Anaesthetic management of patients with a congenital diaphragmatic hernia

Q1 – Answers

a) True. CDH is a rare birth defect affecting 1:3600 registered births. More pregnancies will be affected but not all make it to term due to either miscarriage or termination.
b) True. Approximately 80% occur on the left side.
c) False. Compared with the right, there is no definitive evidence that left sided hernias confer better survival rates.
d) True. Trisomy 13, 18 and 21, Fryns syndrome, Cornelia de Lange syndrome are among the chromosomal and genetic abnormalities associated with this condition.
e) True. Cardiac abnormalities occur in approximately 14% of patients with diaphragmatic hernia. They are associated with a poorer prognosis.

Q2 – Answers

a) True. Lung protective ventilatory strategies should be employed to avoid further injury to the hypoplastic lung.
b) False. The “VICI” trial in 2016 concluded that there was no difference in mortality between conventional and HFOV. Compared with HFOV, children who had conventional ventilation were ventilated for shorter periods, were given less nitric oxide, and had lower inotrope, sildenafil and Extracorporeal membrane oxygenation (ECMO) requirements.
c) True. Neuromuscular blockade should only be used to aid ventilator synchrony as advised by the CDH EURO Consortium.
d) False. Despite its common usage nitric oxide has not be found to improve mortality rates. Conversely some studies have suggested a detrimental effect on survival.
e) True. This test enables rapid evaluation of cardiac impairment, pulmonary hypertension and cardiac defects.

Q3 – Answers

a) False. The repair of a CDH is not a surgical emergency. There is little evidence to indicate the ideal timing for repair, but it should generally occur when the patient is medically stable and during working hours. Discussions should involve anaesthetists, surgeons, intensivists, paediatricians and parents.
b) True. The higher recurrence rates reported by some studies is a significant drawback to the thoracoscopic approach.
c) False. Despite theoretical advantages, thoracoscopic repair has not shown any improvement in survival rates and has been associated with higher carbon dioxide levels and decreased cerebral oxygen saturations.
d) False. Some centres do proceed with surgery on ECMO. The risks of bleeding are significant. Overall, surgical repair on ECMO is controversial.
e) True. This is often more likely to occur during thoracoscopic repair where it has been associated with more severe acidosis and decreased cerebral oxygen saturations.

Q4 – Answers

a) True. The absence of liver herniation on an antenatal scan is a reliable indicator of an improved prognosis.
b) False. Cardiac anomalies have been shown to be associated with decreased survival rates.
c) False. A patch repair is necessary for a larger defect and is an independent predictor of mortality.
d) True. Term delivery is associated with survival. In contrast, low birth weight and preterm delivery are both associated with high mortality rates.
e) False. Early gestational age at diagnosis suggests a larger defect and therefore confers an adverse prognosis.

Physics for anaesthesia: Magnetic resonance imaging; depth of anaesthesia monitoring; LASER and light spectroscopy
Q1 – Answers

a) False. All atoms precess. Hydrogen is used to form an MRI image because of its ubiquity in body tissues, mainly in water.
b) False. Atoms precess asynchronously when a single large magnetic field is applied. When the transverse field is also applied at the resonant precession frequency of the atom, then resonance occur.
c) True. The Larmor frequency is the precession resonant frequency characteristic of the atom and proportional to the applied magnetic field.
d) True. Following removal of the transverse magnetic field, the precessing, resonating atoms relax and emit a characteristic time related signal which, due to the earlier resonance, is large enough to be detected to form an image, and not to be swamped by the longitudinal field.
e) False. For magnetic resonance to work, hydrogen atoms have to have some mobility. In bone they are fixed in hydroxyapatite crystals. So bone is shown as an absence of an image.

Q2 – Answers

a) True. Phosphorescence is a result of absorption emission rather than stimulated emission. As such, the emitted photon waves from multiple atoms are neither monochromatic nor coherent, nor particularly collimated.
b) True. In order to achieve the intensity characteristic of a LASER beam, the beam is reflected off a mirror at each end of the tube, and made to traverse the tube many times, repeatedly energising many atoms, before it emerges from a hole at one end of the tube.
c) False. It is a carbon dioxide LASER which has this wavelength; a ruby LASER has a wavelength of 694 nm.
d) False. High power class 4 LASERS are considered hazardous because their output is in excess of 500 mW.
e) False. In a depth of anaesthesia monitor using auditory stimuli, the evoked potential from the brainstem in the first 10 ms is resistant to change in anaesthetic depth, whereas the evoked potential emanating from the auditory cortex at 10 – 50 ms is sensitive to anaesthetic dose.

