Example Questions and Explanations

Primary FRCA Single Best Answer Questions

Pharmacology

Question 1

A ventilated patient has been admitted to the Intensive Cre Unit after emergency major colorectal surgery and is receiving a continuous intravenous infusion of a drug to support his cardiovascular system. Blood glucose concentration 12 hours later is 13 mmol L^{-1} although he is not known to be diabetic. You suspect that the choice of drug infusion may be responsible.

The drug infusion is most likely to be which of the following?

A. Adrenaline
B. Dobutamine
C. Enoximone
D. Noradrenaline
E. Vasopressin

Correct answer: A. Adrenaline

Explanation: Adrenaline is well known to increase plasma glucose by promoting glycogenolysis in the liver and skeletal muscle, liver gluconeogenesis and reduction of glucose uptake by tissues such as skeletal muscle via activation of α1- and β2-adrenoceptors. In both liver and skeletal muscle, glycogenolysis occurs because of β1-adrenoceptor-mediated activation of glycogen phosphorylase.

Question 2

A patient undergoes day case removal of a sebaceous cysts under total intravenous general anaesthesia using propofol and alfentanil. The surgeon infiltrates local anaesthetic at the end of surgery.

Which of the following properties is the best reason for choosing it rather than fentanyl?

A. Clearance
B. Inactive metabolites
C. pKa
D. Potency
E. Volume of distribution

Correct answer: E. Volume of distribution

Explanation: the key point here is the speed of offset of the alfentanil is faster than that of fentanyl. A lower volume of distribution means that alfentanil has a faster offset than fentanyl despite its lower clearance rate. Potency relates to speed of onset – although useful, this is not the best reason for using this drug.

Question 3

A two-year-old boy weighing 12.5kg requires day case inguinal hernia repair. After induction of general anaesthesia, a caudal block is performed using levobupivacaine for intra and post-operative analgesia.

Which of the following doses is most appropriate?

A. 0.25%, 10ml
B. 0.25%, 20ml
C. 0.5%, 5ml
D. 0.5%, 10ml
E. 0.75%, 3ml

Correct answer: A. 0.25%, 10ml

Explanation: consider the maximum safe dose of levobupivacaine (with or without adrenalin) – 2mg kg^{-1}. Therefore, for this child the maximum safe dose is 25mg. You can therefore immediately exclude options B and D. A, C and E all contain safe doses. The greater volume with option A should provide sufficient spread of local anaesthetic and therefore blockade of the lumbar and lower thoracic dermatomes for this child.

Question 4

A patient with asthma develops severe bronchospasm after taking over the counter diclofenac.

The production of which of the following is most likely to be responsible?

A. Arachidonic acid
B. Leukotrienes
C. Phospholipase A2
D. Prostacyclin
E. Thromboxane A2

Correct answer: B. Leukotrienes

Explanation: consider the metabolic pathway from arachidonic acid to prostaglandins. Blockade of the cyclooxygenase enzyme shunts metabolism away from prostaglandins and to leukotrienes which my provoke bronchospasm in susceptible individuals.

Question 5

A new aminosteroid non-depolarising neuromuscular blocker with a similar molecular weight to rocuronium produces satisfactory intubating conditions 45 seconds after administration.

Which of the following is most likely to be a property of the new drug?

A. Clinical intubating dose 2mg kg^{-1}
B. Greater potency than rocuronium
C. Muscle fasciculation
D. Recovery of train of four ration >0.9 within 15 minutes

E. Reversed by sugammadex

Correct answer: A.

Explanation: Consider the Bowan principle: lower potency requires a larger clinical intubating dose which means more molecules of the drug are given and so onset is faster according to the law of mass action. B is therefore false. Fasciculation is a feature of depolarising muscle relaxants. D is dependent on metabolism. While reversibility with sugammadex may be a feature it is not the most predictable one.

Physiology

Question 6

Myocardial contractility may be defined as the intrinsic ability of cardiac muscle fibres to do work with a given preload and afterload.

Which of the following is the best measure of left ventricular (LV) contractility?

