COLLEGE OF INTENSIVE CARE MEDICINE
OF AUSTRALIA AND NEW ZEALAND

REPORT OF THE
INTENSIVE CARE FIRST PART EXAMINATION

August/October 2023

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: 106
Number of candidates scoring > 50% in the written: 42
Number of candidates scoring 45 – 50% in the written: 1
Number of candidates carrying a written score: 2
Total number invited to the oral section based on written marks: 45
Total number of candidates successful at the CICM First Part Exam: 43

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. Candidates are also reminded to ensure their writing is legible.

SHORT ANSWER QUESTIONS

1. Explain why the oxygen-haemoglobin saturation value derived by a pulse oximeter (SpO2) could be different from the measured arterial value (SaO2).

32% of candidates passed this question.

This question required candidates to identify that the measured arterial value (SaO2) was the gold standard to which the limitations of the pulse oximeter should be compared. A detailed description of the intrinsic and extrinsic factors of potential sources of difference of the SpO2 measurement was then expected. Intrinsic factors included wavelengths used, pulse added absorbance, derivation of the SpO2 value and time delays. Extrinsic factors where largely patient and environment related including light pollution, poor peripheral perfusion for various reasons, probe location variances and probe artefact.

2. Outline the anatomy of the cardiac ventricles including the chambers, valves and conduction elements.

11% of candidates passed this question.

This question expected an outline of the anatomy of the cardiac ventricles. Candidates that broke down the anatomy into subsections with correct and clear descriptions of each component were most successful. A potential structure to approach this question is included below;

- position, orientation, relations and characteristics of the chambers including ventricular interdepence
- internal ventricular structures including muscle type, septum, trabeculae, papillary muscules, infundibulum and moderator band
- valves and valvular rings' position, structure and attachments
- conduction elements position and divisions
- blood and nerve supply

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

52% of candidates passed this question.

This question required the identification of the components of the kidneys function that work to concentrate urine and a detailed description of how each of these components contribute to this. These components included the role of the loop of henle and vasa recta in the establishment and maintenance of the medullary osmotic gradient, the contribution of urea and urea cycling to this gradient and the subsequent contribution of antidiuretic hormone. A focus on not how urine is formed but how it is concentrated was expected.

4. Classify the mechanisms of action of anti-convulsant drugs (30% marks). Outline the pharmacology of gabapentin (70% marks).

21% of candidates passed this question.

The first part of this question required candidates to correlate the mechanism of action of anti epileptic drugs with atleast one example under each section. These included GABA potentiation (Barbiturates/Tiaganbine), reduction in excitory transmission (including NMDA/AMPA antagonists) and modification of ionic conductances (sodium channel blockade-Phenytoin, Calcium channel blockade-Lamotrigine, Gabapentin, activation of potassium channels- Retigabine).

The second part of this question involved an overview of gabapentin pharmacology. Gabapentin is an amino acid analogue of GABA utilised in neuropathic pain and epilepsy. There a multiple proposed mechanisms of action including Ca+ antagonism, inhibited glutamate release and anatagonism and

increased GABA concentrations.. Important pharmacokinetic properties included dose dependent absorption, minimal protein binding, no metabolism with renal clearance and requirement for dose reduction in renal failure. It has largely central neurological side effects with a rare but important association with steven johnson syndrome or toxic epidermal necrolysis.

5. Outline the carbohydrate and lipid energy stores of the body (15% marks). Outline the metabolic responses to starvation under the following headings: <24 hours; 24-72 hours; and >72 hours (85% marks).

67% of candidates passed this question.

The first part of this question required the details of carbohydrate and lipid stores with their anatomical locations, biochemical forms, average amount of energy stored.

Under the metabolic responses to starvation, a detailed description was expected of major sources of energy production, associated biochemical processes and their transition from one process to another or one source to another over time, and the hormonal influences that govern this. A more detailed answer would also include organ specific energy utilisation under a starved state. Overall it was expected that a transition of glycogenolysis to gluconeogenesis to ketogenesis would be described. It would also be important to highlight how an initial protein conservation strategy transitions to eventual protein catabolism and how muscle glycogen, an important store of glucose is unavailable to maintain blood glucose concentrations in starvation.

6. Explain perfusion limited and diffusion limited transfer of gases in the alveolus.

48% of candidates passed this question.

This question required an explanation of the factors that influence perfusion and diffusion and a detailed description of the behaviour of specific gases including perfusion limited oxygen and carbon dioxide and diffusion limited carbon monoxide. Factors influencing perfusion include flow/cardiac output, resistance (radius and length) and viscosity whereas diffusion is influenced by the characteristics of the gas (MW and solubility), surface area of diffusing surface and the pressure/concentration gradient. Perfusion and/or diffusion limited characteristics of different gases included how quickly if at all equilibrium is reached and why this occurs with each specific gas.

