COLLEGE OF INTENSIVE CARE MEDICINE
OF AUSTRALIA AND NEW ZEALAND

REPORT OF THE
INTENSIVE CARE FIRST PART EXAMINATION

AUGUST/OCTOBER 2022

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 is a guide as to what was expected.

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: 100
Number of candidates scoring > 50% in the written: 53
Number of candidates scoring 45 – 50% in the written: 5
Number of candidates carrying a written score: 3
Total number invited to the oral section based on written marks: 61
Total number of candidates successful at the CICM First Part Exam: 60

WRITTEN SECTION

EXAMINERS' COMMENTS

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

Candidates are expected to have a detailed knowledge and depth of understanding of "level I" topics. Candidates are strongly encouraged to read widely to gain a high level of understanding and are reminded to ensure writing is legible.

SHORT ANSWER QUESTIONS

1. Describe the pharmacology of midazolam.

88% of candidates passed this question.

Most candidates had a broad understanding of the indications, mechanism of action and the broad pharmacodynamic effects of midazolam. Those candidates who scored poorly demonstrated a lack of clarity and detail around the pharmacokinetics which are critical to its use and side effect profile. The examiners noted the details surrounding its bioavailability, protein binding was either almost universally absent or were generic statements that don't score marks. Better candidates mentioned the changes in ring structure and lipophilicity associated with changes in pH and showed good understanding of clinically relevant facts regarding lipid solubility and active metabolites.

2. Compare and contrast fresh frozen plasma and prothrombin complex concentrate.

52% of candidates passed this question.

The safe and appropriate use of these products in ICU is a key area of critical care practice so a fair bit of detail was required for a pass. Most candidates had a decent understanding of the main constituents of the two products, although few mentioned that FFP may still contain some cells, or that prothrombin concentrates contain heparin. To gain full marks for this section the components and concentration/amounts would need to be accurately described. Production of the two products was generally well understood and articulated. A more comprehensive and specific list of indications than rather than "bleeding" or "coagulopathy" was expected. While using elements of the standard "compare/contrast" pharmacology structure was helpful, rigidly adhering to it, for instance, noting FFP's "poor oral bioavailability" - did not garner marks. It is important to note that heparin is not reversed by FFP and FFP may in fact increase heparin's effect. FFP does not cause dilutional coagulopathy, it is the treatment for dilutional coagulopathy. Most candidates recognised the need for ABO matching with FFP but not prothrombin concentrates, however few noted that Rhesus matching is not required. The larger fluid load of FFP in comparison to prothrombin concentrates was well recognised a major drawback of FFP use.

3. Briefly outline the major somatosensory pathways of the body (excluding cranial nerves)

35% of candidates passed this question.

Many candidates struggled with this question due to poor structure and limited knowledge with incorrect facts. Good answers were able to outline the various pathways from receptor, through the spinal cord to the higher centres with some detail of each aspect of the pathway whilst highlighting some points of difference between the pathways. For example, information expected regarding the types of receptors involved included, vibration, pain, touch, pressure, thermoreceptors, nociceptors and free nerve endings. Information required for the spinal nerve component would include myelinated versus unmyelinated and linked to the specific receptor, eg myelinated A alpha fibre for assessment of proprioception. As the question specifically asked for more than one pathway those answers describing a single somatosensory pathway failed to score well.

4. List the physiological factors which increase respiratory rate and explain their mechanism

22% of candidates passed this question.

It was expected that candidates would provide not only a list of factors which increase respiratory rate but to give physiological reasoning behind each mechanism. Providing a list of factors was not sufficient for a pass. Vague, imprecise answers attracted fewer marks. A request to explain a mechanism requires the candidates to write a comprehensive physiological reasoning. Many candidates did not demonstrate a comprehensive understanding of these mechanisms. Most answers failed to include all the stimulants of respiratory rate, especially the non-chemical controls. Many answers were not structured or structured in a way that meant they missed many of the mechanisms or that they repeated the same information through the answer which used time but failed to gain additional marks.

5. Outline the structure of fast cardiac sodium channels and describe in detail how they work.

18% of candidates passed this question.