A. Ejection fraction
B. LV end diastolic pressure
C. LV end diastolic volume
D. LV end systolic pressure
E. Stroke volume

Correct answer: A. Ejection fraction

Explanation: All listed factors are influenced by loading (preload and afterload) and/or the compliance of the LV. Ejection fraction is the least influenced and is therefore the best overall measure of contractility within this list.

Question 7

Oxygen delivery to skeletal muscle may increase by a factor of 50 during vigorous exercise.

Which of the following physiological changes increases the oxygen delivery to cyclical muscle during exercise by the greatest factor?

A. Decreased parasympathetic tone to skeletal muscle
B. Increased cardiac output
C. Increased partial pressure gradient for oxygen between capillary blood and mitochondria
D. Relaxation of skeletal muscle precapillary sphincters
E. Right shift of the oxyhemoglobin dissociation curve

Correct answer: D. Relaxation of skeletal muscle precapillary sphincters

Explanation: All of these factors will increase oxygen delivery to skeletal muscle. The increased by cardiac output is only 5-10 fold. Oxygen offload from haemoglobin may increase 2-3 fold. The partial pressure gradient for oxygen increases less than 2 fold. However, the relaxation of

precapillary sphincters caused by autoregulatory change affected by local mediators causes skeletal muscle blood flow and therefore oxygen supply to increase 20-30 fold.

Question 8

The pH of venous blood is only slightly lower than that of arterial blood despite the addition of large amounts of CO2 in the tissues.

Which of the following is the best explanation for this?

A. Bohr effect
B. Buffering of H^+ ions by plasma proteins
C. Carbon dioxide is very soluble in blood
D. Carbonic anhydrase activity
E. Haldane effect

Correct answer: E. Haldane effect

Explanation: the Haldane effect describes the increased capacity of deoxyhaemoglobin to carry CO_2 as carbaminohaemoglobin and to buffer H^+ ions generated from the dissociation of carbonic acid. This is termed isohydric buffering. Plasma proteins and dissolution of CO_2 play a minor role in CO_2 transport. Carbonic anhydrase is of course essential and plays a major role, but it cannot buffer pH changes caused by addition of CO_2. The Bohr effect is irrelevant.

Question 9

A patient with a body mass index of 50 kg m^{-2} and no other medical history of note is scheduled for surgery under general anaesthesia. The ODP has changed his position from semi sitting to horizontal for induction of anaesthesia.

Which of the following is the most important respiratory change that will occur?

A. Chest compliance will decrease
B. Functional residual capacity will decrease
C. Inspiratory reserve volume will increase
D. Peak expiratory flow rate will decrease
E. Respiratory rate will increase

Correct answer: B. B. Functional residual capacity will decrease

Explanation: All the listed changes will occur. However, by far the most important is decreased FRC, which may now encroach on the closing volume, tending to cause an increase in shunt and therefore hypoxemia. It will also decrease the oxygen store in the lungs Resulting in more rapid desaturation during any period of apnoea.

Question 10

In an experimental situation, a myelinated axon is bathed in an electrolyte solution containing chloride, potassium and sodium ions.

Which of the following changes would have the greatest effect in making the resting membrane potential less negative?

A. Decreasing the extracellular concentration of potassium ions
B. Decreasing the extracellular concentration of sodium ions
C. Increasing the extracellular concentration of chloride ions
D. Increasing the extracellular concentration of potassium ions
E. Increasing the extracellular concentration of sodium ions

Correct answer: D. Increasing the extracellular concentration of potassium ions

Explanation: this question is simply a test of the application of the Goldman and Nernst equations and knowledge that the resting membrane is relatively impermeable to sodium.

Physics and clinical measurement

Question 11

A sevoflurane vaporiser calibrated at sea level is being used in a hospital at 3000 metres altitude. The vaporiser is used making no allowances for the increase in altitude. Maintenance of anaesthesia using a vaporizer setting of 1.7-2% sevoflurane in air appears to run uneventfully.

Which of the following best explains why the vapouriser may be used at the same dial settings at high altitudes as at sea level?