7. Describe the mechanism of action, dose, pharmacokinetics and pharmacodynamics of clonidine.

38% of candidates passed this question.

This question was broken down into mechanism of action, dose, PK and PD. The mechanism of action required a detailed description of its alpha agonism 200:1 affinity for alpha 2 over alpha 1 including the classification of these receptors and the downstream effects. Correct dose and/or dose ranges for oral and intravenous formulation particularly for different indications for the prescription of clonidine. Pharmacokinetic details expected the absorption, distribution, metabolism and elimination characteristics, with enough detail to demonstrate an understanding. Pharmacodynamic marking was weighted towards the significant cardiovascular, neurological and the relative absence of respiratory effects that make it desirable for use as a sedative/co-analgesic in ICU practice. A description of the these pharmacodynamic effects and why they occur was required to achieve marks in this section.

8. Compare and contrast the pharmacology of frusemide and acetazolamide.

31% of candidates passed this question.

Pharmacology questions largely have a standardised structure to follow; pharmaceutics, pharmacokinetics and pharmacodynamics. However compare and contrast questions require answering in a way that highlights important similarities and differences between the drugs chosen and the impact of these differences when administered. Whilst these are both diuretics they have very different renal and non-renal effects and thus very different metabolic and electrolyte disturbances. It was expected that these points be highlighted as well as the provision of other pharmacological information in order to pass this question.

9. Outline the classification, structure and distribution of the opioid receptors (50% marks). Describe the intracellular events following opioid receptor activation (50% marks).

20% of candidates passed this question.

This question was asked in a specific way to provide candidates with a template for their answer. The classification most commonly used for opioid receptors (μ(MOP), δ(DOP), k(KOP) & NOP) and a description of the important characteristics or differences between them was expected. A description of their central and peripheral distribution was required including specific central nervous system sites such as pre and post synaptic locations in the brain (ie. the periaqueductal gray, locus ceruleus and amygdala) and spinal cord (ie. primary afferent neurons in the dorsal horn).

Opioid receptors as a class are transmembrane spanning G protein receptors that have significant downstream effects including presynaptic inhibition of neurotransmitters of primary afferent neurons such as noradrenaline and substance P, and postsynaptic inhibition of membrane depolarization of dorsal horn nociceptive neurons. Specifity of detail in descriptions of these actions was expected.

10. Outline the impact of sedative agents on thermoregulation (40% marks). Describe the physiological effects of a low body temperature (60% marks).

66% of candidates passed this question.

The first part of the question required candidates to outline the impact of sedatives on the interthreshold range with an explanation of what this is, how heat is lost, how heat generation is impaired and the mechanism by which these occur (ie. radiation/conduction/convection via vasodilation, with absence of vasoconstriction/heat generation strategies).

The second part of the question required a systems based approach with an outline of the perturbation as a result of the low body temperature. Temperature thresholds for certain physiological effects ie. loss of consciousness or arrhythmia was also expected for an overall thorough answer to this question.

11. Describe the mechanism of action, dose, pharmacokinetics and pharmacodynamics of aminophylline.

21% of candidates passed this question.

This question required a detailed description of the many mechanisms of action of aminophylline. This included PDE inhibition and the down stream pathway and its adenosine antagonist and anti-inflammatory actions. Important pharmacokinetic concepts included hepatic metabolism with saturable kinetics and thus a narrow therapeutic window/index requiring need for drug monitoring and the risk of metabolic interactions with accelerated or reduced metabolism from inducers or inhibitors of the main enzyme (CYP1A2). Detailed pharacodynamic consequences on the respiratory and cardiovascular

systems were prioritised as well as highlighting the neurological, cardiovascular and musculoskeletal consequences of toxicity.

12. List the effects of stimulation of adrenoreceptors on target organs and tissues (60% marks). Describe the mechanism of action and pharmacokinetics of metoprolol (40% marks).

74% of candidates passed this question.

This question required a list of effects of the stimulation of adrenoreceptors, thus detailed description of downstream effects and exact mechanisms was not required. Using a systems based structure with a subdivision into each receptor (or vice versa) meant that important GIT, GUT, endocrine and metabolic effects were not omitted. Given the need for little depth, this part of the question required breadth particularly within cardiovascular effects. Venoconstriction, dromotropy and lusitropic effects should also be covered.

The second part of the question required a detailed description of the mechanism of action and pharmacokinetics only, thus dose, pharmaceutics and pharmacodynamic information was not required. Here it would be important to elaborate on the downstream effects of blocking the beta adrenergic receptors as compared with the information required in the first part of the question.

