transport to the Fetus**

The delivery of oxygen to the organs of the fetus requires oxygen delivery to the maternal side of the placenta (intervillous spaces), placental transfer of oxygen to the fetal blood in the chorionic villi by passive diffusion and an intact fetal circulation.

**Oxygen delivery to the placenta.** Placental blood flow is determined by the perfusion pressure (arterial pressure - venous pressure) and the resistance to blood flow. Oxygen delivery is defined as placental blood flow multiplied by the arterial oxygen content (haemoglobin concentration multiplied by the arterial oxygen saturation). Branches of the uterine arteries supply the intervillous spaces and the blood returns to the maternal circulation via the uterine veins. The branches of the uterine arteries are maximally dilated during late pregnancy and therefore placental oxygen delivery is close to maximum at this time provided that the mother has a normal haemoglobin concentration, normal oxygen saturations and a normal perfusion pressure.

**Placental transfer of oxygen.** In the placenta, chorionic villi project into the large 'lakes' of maternal blood in the intervillous spaces and contain fetal capillaries. These chorionic villi are perfused by the umbilical arteries and the blood returns to the fetal circulation via the umbilical vein. The placental transfer of oxygen is a passive process from maternal blood, with a relatively

high  $PO_2$ , to the fetal capillaries with a low  $PO_2$ . Fetal umbilical venous  $PO_2$  is relatively low (35mmHg) compared to maternal arterial  $PO_2$  (100mmHg when breathing air). This is thought to be due to the structural characteristics of the placenta (it functions as a concurrent exchange system rather than a countercurrent exchange system), poor matching of fetal and maternal blood flow in certain areas of the placenta (analogous to shunt and ventilation/perfusion mismatch in the lung) and because of the high oxygen consumption of the placenta itself.

**Fetal circulation.** An adequate fetal oxygen delivery is still possible despite the low umbilical venous  $PO_2$  because of a number of factors. The haemoglobin concentration is high (17-19g/dl), the cardiac index high (350mls/m<sup>2</sup>/min) and the haemoglobin dissociation curve is shifted to the left compared to the adult because of the presence of haemoglobin F. This means that despite the low  $PO_2$  in the umbilical vein the haemoglobin is 75-80% saturated. The fetal circulation is also designed such that the best oxygenated blood from the umbilical vein is directed via the ductus venosus to the inferior vena cava and via the foramen ovale to the left side of the heart and then to the head and neck of the fetus. The less well oxygenated blood from the superior vena cava enters the right ventricle and then enters the aorta via the ductus arteriosus distal to the left subclavian artery. The less well oxygenated blood is therefore diverted to the trunk and lower body of the fetus.

**Effect of uterine contractions on oxygen transport.** Active contractions during labour generate intra-uterine pressures of 45-50mmHg which compress the uterine veins and decrease arterial blood flow. This causes a reduction in the  $PO_2$  of the blood in the intervillous spaces and the fetal oxygen saturations decline about 7% to a low point about 90-120sec after the peak of the contraction. Recovery occurs over a similar period of time. When oxygen delivery is borderline contractions may cause a marked fall in fetal oxygenation and fetal bradycardia. This is seen as a late deceleration on the CTG. When oxygen delivery is severely impaired, oxygenation fails to recover between contractions and a sustained bradycardia results.

Pathological Conditions Causing an Inadequate Oxygen Delivery to the Fetus

- **Maternal hypoxia**
- **Maternal hypovolaemia / hypotension**

- **Aortocaval compression.** The pregnant uterus may compress the inferior vena cava and aorta within the abdomen. This is usually worst when the mother is lying on her back but can occur in other positions to. Caval compression decreases venous return and cardiac output and may result in maternal symptoms of hypotension. Isolated aortic compression does not produce maternal symptoms but will also result in a decrease in fetal oxygen delivery.
- **Uterine hyperstimulation.** This is defined as a contraction frequency of more than one in every 2 minutes and does not allow recovery of fetal oxygenation between contractions. As already explained a normal contraction frequency can cause distress to a fetus without physiological reserve.
- **Placental separation/abruption**
- **Pre-eclampsia**
- **Umbilical cord compression.** This is most obvious when the cord prolapses into the vagina but it may also be compressed in the uterus. If compression is severe enough to cause fetal hypoxia the bradycardia follows contractions but the timing is not constant (variable decelerations).
- **Fetal haemorrhage**
- **Regional analgesia.** Sympathetic blockade will worsen any tendency to supine hypotension. Some of the changes in fetal heart rate pattern seen after regional analgesia may be due to an increase in uterine activity.

[Ref: Thurlow JA and Kinsella SM. Intrauterine resuscitation: active management of fetal distress. *International journal of Obstetric Anaesthesia* (2002)**11**,105-116]

#### Question 2 - Answer

Left lower lobe collapse (left diaphragm not seen and double shadow along left heart border). Initial treatment would include humidified oxygen and physiotherapy to re-expand the lung. If this was not successful a bronchoscopy could be performed. Antibiotics should be prescribed.

#### Question 3 - Answer

- 1) Chronic subdural haematoma
- 1) Acute extradural haematoma
- 2) Subarachnoid haemorrhage