A. Depth of anaesthesia is titrated against clinical response not anaesthetic concentration
B. Sevoflurane concentration at the vaporiser output increases as ambient pressure decreases
C. Monitors of end tidal vapour concentration compensate for altitude
D. Plenum vaporisers deliver the same partial pressure at any particular dial setting irrespective of ambient pressure
E. The temperature drop at higher altitudes has only minimal effect on vaporizer function

Correct answer: D. Plenum vaporisers deliver the same partial pressure at any particular dial setting irrespective of ambient pressure

Explanation: although all of the options above are true statements, the key reason why the vaporiser functions independently of altitude is that it delivers a fixed partial pressure, independent that altitude. Option B is a variation of D but is less able to explain the phenomenon.

Question 12

A patient is receiving oxygen therapy using a venturi face mask with entrainment ratio of approximately 1:10 and oxygen flow rate of 6 L min^{-1}.

What is the approximate inspired oxygen concentration?

A. 24%

B. 28%
C. 35%
D. 40%
E. 60%

Correct answer: B. 28%

Explanation: a simple calculation question. Oxygen concentration = ((6 x 1.0) + (60 x 0.21)) / 66 = 0.282 = 28%

Question 13

An oxygen rotameter bobbin reads a flow rate of 1 L min^{-1}. As the rotameter needle valve is opened further the bobbin rises up the tube then comes to a rest at a reading of 8 L min^{-1}.

Which of the following descriptions of the physics of gas flow around the bobbin best explains why the bobbin comes to arrest opposite the 8 L min^{-1} marker?

A. The cross-sectional area of the rotameter tube has increased
B. The flow has become less laminar
C. The flow has become more turbulent
D. The forces acting above and below the bobbin have equalised
E. The pressure gradient across the bobbin has remained constant during its ascent

Correct answer: D. The forces acting above and below the bobbin have equalised

Explanation: over statements above are true except E. The reason the bobbin comes to arrest is an expression of Newtonian physics where a stationary body must have equal and opposite forces applied to it. None of the other statements can in themselves explain why the bobbin does not continue to rise in the gas flow.

Question 14

An arterial line and its associated measurement system have an intrinsic resonant bandwidth. The system needs to be damped to function correctly, and the phrase “optimal damping” is used to describe the ideal level of damping that should be applied.

Which of the following statements fits the description of “optimal damping” most closely?

A. Damping where overshoots and oscillations are minimised
B. Damping where real time accuracy is greatest
C. Damping where the coefficient is between 0 and 1
D. Damping where the response time is greatest
E. Damping where there is least resonance

Correct answer: B. Damping where real time accuracy is greatest

Explanation: optimal damping is the trade-off between response or rise time and the overshoot of the true value or resonance. C is true of damping in general but not of optimal damping. D is true of a very small damping value, but it would oscillate around the true value for too long. E is not the best answer as although a lack of resonance is a desirable general property of a

measuring system it is not a feature unique to optimal damping. A is not correct as higher values than 0.7 would cause even fewer overshoots and oscillations but would have an unacceptably long response time before reaching the true value. Therefore, B is the best answer combining minimal oscillation and overshoot and resistance to resonance across a wider bandwidth of input oscillations.

Question 15

With patients routinely connected to a variety of electrical equipment in the operating theatre safety is paramount.

Which of the following is the most important electrical safety feature of such equipment?

A. A current operated earth leakage circuit breaker is in place
B. An isolation transformer is used
C. Avoidance of earth leakage currents
D. Equipment is earthed
E. Equipment meets Class 1 safety standards