The expectation for this question was an appropriate description of the fast sodium channel structure included outlining its single alpha and 2 beta sub-units, activation (m) and inactivation (h) gates and sodium selectivity. It was expected that candidates would comment on cycling between the 3 states (resting, open and inactive), corresponding conformational changes to the fast sodium channel, triggers for these changes (voltage or time) and ionic events, including reference to and description of absolute and relative refractory periods. Better candidates were able to relate events to a diagram of a fast action potential, simply drawing a diagram without referencing events at the sodium channel scored few marks. No marks were awarded for description of drug effects on the fast sodium channel. The question specifically relates to fast Na channels, so descriptions of other channels (e.g. ligand gated sodium channels) did not score marks. Details of the subsequent contraction of cardiac muscle following an action potential was also not part of the question and did not score marks.

6. Outline the dose (10% marks), composition (75% marks) and side effects (15% marks) of enteral feeds.

60% of candidates passed this question.

Generally, most candidates had a reasonable approach to structuring their answers using the headings provided in the question. To score well candidates were required to outline a method of dosing (per body weight, variations based on age, using equations or indirect calorimetry) and describe the composition in terms of the macronutrient daily requirements and energy content as well as other included components (micronutrients). Very few candidates discussed the variations in formulations beyond concentration change nor the reasons for such variations in sufficient detail. Candidates that did not score well were often lacking in detail or missing sections such as side effects or significant elements of the composition. No marks were awarded for content related to the presence of delivery tubes, administration details (e.g. definitions of gastric tolerance, trophic feeding, commencement rate) or for details that related specifically to parenteral nutrition.

7. Describe the physiological mechanisms by which the kidney is able to maximally concentrate urine.

35% of candidates passed this question.

Answering this question well required the demonstration of understanding of the concept of achieving maximum urinary concentrating ability. Answers required a description of the usual concentrating processes and the changes that would occur in circumstances where maximally concentrated urine would be made. A key concept was the creation of a medullary concentration gradient to allow water reabsorption independent of solute reabsorption. This required an explanation of the contribution of the loop of Henle, the vasa recta, and urea cycling in the creation and maintenance of this gradient, along with the impact of ADH. More detailed explanation of each contribution was required as overarching statements were not sufficient to attract all marks for each section. Answers that focused solely on the counter-current exchange and multiplier process were insufficient on their own to achieve a passing mark. The examiners commented that a significant proportion of candidates excluded the role of urea in their answers.

8. Classify calcium channel blockers providing examples (15% marks). Describe the pharmacology of verapamil (85% marks).

35% of candidates passed this question.

Most candidates provided an acceptable classification of calcium channel blockers. Candidates are encouraged to read the question as a few failed to provide relevant examples with their classification. A basic understanding of the common features of verapamil (indeed most of these are common to the calcium channel blockers as a group) in clinical practice and toxicology was sufficient to pass. Marks allocated to dosing and presentation were not gained for writing that it is available as tablets or as a clear colourless solution, unless relevant information was given. Many candidates listed neuropsychiatric effects of verapamil, which are not a feature normally associated with calcium channel blockers. Many also listed QT prolongation among its effects, which is not listed in the standard texts and is the opposite to the true effect. The examiners noted that in some papers there appeared to be a contradiction between the effect of Verapamil on the cardiac action potential and the detail provided about the drugs clinical effects, these answers demonstrated a lack of solidity in the understanding of the underlying physiology.

9. List any five classes of antibiotics with anti-staphylococcal activity and provide one example of each class. Outline the mechanism of action and side effects of the five drugs.

82% of candidates passed this question.

In general, the question was well answered. Better answers provided examples of antibiotics from different categories of mechanism of action and were able to describe specific side effects relevant or unique to that antibiotic. Mechanisms of action that were generic in terms of site of action attracted fewer marks. Some examples of antibiotics that candidates provided were not anti-staphylococcal antibiotics (eg; Benzyl Penicillin, Clavulanic acid). The examiners commented that the use of a tabular format as an answer template resulted in answers scoring marks in most time efficient manner. Frequent omissions or commissions resulting in lost marks noted by the examiners were as follows; many papers showed a lack of detail regarding the precise mechanism of action of penicillins particularly around inhibition of transpeptidases whilst the use of non-specific side effects such as nausea vomiting and diarrhoea did not attract marks.

10. Draw a labelled diagram of both the aortic root and radial artery pressure waveforms in a young adult using the same axis (60% marks). Explain the factors that account for the differences between these two waveforms (40% marks).

21% of candidates passed this question.