Q3 – Answers

a) False. While the uniqueness of the BIS monitor lies in its ability to analyse bispectral relationships in more than one waveband, the monitor uses a complex algorithm which includes the burst suppression ratio and the power spectrum ratio at more than one waveband.
b) False. In research leading to the development of depth of anaesthesia monitors, the EEG power spectrum was analysed in the frequency domain. It was found that both the spectral edge frequency and the median power frequency were of limited value because they are both drug type and drug dose dependent.
c) True. The analysis of the bispectrum is the examination of the phase relationships between two or more sets of neuronal electrical generators, which would otherwise be difficult to distinguish from each other by amplitude and frequency analysis of the power spectra alone. Depth of anaesthesia is deduced from the knowledge that there is more phase coupling between generators in the anaesthetised state than in the awake state.
d) True. The BIS monitor analyses bispectra in the 0.5 – 47 Hz and 40 – 47 Hz bandwidths, as well as the power spectra in the 11 – 20 Hz and 30 – 47 Hz bandwidths, and examines periods of isoelectric activity in the time domain (burst suppression ratio).
e) False. In a depth of anaesthesia monitor using auditory stimuli, the evoked potential from the brainstem in the first 10 ms is resistant to change in anaesthetic depth, whereas the evoked potential emanating from the auditory cortex at 10 – 50 ms is sensitive to anaesthetic dose.

Q4 – Answers

a) False. The use of two wavelengths of light for spectroscopy in pulse oximetry (660 nm and 940 nm), can only distinguish HbO₂ and HHb species of haemoglobin. A co-oximeter with four or more light wavelengths is needed to detect and distinguish other haemoglobin species, such as MetHb and COHb.
b) False. As in a) above, two spectroscopic wavelengths are used in pulse oximetry to distinguish two Hb species. A different aspect of the algorithm electronically filters the signal to identify its pulsatile component.
c) True. Infrared light is characteristically absorbed by the inter-atomic bonds between dissimilar atoms in polyatomic molecules.
d) False. IR light is not characteristically absorbed by molecules containing one atom type such as oxygen.
and nitrogen, but as in c) above, water, H₂O is a strong absorber of IR light.
e) True. Raman spectroscopy is used to distinguish different molecules by the characteristic change of wavelength of the reflected LASER light from a substance (solid, liquid or gas), and the amplitude of the reflected wave indicates the individual gas concentration in anaesthesia. All gases and vapours can be detected by this method.

Prognostication of patients following cardiopulmonary resuscitation

Q1 – Answers

a) True. Early recognition and call for help is to prevent a cardiac arrest.
b) True. Early CPR buys time.
c) True. Early defibrillation, in the case of VT and VF will start the heart.
d) False. Prognostication should occur at least 72 hours after return of spontaneous circulation.
e) True. Post resuscitation care aims to restore quality of life to the patient.

Q2 – Answers

a) False. Pupillary responses are not helpful in the first 72 hours following ROSC. They must be assessed with corneal reflexes at 72 hours. It must be noted that drugs including sedation may hinder assessment of responses.
b) True. At 72 hours, poor prognosis is very likely with absent pupillary and corneal reflexes. However, this is only seen in 19% of patients who have a definite outcome of poor prognosis. It should be used as part of a wider assessment of neurological function.
c) False. The presence of intermittent myoclonus lasting less than 30 minutes is unhelpful is making useful decision about prognosis. Persistent status myoclonus lasting greater than 30 minutes is useful at predicting poor prognosis when the rare condition of Lance Adams syndrome is excluded which carries a more favourable prognosis.
d) False. A low or reduced Glasgow Coma Score (GCS) has little place in assessment of neurological function especially immediately following ROSC. The use of the motor score component only with an absent (score of 1) or extensor response (score of 2) is only useful after 72 hours and will lead to the initiation of further assessment of neurological function.
e) True. When electrical interference is excluded and interpreted by an experienced operator, this is a very useful test of prognosis. However, its availability and need for expert interpretation limits its use.

Q3 – Answers

a) False. The Median nerve is the ideal site for electrode placement. Testing should be performed bilaterally on each arm ensuring that patency of nerve signal is present in the upper part of the cervical cord and brachial plexus.
b) False. Nerve signals are only affected at the neuromuscular junction and since the nerve is being directly stimulated, it is unaffected by neuromuscular blocking agents.
c) True. This refers to the time take from stimulation at the median nerve to reception at the primary somatosensory cortex (also known as the post-central gyrus).
d) True. Of the very few false positive results in studies, it was hypothesised that this was due to artefactual disturbance. Electrical and noise interference are issues on ICU given the number of devices such as ventilators and renal replacement therapy.
e) False. Although SSEP’s are very reliable at assessing neurological function but are subject to interference and need experienced interpretation. Multimodality assessment is important is making an accurate decision about prognosis.

Q4 – Answers

a) True. Mortality is often reported.
b) False. The EuroSCORE is a risk model used in cardiac surgery. It is not relevant in the post-arrest state.
c) True. The cerebral performance categories scale is used to measure neurological functioning.
d) True. The Rankin scale is like the Cerebral Performance Categories scale and is used to measure disability.
e) False. The Scoville scale is used to measure the pungency of chilli peppers.