Correct answer: C. Avoidance of earth leakage currents

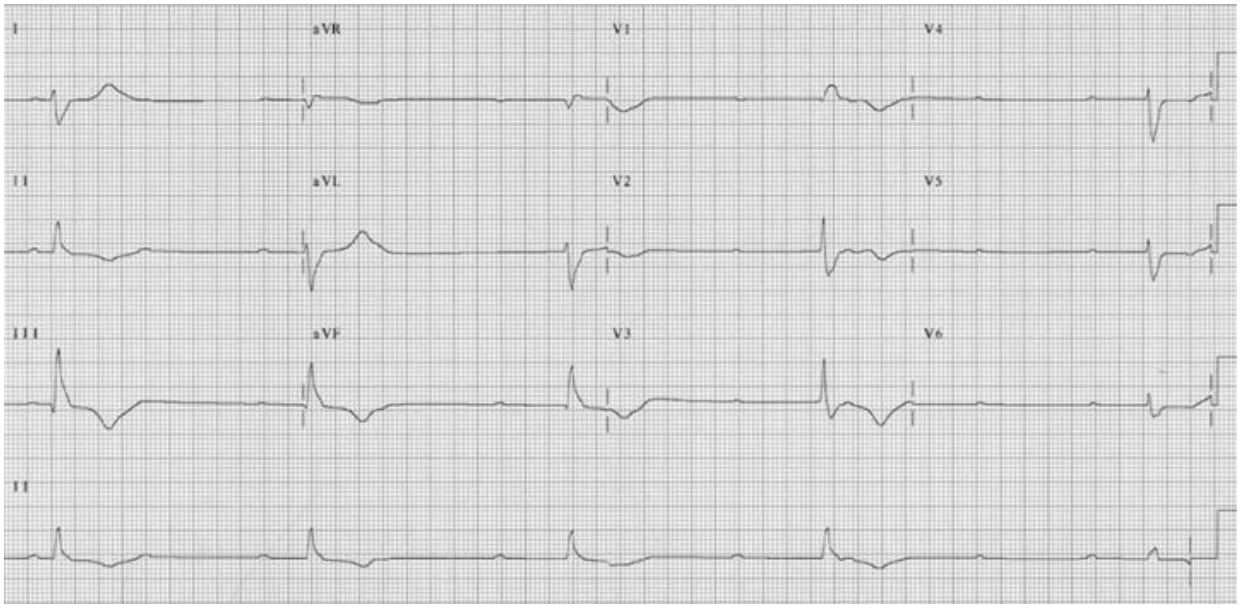
Explanation: The whole rationale of electrical safety centres around the avoidance of earth leakage currents.

Clinical and Data Interpretation

Question 16

You are seeing patients for your orthopaedic trauma list tomorrow. One of your patients is a frail 83-year-old man, who sustained a fractured neck of femur after a fall. The surgical team want to perform a cemented hemiarthroplasty. On speaking with the patient, he complains of several weeks of fatigue and feeling faint in the run up to the fall.

His ECG is show below.



What is the most appropriate course of action?

A. Advise the surgeons to perform a less invasive operation
B. Proceed under general anaesthetic
C. Proceed under spinal anaesthetic
D. Proceed with external pacing available
E. Refer to cardiology

Correct answer: E. Refer to cardiology

Explaination: In this question you are expected to be aware of possible causes for falls in elderly patients, be able to interpret a 12 lead ECG and know what to do before proceeding with anaesthesia in patients with symptomatic 3rd degree heart block.

Advising the surgeons to change their operation is not appropriate – they are the experts on fracture management, not you. You will need to discuss this case with the surgeons though and make your concerns clear.

Proceeding under spinal or GA is equally inappropriate – this patient has symptomatic 3rd degree heart block, and any anaesthetic carries the risk of serious adverse consequences.

Proceeding with external pacing available may be a reasonable choice if the patient had a life-threatening problem that must be intervened upon immediately. However, in this case you do

have time to optimise the patient (target for definitive hip fracture management is <36 hours from time of injury).

Therefore, a referral to the cardiology team for review and consideration of a permanent pacemaker (or temporary wire if a PPM cannot be performed pre-op) is the most appropriate option here.

Question 17

You are anaesthetising an otherwise healthy 21-year-old woman for a laparoscopic appendicectomy. Following a rapid sequence induction using fentanyl, propofol and rocuronium you have given co-amoxiclav, gentamicin, morphine and ondansetron.

After skin preparation and before knife-to-skin the patient's blood pressure falls and the ventilator high pressure alarm sounds.

What is the most likely cause of this?

A. Chlorhexidine
B. Co-amoxiclav
C. Gentamicin
D. Morphine
E. Rocuronium

Correct answer: B. Co-amoxiclav

Explanation: In this question you are expected to be able to diagnose likely anaphylaxis and know what the most likely causative agent is.