This question required the integration and understanding of cardiovascular monitoring with what influences the changes as the arterial pulse moves through the vascular tree. In general, the waveforms drawn were often of a poor standard, with little attention given to accurately representing the different shapes, correct axis (pressure and timing) and labelling. The description of the differences was of a better standard however, there were often contradictions between what was drawn and described. For example, several answers correctly described a delay in the systolic peak seen in the radial artery, but this was not illustrated in the diagram. The windkessel effect was often correctly mentioned but not further explained to help describe the changes seen in the waveforms. Interruptions to the arterial traces from the anacrotic and diacrotic notches, the origins of the diacrotic hump, and insuria were often incorrect and poorly explained. The examiners reported that answer template structure was not a major issue, but a lack of integration of the waveform and translation of that knowledge into a description of the cardiac cycle was often poorly done.

11. Describe the body fluid compartments.

25% of candidates passed this question.

This question was answered poorly. Many answers provided incorrect facts relating to the body fluid compartments, their approximate sizes, the factors that regulate and contribute to those sizes and their constituents. Total body water was often incorrectly calculated and associated with limited explanation as to the factors that may affect it.

12. Describe the effects of ageing on the cardiovascular system.

46% of candidates passed this question.

The physiological changes associated with ageing are well described in the major texts although candidates do need to assimilate this information from a number of sources. Core components of the answer templates that were frequently missed included those of; concentric hypertrophy and its effects on afterload, as well as the difference between compliance, elastance, elasticity, elastin and collagen and how ageing affects these elements. A template using broad headings such as the effects on the heart/myocardium, the vasculature, the autonomic nervous system, the conduction system and perhaps epithelial function would be a good starting point when constructing an answer to this question. The examiners noted that several candidates wrote at length about various pathologies that increase in incidence with ageing which does not adequately address the core of the question.

13. Compare and contrast the pharmacology of EPHEDRINE and METARAMINOL.

27% of candidates passed this question.

The 'compare and contrast' pharmacology question indicates the use of a standardised structure that incorporates pharmaceutics, pharmacokinetics and pharmacodynamics. The best answers provided excellent detail, ie. precise descriptions of mechanisms of action and emphasised noteworthy areas of contrast between the two drugs. Highlighting opportunities for use and areas of caution/drug limitations.

Overall, most candidates seemed to have a sufficient knowledge of metaraminol but details surrounding ephedrine were often lacking.

14. Describe the physiological role, distribution and regulation of potassium ions (K+).

51% of candidates passed this question.

The best answers demonstrated an appreciation of the multiple roles of potassium in normal physiology and described the integrated regulation of potassium concentration/distribution as opposed to many answers that seemed to focus purely on the renal handling of a filtered potassium load.

15. Describe the anatomical (20% marks) and physiological (80% marks) features of the pulmonary circulation.

23% of candidates passed this question.

Many candidates described the anatomical pattern of right ventricle to arteries to smaller arteries to arterioles to capillaries to venules to veins to the left atrium. To obtain full credit one needed to describe relevant aspects of anatomy including main pulmonary artery ~5cm in length divides into L and R pulmonary arteries. Arteries are relatively thin walled with little smooth muscle, capillaries form an extensive sheet of blood flow over the alveolar wall, and the pulmonary circulation drains into four pulmonary veins that empty into the left atrium. A structured approach would then follow regarding physiology. There is ~500 ml of blood in the pulmonary circulation with ~10% in the capillaries and half the remainder in each of arteries and veins. The system has a high capacitance and is very distensible. The volume can halve or double to adjust for posture, respiratory effort and changes to the systemic circulation. Values for normal pulmonary artery pressure were expected and an explanation that this is just adequate to reach the apices of the lung and that if the pulmonary pressure was higher there would be a risk of compromised perfusion and flow. Comparisons with the systemic pressures or detail such as capillary values gained extra credit. For example, highlighting that regional distribution and regulation is relatively passive compared to the systemic circulation and thus gravity and posture have significant effects. Many candidates gave the units incorrectly. Of the candidates who described the West Zones, most seemed aware of the influence of alveolar pressure, but few seemed aware of the importance of low pulmonary pressure relative to the effect of gravity, such that the pulmonary arterial pressure was just adequate to reach the apex of the lung. Most candidates were aware of the important role of hypoxic pulmonary vasoconstriction to optimise VQ matching. The autonomic system has relatively little effect upon regulation especially compared to the systemic circulation. Many candidates wrote in generalities about the physiology of circulatory systems without discussing special features of the pulmonary circulation. The detail supplied was often less than the expected level.

