COLLEGE OF INTENSIVE CARE MEDICINE
OF AUSTRALIA AND NEW ZEALAND

REPORT OF THE
INTENSIVE CARE FIRST PART EXAMINATION

March/May 2024

This report is prepared to provide candidates, tutors and their supervisors of training with information about the examination. The report does not constitute model answers but acts as a guide as to what examiners expected for each question.

Unsuccessful candidates should read and then discuss the report with their tutors to prepare appropriately for future examinations.

The exam included two 2.5 hour written papers, each comprised of ten short answer questions and fifty multi-choice questions. Candidates were required to perform at a satisfactory level in the written before being eligible to present for the oral part of the exam. The oral was comprised of eight ten-minute viva stations.

OVERALL STATISTICS

Total number of candidates presenting for the written examination: 89
Number of candidates scoring > 50% in the written: 51
Number of candidates scoring 45 – 50% in the written: 1
Number of candidates carrying a written score: 1
Total number invited to the oral section based on written marks: 53
Total number of candidates successful at the CICM First Part Exam: 52

WRITTEN SECTION

EXAMINERS' COMMENTS

Candidates are reminded that all questions are scored equally, hence time should be apportioned accordingly. Candidates are encouraged to attempt all questions. On occasion some questions were not attempted, and this denies the candidate an opportunity to gain valuable marks.

Candidates are expected to have a detailed knowledge and depth of understanding of the syllabus and are strongly encouraged to read widely. Candidates should refer to the Glossary of Terms provided in the exam to determine the depth and breadth required to answer each question. Answers in point form are acceptable and recommended.

SHORT ANSWER QUESTIONS

Question 1

(a) What are receptors (20% of marks)?

(b) Discuss the relationship between the properties of a drug and potential receptor response under the following headings (20% of marks each):

(i) Agonists

(ii) Partial agonists

(ii) Inverse agonists

(iv) Antagonists

28% of candidates passed this question.

A good answer provided a definition of a receptor as a protein/glycoprotein that undergoes a conformational change upon ligand binding. They then gave an overview of where these are found and the mechanisms of activitation/downstream processing. A definition of each type (agonist, antagonist, partial agonist and inverse agonist) was expected with reference to the intrinsic activity at the receptor and the affinity for the receptor. A good answer also touched upon law of mass action (D+R=DR) and how this equilibrium is altered by each. Concepts such as reversible and irreversible binding and its implications as well as competitve and non-competitive antagonism would elevate the answer.

Question 2

(a) Describe venous admixture and the sources contributing to it in an adult (60% of marks).

(b) Explain the effects of supplemental oxygen on arterial hypoxaemia (40% of marks).

43% of candidates passed this question.

(a) This part of the question required candidates to provide a definition of venous admixture and provide detail on the sources. This would include anatomical (including atelectasis/closing capacity) and V/Q Mismatch or Scatter. V/Q Scatter was commonly omitted from answers. The use of the verb “describe” implies that further details are required beyond a simple list of the sources (such as a description of their mechanism and relative importance).

(b) This part required the effect supplemental oxygen on the many causes of arterial hypoxaemia to be explained. This would require the effect that this has on areas of true shunt and different degrees of shunt fraction and also on V/Q scatter. Information for this can be found on Nunn's Respiratory Physiology.

Question 3

The systemic vascular resistance is suddenly increased, describe the consequences for the otherwise healthy left ventricle.

11% of candidates passed this question.

This question was specific to the left ventricle only. Good answers provided information on immediate changes in LV Volumes and Pressures and how compensatory mechanisms largely within the LV itself eventually lead to restoration of stroke volume. Marks were allocated for a description of the Frank Starling mechanism, baroreceptor reflex and anrep effect. Good answers also discussed the effect of

increased SVR on LV myocardial work and oxygen consumption and coronary perfusion. Common errors included focusing on definitions and determinants of SVR and providing LV PV loops without relating this to the situation of an increased SVR or without adequately labelling or explaining what they were demonstrating with the graph. This question required the integration of a number of physiological principles and is challenging.

Question 4

(a) Describe the physical principles of haemodialysis and haemofiltration, including the factors affecting clearance (80% of marks).