The NAP 6 study found that antibiotics where the most frequent cause of anaphylaxis in theatre, closely followed by neuromuscular blocking agents. Chlorhexidine ranked third. Morphine can cause histamine release that may provoke hypotension and bronchospasm in susceptible patients, but this is considerably less likely in an otherwise healthy young woman.

Of the antibiotics reported to NAP 6 as causing anaphylaxis co-amoxiclav was the most common as it is used most frequently.

Question 18

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After skin preparation and before knife-to-skin the patient's blood pressure falls and the ventilator high pressure alarm sounds.

What is the most appropriate next step in management of this clinical situation?

A. Adrenaline 0.5mg IM
B. Adrenaline 50microg IV
C. Chlorphenamine 10mg IV
D. Hartmann's solution 500ml bolus
E. Hydrocortisone 200mg IV

Correct answer: A. Adrenaline 0.05mg IV

Explanation: At first glance this question is very similar to the last. However, it tests a different aspect of your knowledge – diagnosis and management of anaphylaxis.

Guidelines for the management of peri-operative anaphylaxis in adults are that we should use 0.5mls of 1 in 10,000 adrenaline (50microg) IV.

Intramuscular adrenaline is used for pre-hospital, ward-based management and peri-operative cases where there is no IV access.

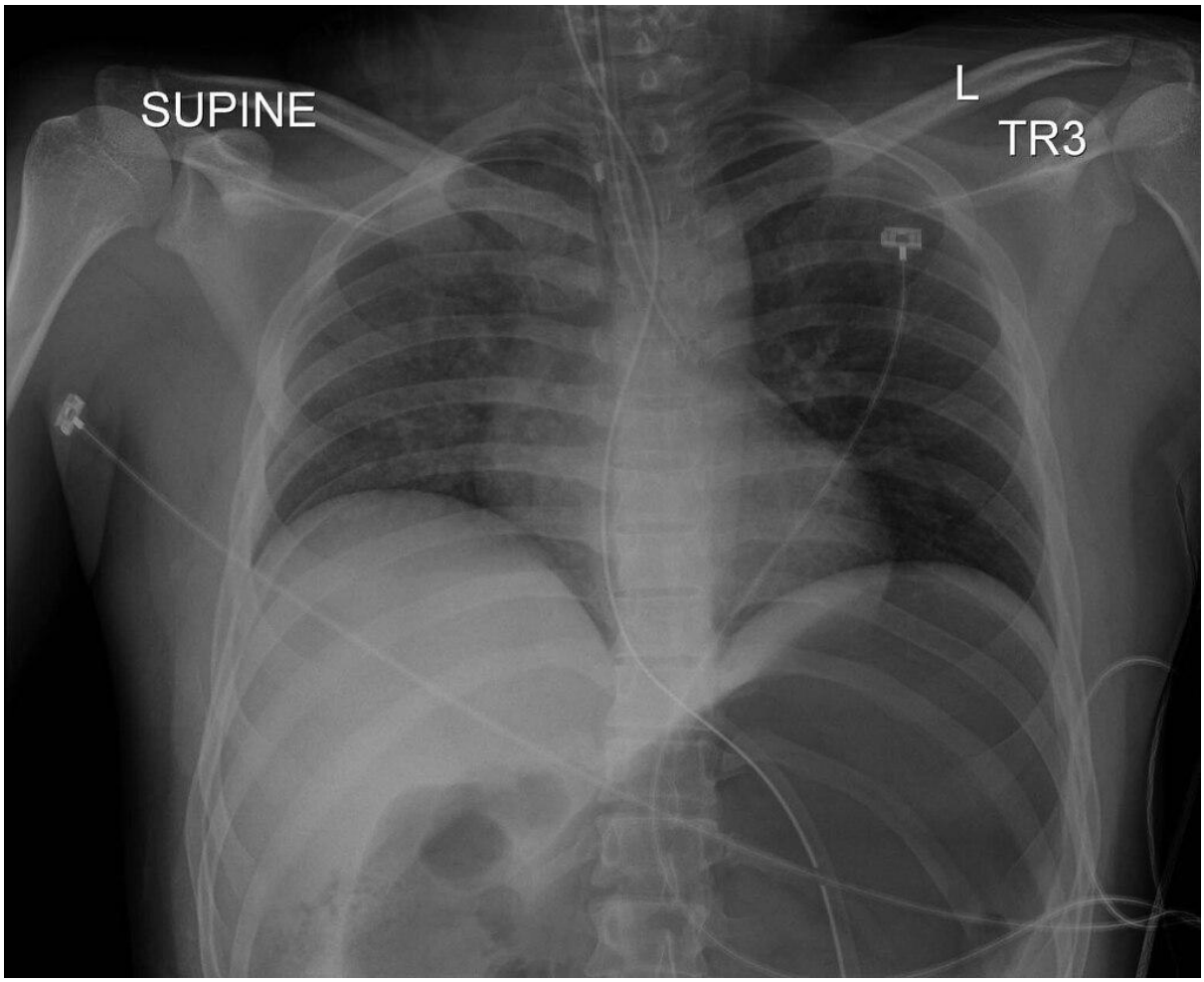
Steroids may be considered in peri-operative anaphylaxis in cases of refractory shock – but they are not first line.