Current recommendations for paediatric resuscitation
Q1 – Answers

a) False. The main priority here is defibrillation and this should not be delayed. If attempts at establishing intravenous access are unsuccessful after 1 minute, an intraosseous needle should be inserted.

b) True. 8–12 cm diameter pads are for children weighing >10 kg. 4.5 cm diameter pads are recommended for infants and children weighing < 10 kg

c) False. Shocks should be delivered at a dose of 4 J kg⁻¹. A 25 kg child should have a 100 Joule shock

d) False. After the third shock, adrenaline 250 mcg (10 μg kg⁻¹) and amiodarone 125 mg (5 mg kg⁻¹) should be administered once cardiopulmonary resuscitation has resumed.

e) False. Therapeutic hypothermia may be instituted if there is no return of consciousness following return of spontaneous circulation. Hyperthermia must be avoided.

Q2 – Answers

a) False. Bag mask ventilation is the first line method for achieving airway control and ventilation. Tracheal intubation should only be attempted when appropriate personnel and equipment are available.

b) True. The formula, Age in years/4 + 4 is used to determine uncuffed tracheal tube size. A size 4 uncuffed tube would be appropriate for this infant. A 3.5 tube should also be available in case of airway narrowing.

c) False. For providers experienced in their use a LMA may be used to provide an airway during paediatric resuscitation, particularly in children with supraglottic airway abnormalities or if mask ventilation is difficult. In this instance a size 3 is too large.

d) True. After a period of bag mask ventilation in an infant, increasing difficulty in ventilation is often caused by gastric distension, oro or nasogastric tube insertion and gastric decompression can improve ventilation significantly in infants.

e) False. As pulmonary blood supply is very low during external cardiac compression, it is not possible to control arterial CO₂ concentrations with positive pressure ventilation. Excessive ventilation may reduce venous return to the chest and coronary and cerebral perfusion pressure. The purpose of ventilation during CPR is simply to supply oxygen to the alveoli. This process only requires intermittent expansion of the lung with a high concentration of oxygen. A respiratory rate of 10–12 bpm is recommended for all ages.

Q3 – Answers

a) True. Primary shockable rhythms are seen in less than 20% of paediatric cardiac arrests.

b) True. If there is a danger of the pads overlapping when applied to the front of the chest, it is best apply them front to back to avoid arcing between them.

c) False. AED rhythm recognition in paediatric cardiac arrest has high sensitivity and specificity.

d) False. Adenosine is recommended for the treatment of supraventricular tachycardia.

e) True. Lidocaine may be used as an alternative drug to amiodarone in shock resistant VF.

Q4 – Answers

a) True. Hypoxia, due to respiratory failure is the most common cause of cardiopulmonary arrest in children and particularly infants.

b) False. 10 μg kg⁻¹ adrenaline, that is to say 100 μg is the recommended dose. Higher doses have not been shown to improve outcome.

c) False. The rhythm is not VF. In non-shockable rhythms, effective CPR is the most valuable intervention.

d) False. Capnography reflects pulmonary blood flow and therefore cardiac output and may help in optimising chest compressions.

e) True. The intraosseous route is a good way of obtaining circulatory access quickly and should be considered immediately if there is any problem obtaining peripheral intravenous access.

How to start a quality improvement project

Q1 – Answers

a) True. Project aims should be SMART (Specific, Measurable, Attainable, Relevant and Time bound).

b) False. All the elements of a good aims statement are not included and there is no time frame. It is also better to have an absolute increase (e.g. improve pain scores so that 95% of patients have mild pain or better in recovery) rather than a relative increase of 20%.
c) False. All the elements of a good aims statement are not included. In particular there is no quantification of the degree of improvement.
d) This has all the elements of a good AIMS statement.
e) This statement does not contain a reason why it is a good idea to decrease cancellation rates. This may appear obvious to those close to the project but may not always be so for other staff members. Also, the statement does not specify the improvement goal but has a relative amount of improvement i.e. 20%. There is no insight into the current performance of the system.

c) False. This is an outcome measure as it is the aim of the project.
d) False. This cost is a balancing measure as it is a potentially negative effect in achieving the goal of reducing the number of patients who have a pain score of moderate or severe in recovery.
e) False. This time is a balancing measure as it is a potentially negative effect in achieving the goal of reducing the number of patients who have a pain score of moderate or severe in recovery.

Q2 – Answers

a) True. Quality improvement measures are Process, Structure, Outcome and Balancing measures.
b) True. Quality improvement measures are Process, Structure, Outcome and Balancing measures.
c) False. Quality improvement measures are Process, Structure, Outcome and Balancing measures.
d) False. Quality improvement measures are Process, Structure, Outcome and Balancing measures.
e) False. Quality improvement measures are Process, Structure, Outcome and Balancing measures.

Q3 – Answers

a) False. This example is a process measure in the Surgical Site Infection bundle where the number of surgical site infections would be the outcome measure.
b) False. This example is a balancing measure. There is an adverse effect of an increase cost through the increased use of forced air warming blankets.
c) True. This example is an outcome measure of the surgical site infection bundle.
d) False. This is a process measure as it is part of the process in the outcome of reducing surgical site infections.
e) This is a process measure as it is part of the process in the outcome of reducing surgical site infections.

Q4 – Answers

a) True. This is a process measure in achieving the goal of reducing the number of patients who have a pain score of moderate or severe in recovery.
b) True. This is a process measure in achieving the goal of reducing the number of patients who have a pain score of moderate or severe recovery.