(b) Outline the key components of renal replacement fluids (20% of marks).

73% of candidates passed this question.

(a) Good answers divided this section into haemodialysis and haemofiltration and answered in two parts. Included information expected that candidates would cover the principles of haemodialysis, solute movement across a semipermeable membrane by diffusion and its dependency on the solute characteristics (size, charge, protein binding, volume of distribution) the dialysis membrane properties (porosity, thickness, surface area), the concentration gradient of substance in dialysate to blood and the rate of solute delivery (blood flow vs dialysate rate). Haemofiltration, solute movement across semipermeable membrane by diffusion and required a discussion of the effect of transmembrane pressure, blood flow, effluent/ultrafiltration rate, plasma oncotic pressure,solute concentration in plasma water and the Sieving coefficient on the clearance.

(b) This part of the question required a brief representation of the substances found in renal replacement fluids including major electrolytes at near physiological concentrations (sodium, potassium, calcium, magnesium, and phosphate) and when these might be varied i.e. no calcium in citrate anticoagulation, less potassium in hyperkalaemia. Also the inclusion of a buffer (such as bicarbonate, lactate or citrate), water and the absence of colloid was also expected.

Question 5

Outline the anatomy of the sympathetic nervous system including:

(i) The origin (15% of marks).

(ii) Fibre types and their course (70% of marks).

(iii) Receptors and neurotransmitters (15% of marks).

54% of candidates passed this question.

The question provided the headings that candidates would be expected to provide information on and those that used these headings to structure their answers provided good overall responses. A definition of the SNS and effects of activation was not required. Candidates were expected to outline SNS anatomy with respect to origin (pre-ganglionic neurons in the grey matter of the lateral horn of the spinal cord, T1 to L2), fibre types including a description of short pre-ganglionic myelinated b fibres, the sympathetic chain and the long post-ganglionic unmyelinated C fibres. Receptors and neurotransmitters included nicotinic Ach receptors in the ganglion and adrenergic alpha and beta receptors on target organs/vessels. A brief discussion of the arrangement at the adrenal medulla was also expected.

Question 6

(a) Outline the process of fibrinolysis including how it interacts with the coagulation system (80% of marks).

(b) Describe the mechanism of action and adverse effects of alteplase (20% of marks).

3% of candidates passed this question.

(a) This part required candidates to demonstrate their knowledge of the fibrinolytic pathway with details of the relevant mediators and inhibitors. Candidates where then required to apply their knowledge of both the coagulation cascade and fibrinolysis, with detail of how the pathways are simultaneously activated by the same stimuli to ensure balance between bleeding and clotting. An example would be endothelial damage stimulating both the clotting cascade through collagen exposure and thromboplastin activation (faster response) as well as fibrinolysis through t-PA activation (slower response).
(b) This section of the question required a detailed description of the mechanism of action of alteplase, recombinant t-PA. A comparison to endogenous t-PA helped illustrate this action and the subsequent bleeding and the non-bleeding effects.

Question 7

Outline the control of blood glucose.

60% of candidates passed this question.

This question required candidates to discuss the role of the pancreas and liver in the homeostasis of blood glucose. This included how the pancreas senses high or low glucose levels, the mechanism of secretion of insulin and glucagon and subsequent effects on the liver. The response in early fasting when glucagon stores are depleted was expected as well as the role of other organs in this setting such as muscle glycogen and hypothalamus driven satiety. A brief mention other hormonal responses in the setting of hypoglycaemia was also expected (including ACTH, cortisol, adrenaline, growth hormone and thyroid hormones).

Question 8

Describe the anatomy of the femoral vein as it relates to central venous cannulation.

22% of candidates passed this question.

Anatomical questions are best answered with a standard structure that details the location; the boundaries (anterior/posterior, superior/inferior, medial/lateral); a description of the contents of that area and layers; and the relevant surface anatomy. For this question a description of the femoral triangle and boundaries, the origin and termination of femoral vein along with its tributaries, the relationship of the femoral vein to different structures in the triangle and information about femoral sheath and its contents was expected. Marks were also awarded for detailing the surface anatomy of femoral vein relevant to cannulation.

This was an anatomy question as such details of femoral vein cannulation technique, complications and the risks associated with femoral venous access was not required.