Antihistamines are no longer recommended.

An IV fluid bolus is appropriate and should be given but this will not address the underlying problem and therefore adrenaline IV is the first thing you should do.

Question 19

Following a high-speed road traffic collision a 54-year-old male patient is brought to the emergency department. He was unconscious at the scene and the pre-hospital team have intubated the trachea. You have confirmed endotracheal tube placement with waveform capnography and placed an orogastric (OG) tube. As part of the primary survey a chest x-ray is performed, shown below.



What is the most appropriate next step in management?

A. Aspirate the OG tube
B. Bilateral thoracostomies
C. Central venous line insertion
D. Trauma series CT scan
E. Withdraw the endotracheal tube

Correct answer: E. Withdraw the tracheal tube

Explanation: Here we are testing your ability to correctly interpret a chest x-ray. The tracheal tube is in the left main bronchus, and, as a result, the right lung appears underinflated.

The stomach is very distended, and the OG tube should be aspirated – but the endotracheal tube needs to be repositioned first. Thoracostomies are sometimes performed by the pre-

hospital team if they are concerned about pneumothoraxes - this x-ray shows no obvious pneumothorax. A central line is likely indicated but can happen later (perhaps in the ICU) after the primary survey is completed. A trauma series CT scan is appropriate, but the airway should be optimised first to ensure as safe a transfer as possible.

Question 20

Earlier today a 67-year-old man was admitted to the intensive care unit with an infective exacerbation of COPD. He has been started on antibiotics, steroids and non-invasive ventilation (NIV) synchronised with his own respiratory rate. His NIV settings are as follows:

FiO_2 0.6
Inspiratory pressure 12 cmH_2O
Expiratory pressure 5 cmH_2O

His nurse tells you that he has a respiratory rate of 12/min, has become impossible to wake, and hands you the following arterial blood gas.

pH 7.14
$PaCO_2$ 11.2 kPa
PaO_2 7.4 kPa
HCO_3 34 mmol L^{-1}
BE 7.4

What is the most appropriate next step in management?

A. Doxapram Intravenously
B. Increase inspiratory pressure
C. Increase FiO_2 to 0.8
D. Invasive ventilation
E. Reduce FiO_2 to 0.4

Correct answer: D. Invasive ventilation

Explanation: In this question we are testing your interpretation of a clinical scenario, management of NIV and the arterial blood gas.

This patient is likely CO_2 narcosed and has dangerous hypoxaemia. His respiratory drive may well be governed by oxygen rather than carbon dioxide levels. His airway need to be protected and full invasive mechanical ventilation started and titrated to ensure he is safe.

Doxapram can be used as a central respiratory stimulant but is rarely used these days – there are better options for this man.

Increasing the inspiratory pressure should increase the minute ventilation and so help lower the carbon dioxide level – but he is unconscious with an unprotected airway.

Increasing the FiO_2 may help improve the low oxygen levels but may further depress the patient's hypoxic drive and worsen his level of consciousness.

This patient is already dangerously hypoxaemic – reducing the FiO_2 is absolutely wrong.

END