16. Describe how the values for PaO2, PaCO2, pH and bicarbonate are determined on a blood gas sample.

36% of candidates passed this question.

This question about how PaO2, PaCO2, pH, and HCO3 are obtained was not well answered by most candidates. Arterial blood gasses are routinely performed in most ICU on a daily basis. This question relates to a Level 1 (L1) topic in the CICM First Part Syllabus. Most answers simply lacked enough information. Details of how the Clark, Severinghaus, and Sanz electrode's function was expected. Many candidates confused the pH and PaCO2 electrodes and confused the Clark (Polarographic) electrode with a Fuel Cell. Some knowledge about the types of electrodes and chemical reactions (e.g. reduction of O2 at the Platinum cathode in the Clark electrode) occurring in these devices was expected.

17. Describe the site of action, mechanism of action and the biochemical effects of five different classes of diuretics; include an example in each class.

90% of candidates passed this question.

This question was best structured using the headings supplied in the stem (site, mechanism of action, biochemical effects and an example). Some answers utilised a table format which often meant that the content was squashed. Given the amount of information required a better format was simply to use separate sections for each class. Non-biochemical effects did not attract any marks. Similarly, an introductory statement about diuretics was not required and attracted no marks. Biochemical effects were not answered clearly or completely. Effect on acid-base was answered correctly by very few candidates. Vague statements such as "increased sodium" did not score as well as more precise terminology like "hypernatraemia" or "raised serum sodium". A few answers incorrectly stated that the mechanism of action of thiazides was ENaC inhibition.

18. Describe the generation of ATP by mitochondria (50% marks) and outline the processes by which ATP is generated in red blood cells (50% marks).

15% of candidates passed this question.

Excellent answers focused on oxidative phosphorylation and the chemiosmotic mechanism in their description of ATP production by mitochondria. This required a description of the structure of the mitochondrial components involved in ATP production, the establishment of an electrochemical gradient of protons across the inner membrane, how the electron transport chain works and its components, and the roles of cytochrome oxidase and ATP synthase. Excellent answers describing ATP generation in red blood cells focused on anaerobic glycolysis in the absence of mitochondria, with an emphasis on the key steps that consume or produce ATP. The role of lactate dehydrogenase in regenerating NAD+ was also emphasised. Some candidates described other pathways of metabolism that do not generate ATP, for which no marks were awarded.

19. What are receptors? (20% marks). Discuss the relationship between the properties of a drug and potential receptor response under the following headings: agonists, partial agonists, inverse agonists and antagonists (80% marks)

31% of candidates passed this question.

The description of a receptor was worth 20% thus it was expected that detailed information on the different forms of receptors, their structure, the resultant conformational change when activated and where they are found would be provided for full marks. Most candidates were able to correctly define an agonist, antagonist, partial agonist and inverse agonist. Unfortunately, this was the limit of most answers. Candidates were expected to provide details of drug or agonist/receptor interaction discussing the terms affinity/intrinsic activity and how different mechanisms of binding and interacting with the receptor alters these terms.

20. Describe the pharmacokinetics of prednisone (50% marks). List the cardiovascular, renal, metabolic, haematological and immunological effects of prednisone (50% marks)

40% of candidates passed this question.

The question asked for detailed information on the pharmacokinetics and selected pharmacodynamics of prednisone. Most candidates provided unnecessary details of the mechanism of action and pharmaceutics significantly wasting time. Many provided incorrect information and general information without specifics which is represented by the low pass rate. The pharmacokinetics part was answered poorly. It was expected from the candidates to have detailed knowledge on the prednisolone binding capacity and affinity to albumin and corticosteroid binding protein as well as the important metabolism of prednisone.

MULTIPLE CHOICE QUESTIONS – PAPERS 1 AND 2

92% of candidates passed overall.
94% of candidates passed Paper 1.
85% of candidates passed Paper 2.

ORAL SECTION

DAY 1

VIVA 1

This viva will explore your understanding of temperature and measurement.

What is the temperature and how can I be measured?

VIVA 2

This viva will explore your knowledge and understanding of respiratory physiology and pharmacology.