Question 9

(a) Describe the pharmacokinetics of intravenous fentanyl and intravenous remifentanil (40% of marks).

(b) Explain how these features create contrasts between the two drugs (20% of marks).

(c) Discuss the concept of context sensitive half-time using these drugs as examples (40% of marks).

31% of candidates passed this question.

This question is essentially a compare and contrast question. It was worded specifically to encourage candidates to describe the pharmacokinetics of the drugs in question (in particular the relative lipid solubilities, volume of distribution, pka/ionisation, plasma protein binding, and metabolism) and then use these features to discuss the clinically relevant implications. In part (c) a brief definition of what is meant by the context sensitive half time followed by how these pharmacokinetic differences influence the CSHT of each was required.

Question 10

(a) Explain the excitation contraction mechanism as it relates to the smooth muscle of the myometrium including a gravid uterus (50% of marks).

(b) For each tocolytic agent: salbutamol, nifedipine, magnesium sulphate, provide the following information:

(i) List the class (10% of marks)

(ii) Provide a dose (10% of marks)

(iii) Describe the mechanism of action (20% of marks)

(iv) Outline the adverse effects (10% of marks)

42% of candidates passed this question.

(a) This question required an explanation of the process of contraction in smooth muscle, as well as specific information pertaining to the smooth muscle of theuterus. Specific information included: stimuli for contraction (i.e., hormones such as oxytocin, oestrogen, and prostaglandins and stretch); possessing an unstable membrane potential which plays a greater role than nervous input; as well as the uterus smooth muscle functioning as a syncytia and having baseline tone. The key steps of contraction (influx of calcium, formation of calcium-calmodulin formation, activation of MLCK, creation of myosin-actin cross bridges with utilisation of ATP) are those generic to any smooth muscle and marks were awarded accordingly. Descriptions of striated muscle did not attract marks. A description or explanation was required rather than a list of steps (e.g., the sources of calcium rather than a simple statement of calcium influx occurring).

(b) Use of these drugs as tocolytics is acknowledged as a less common reason for their utilisation - the fractionation of this question was to breakdown into more achievable parcels of information. This allowed candidates to score more marks for relating the mechanism of action specifically to the uterus. Higher marks in this section were awarded for specific unwanted effects relevant to use as a tocolytic e.g., foetal tachycardia for salbutamol as result of crossing the placenta. Marks were awarded to doses for these drugs when used as a tocolytic, as opposed to for other indications (i.e., salbutamol infusion rather than nebulised).

Question 11

Compare and contrast the carriage of oxygen in the blood with the carriage of carbon dioxide.

55% of candidates passed this question.

A good response included normal values of the partial pressures of both oxygen and carbon dioxide including the arterial and venous contents. Methods of carriage (haemoglobin, dissolved and other forms), haemoglobin binding characterisitcs (co-operative binding and affinities); and impact on

loading/off loading at tissues and lungs for both oxygen and carbon dioxide was included. Correctly labelled diagrams with a brief accompanying explanation could be used to convey some of these concepts.

Question 12

(a) Describe the action potential of the cardiac pacemaker cells including the ionic events (60%).

(b) Explain how excitation then propagates through the conducting pathway of the heart, including mechanisms to prevent abnormal conduction (40%).

69% of candidates passed this question.

(a) A detailed description of the ionic events of the phases of the sino-atrial node AP was expected. A diagram of the sino-atrial node potential which included the phases and labelled x and y axis was helpful in this description. Some comparison with other cardiac action potentials added depth to answers, as did a brief description of the inflences on the action potential such as the autonomic nervous system.

(b) This section required a detailed explanation of impulse propagation both between cardiac myocytes and across the myocardium. Safety mechanisms to be mentioned included anatomical insulation, refractory periods and rate.

Question 13

Explain the counter-current mechanism in the kidney.

67% of candidates passed this question.

A good answer included an explanation of the purpose of the countercurrent mechanism followed by a detailed description of the functional and anatomical relevance of the Loop of Henle, vasa recta and urea recycling. A diagram if included required some explanation as it is not sufficient to completely replace text alone.

Question 14

(a) List the normal parameters for cerebral blood flow (5% of marks).

(b) Describe the physiological factors that influence cerebral blood flow (95% of marks).

62% of candidates passed this question.

The first part of this question required a list of the normal values for cerebral blood flow including differential flow to grey and white matter. For the second part, an answer structured around the cerebral perfusion/cerebral vascular resistance formula worked well to ensure breadth. Factors influencing flow include autoregulation of pressure (via the myogenic reflex), metabolic autoregulation and local acidity, arterial levels of CO_2 and O_2, temperature and a minor role for the sympathetic nervous system. Many answers were augmented effectively with graphs of cerebral blood flow versus CPP, PaO_2 and $PaCO_2$. A detailed discussed of ICP and factors effecting this was not required.

Question 15

Outline how the measurement of the following can be used in the assessment of liver function (25% of marks each):

(i) Albumin

(ii) Prothrombin time (PT)

(iii) Glucose

(iv) Ammonia.

56% of candidates passed this question.

A good answer should cover the following points: normal range, how and why the value is affected by liver failure and potential con-founders. As an example in the case of albumin; the normal range is 35-50g/L; it is produced in the liver and thus the measured value will decrease in synthetic liver dysfunction; the half life of albumin is long (20 days) and therefore it is a better marker of chronic dysfunction; potential con-founders include inflammation (negative phase protein), malnutrition and increased loss (nephrotic syndrome etc). Marks were not allocated for information not relevant to the question asked (such as the function of albumin).

Question 16

(a) Define heat and temperature (15% of marks).

(b) Describe how body temperature is regulated (85% of marks).

75% of candidates passed this question.

(a) The definition of temperature and heat varies considerably in texts, so reasonable leeway was granted in marking this part.
(b) In this section the following information was expected; body temperature range; thermoneutral zone; sensors (including receptors, fibres, and tracts); central processing (the role of the hypothalamus including anterior and posterior portions); interthreshold range; and a detailed description of the efferent responses for either increasing or decreasing body temperature.

Question 17

(a) Define innate immunity including how it differs from adaptive immunity (10% of marks).

(b) Outline the components of the innate immune system including their role in the immune response (90% of marks).

17% of candidates passed this question.

Expectations for a high scoring answer were:
(a) a definition of innate immunity featuring its presence since birth, the non-specificity and lack of memory when compared with the adaptive immune system,
(b) an outline of different components of innate immune system including; physicochemical (skin, mucus, cilia, gastric acid), humoral (lysosome, complement, acute phase proteins) and cellular (neutrophils, macrophages, natural killer cells, mast cells). In addition to listing a number of these examples, a brief explanation (“outline”) of their function should be included.

Question 18

Compare and contrast the use of external ventricular drains with intraparenchymal fibreoptic pressure monitors to measure intracranial pressure.

38% of candidates passed this question.

This question required an accurate explanation of the mechanism of measurement for each device. A head to head comparison of the differences and similarities in utility, accuracy, global versus regional measurements, calibration, drift and dampening should follow. A comparison of potential complications was also expected.

Question 19

Describe the pharmacology of amiodarone using the following headings:

(i) Indications for use (5% of marks)

(ii) Dose (10% of marks)

(iii) Mechanism of Action (20% of marks)

(iv) Pharmacodynamics including adverse effects (25% of marks)

(v) Pharmacokinetics (25% of marks)

(vi) Drug Interactions (15% of marks).

65% of candidates passed this question.

The headings were provided to candidates to ensure that information was limited to these domains. This question required specific detail about amiodarones action at K+, Na+ , B and Ca channels, including second messenger systems and effects on SA / AV and myocyte action potential. Simply stating that there is hepatic metabolism and renal excretion is not enough information for pharmacokinetics and some detail was expected regarding the mechanism of metabolism, presence (or absence) of active metabolites and organs involved in clearance with rough figures for half life, Vd, loading dose and clearance values. It is recommended to include the mechanisms by which side effects occur rather than just listing them.

Question 20

Outline the important similarities and differences between unfractionated heparin and enoxaparin using the following headings (20% of marks each):

(i) Mechanism of action

(ii) Pharmacokinetics

(iii) Adverse effects

(iv) Dosing

(v) Monitoring and reversal

27% of candidates passed this question.