Use the diagram below to demonstrate regional variability of ventilation and perfusion through the upright lung.

(Image removed from report.)

VIVA 3

This viva will explore your understanding of skeletal muscle.

What is a motor unit?

Describe events in the motor unit resulting in skeletal muscle contraction and relaxation.

VIVA 4

This viva will explore your understanding of the left ventricle.

This is an idealised pressure vs volume loop of the left ventricle in a healthy adult. Please describe the loop.

(Image removed from report.)

VIVA 5

This viva will explore your knowledge of liver physiology.

Please identify the labels on the diagram of the basic structure of a liver lobule.

(Image removed from report.)

VIVA 6

This viva will explore your knowledge of the Autonomic Nervous System.

Describe the Physiologic consequences of an unexpected cut to your hand with a sharp knife?

VIVA 7

This viva will explore your understanding of cerebral blood flow.

Describe the relationship between cerebral blood flow and
1: the arterial partial pressure of carbon dioxide
2: the arterial partial pressure of oxygen
3: the cerebral perfusion pressure

(Image removed from report.)

VIVA 8

This viva will explore your understanding of acid-base physiology.

Please interpret the following blood gas:

pH: 7.30 Na: 133 mmol/L

pCO2: 19 mmHg K: 4.8 mmol/L

pO2: 79 mmHg Cl: 104 mmol/L

HCO3: 9.0 mmol/l Lactate: 7.5 mmol/L

FiO2: 30%, Temp: 37.5C Base Excess: - 16.4 mmol/L

DAY 2

VIVA 1

This viva will explore your understanding of Respiratory – oxygen cascade.

What is the oxygen cascade?

(Image removed from report.)

VIVA 2

This viva will explore your knowledge and understanding of cardiovascular physiology and pharmacology.

Explain the mechanical events shown in the left ventricular pressure-volume loop.

(Image removed from report.)

VIVA 3

This viva will explore your understanding of the plasma proteins.

What are the 3 most abundant types of plasma proteins and in what concentrations do they normally exist?

VIVA 4

This viva will explore your understanding of renal physiology and glomerular function.

Describe the regulation of renal blood flow.

VIVA 5

This viva will explore your understanding of neurophysiology.

Explain this pressure-volume relationship for intracranial pressure.

(Image removed from report.)

VIVA 6

This viva will explore your understanding of coagulation system.

How is a viscoelastic assay performed?

What do the various parts of the curve represent?

(Image removed from report.)

VIVA 7

This viva will explore your understanding of the pain pathways and analgesic medications.

Define Pain and describe how pain is detected in response to a peripheral noxious stimulus?

VIVA 8

This viva will explore your knowledge of carbohydrate metabolism.

What factors cause an increase in insulin secretion?

DAY 3

VIVA 1

This viva will explore your understanding of acid base physiology.

Please interpret this blood gas.

pH 7.30

pO2 400 mmHg (53.3 kPa)

pCO2 30 mmHg (4 kPa)

HCO3- 14 mmol/L

BE – 8 mmol/L

Na 140 mmol/L

K 4 mmol/L

Cl 120 mmol/L

VIVA 2

This viva will explore your knowledge of gas transfer via the placenta, and foetal physiology and anatomy.

Identify which curves belong to the major vessels involved in placental gas transfer.

(Image removed from report.)

VIVA 3

This viva will explore your knowledge of renal physiology.

This is a diagram of the renal vasculature. Explain the renal artery divisions beyond the arcuate artery.

(Image removed from report.)

VIVA 4

This viva will explore your understanding of red blood cell production, storage, and transfusion.

How are red blood cells formed?

VIVA 5

This viva will explore your understanding of respiratory physiology.

Using the diagram as an aid, define work of breathing and describe its components.

(Image removed from report.)

VIVA 6

This viva will explore your understanding of cardiovascular function.

Explain the physiology of these 2 curves.

(Image removed from report.)

VIVA 7

This viva will explore your understanding of GABA receptors and anticonvulsant pharmacology.

What are the different types of GABA receptors?

VIVA 8

This viva will explore your knowledge of Carbohydrate metabolism.

What are the things that cause an increase in insulin secretion?

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 synthesize that knowledge across different scenarios as they apply 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 approximately 12 months to study). 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 that are covered but do not provide model answers and should be read as such.

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