These are commonly used and important drugs in intensive care practice and a high level of detail was expected. Unfractionated heparin and enoxaparin have specific differences that influence how we use them in practice and this information was required for full marks. This question was answered well by

providing the detail on each domain for both heparin and enoxaparin and then highlighting if this factors into how they are used.

MULTIPLE CHOICE QUESTIONS – PAPERS 1 AND 2

96% of candidates passed overall.
92 % of candidates passed Paper 1.
98 % of candidates passed Paper 2.

ORAL SECTION

DAY 1 – Wednesday 15th May 2024

VIVA 1

This VIVA will examine respiratory physiology.

Define work of breathing (WOB) and discuss its components using the diagram below.

(Image removed from report.)

VIVA 2

This VIVA will examine blood pressure physiology and measurement

What are the changes in the arterial blood pressure waveform as it moves from the level of the ascending aorta to the peripheral blood vessels and what accounts for this?

VIVA 3

This VIVA will examine neuromuscular junction monitoring and neuromuscular blocking agents.

Describe in detail the train of four (TOF)?

VIVA 4

This VIVA will examine acid-base physiology.

Describe the following arterial blood gas.

(Image removed from report.)

VIVA 5

This VIVA will examine respiratory anatomy and general pharmacology.

This is a schematic diagram of the terminal respiratory unit. Please take us through the structures labelled from 1 to 5 and outline their functions?

(Image removed from report.)

VIVA 6

This VIVA will examine hepatobiliary physiology.

How is bile produced and secreted by the liver?

VIVA 7

This VIVA will examine coagulation physiology.

This figure represents a thrombo-elastography tracing.
What is a thrombo-elastography, what does it show and what is indicated by a, b, c, & d?

(Image removed from report.)

VIVA 8

This VIVA will examine adrenal physiology and pharmacology.

How is ACTH secretion controlled?

DAY 2 – Thursday 16th May 2024

VIVA 1

This VIVA will examine respiratory physiology and measurement.

Explain how factors that vary between **AND** within healthy individuals can alter the Functional Residual Capacity (FRC)?

VIVA 2

This VIVA will examine cardiovascular physiology and monitoring.

Relate the parts of the cardiac cycle and ECG to the CVP waveform below?

(Image removed from report.)

VIVA 3

This VIVA will examine pain physiology and pharmacology.

Describe the steps that lead to the perception of pain following a noxious stimulus?

VIVA 4

This VIVA will examine your potassium physiology and pharmacology.

Beginning at the glomerulus, describe how potassium is handled along the nephron?

(Image removed from report.)

VIVA 5

This VIVA will examine general pharmacology.

Define bioavailability and explain how can you use this curve to calculate it?

(Image removed from report.)

VIVA 6

This VIVA will examine digestion and nutrition.

Outline the main phases of gastrointestinal secretion that occur when eating a meal?

VIVA 7

This VIVA will examine haematological pharmacology.

What are the steps involved in performing a group and screen?

VIVA 8
This VIVA will examine maternofoetal physiology and pharmacology.

How is oxygen delivered to the placenta and then fetus? What factors influence that delivery?

(Image removed from report.)

SUMMARY OF THE EXAMINATION

The CICM First Part Examination explores the knowledge of the basic sciences that form the basis of Intensive Care practice. A detailed syllabus has been developed and clearly sets out the Level of Understanding expected for each listed topic and drug. It is important that Candidates study the Syllabus in its entirety. All questions are sourced from the Syllabus and the recommended texts are a guide to study. Some sections will require more extensive research and the use of other textbooks.

Candidates are expected to attain a level of knowledge that goes beyond just the listing of pure facts but should be able to explain, describe, collate, and apply that knowledge across different circumstances relevant to Intensive Care practice. Sufficient depth of understanding and a structured approach to topics continues to remain an area of weakness for many candidates.

Candidates must allow sufficient time to prepare (typically 12 months). Candidates are strongly encouraged to discuss their level of preparedness and to trial written and oral questions, with their Supervisor of Training and other CICM Fellows, prior to undertaking the CICM First Part Examination. The examination reports are available as a guide to areas of the exam and syllabus that are covered, information expected to answer each question but are not model answers and should be read as such.

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May 2024