13. Outline the distribution, clearance and physiologic functions of magnesium in the body.

36% of candidates passed this question.

This question was best answered under the headings distribution, clearance and physiologic functions. Distribution involved intracellular vs extracellular concentrations, the spread amongst organ systems and state of ionisation and protein binding. Clearance of magnesium required an accurate description of its renal filtration and sites and proportion of reabsorption and secretion along the nephron. The regulatory factors and factors that influence this clearance should also be outlined. This included; Mg plasma concentrations, other cations, ECF volume and PTH. Physiologic functions should cover its role as a cofactor of metabolism and enzyme systems with some examples, the role and mechanism in the musculoskeletal system as a calcium antagonist and inhibitory action in the nervous system including the action against Ach, nerves and NMDA activity.

14. Describe the physiological factors that influence cerebral blood flow?

56% of candidates passed this question.

Cerebral Blood Flow is result of CPP/CVR. The brain defends a relatively constant high blood flow via multiple auto-regulatory processes that influence cerebral vascular resistance. This question required an in detail description of the physiological factors that alter CBF. Autoregulation via the myogenic and metabolic mechanisms, the difference between grey and white matter due to metabolic variation, the role of pCO2 and O2, sympathetic nervous system and temperature was expected. A "describe" question requires not only the factors that influence CBF but how and why, so detail is required. Whilst the monroe kellie doctrine does describe changes in blood flow this is only important at extremes of intracranial pressure when these normal autoregulatory mechanisms are exceeded, as such it was not part of the answer to this question.

15. Describe the components and function of the complement system including the role, activation and control?

8% of candidates passed this question.

Based on the question stem answers should have been structured to address the components of the complement system as well as the role, activation and regulatory mechanisms. A description of the components should include the number and type of molecule highlighting the important combinations of complement to produce the membrane attack complex. A description regarding the role in the innate immune response against bacterial infections was then required with a detailed description regarding the many ways this is achieved including opsonisation, phagocytosis, chemotaxis, mast cell/basophil activiation, lysis of cells and clearance of immune complexes. Information about the 3 pathways of activation where expected; classic, alternate and lectin pathyway, with some detail regarding the downstream effect of each that would take into account for the amplication of the response. The cessation of complement response is largely due to the limitatations of the half lives of the particular complement glycol-proteins or presence of specific inactivators.

16. Outline the anatomy of the larynx.

44% of candidates passed this question.

This question required candidates to address the following relevant to the anatomy of the larynx - it's location and extent; relations; structure (paired and unpaired cartilages; major ligaments; intrinsic and extrinsic muscles); nerve supply (sensory and motor); and blood supply (and venous darinage). There were some marks allocated for other correct information relevant to the anatomy of the larynx (e.g. epithelium; differences in age; lymphatic drainage). This was a purely anatomy question so functions of the larynx was not required.

17. Describe the consequences for the left ventricle of a sudden and sustained increase in afterload.

7% of candidates passed this question.

This question expected a detailed description of the effect of afterload on the left ventricle. This should cover the acute effect of increased afterload on left ventricular end systolic (and diastolic) pressure and volume, contractility, work and oxygen consumption, coronary perfusion pressure and baroreceptor responses. “Sustained” implied more longer term left ventricular exposure which would include the ventricular cellular response, concentric hypertrophy and the subsequent effects on diastolic and elevations of left atrial pressure. Definitions of afterload, cardiac output equations, vascular function curves and LV/PV loops are not required if the above concepts are described in adequate detail. The use of a diagram can assist in explaining concepts however should be linked back to the question in order to demonstrate the candidates understanding of the question being asked.

18. Compare and contrast the pharmacology of Hartmann’s solution and 0.9% saline?

17% of candidates passed this question.

This question asked for a comprehensive description of the components and chemical properties of each solution (including pH and calculated and measured osmolarity). A mechanistic description of the different acid base effects was expected. Marks were also allocated for the advantages and disadvantages of each fluid (for example the calcium in Hartmann’s risks causing precipitation when mixed with certain drugs and blood products). Lastly, it was expected that answers would provide situations where one fluid might be preferred over the other (for example saline to treat dehydration and metabolic alkalosis secondary to gastric losses – as in a pyloric obstruction). Descriptions of the physiological handling of each fluid after bolus or infusion was not required.

19. Describe the mechanism of action, dose, pharmacokinetics and pharmacodynamics of ceftriaxone.

39% of candidates passed this question.

A structured answer under the headings of mechanism of action, dose, pharmacokinetics and pharmacodynamics worked most effectively for this question. It was expected that candidates would link the mechanism of action of Ceftriaxone (binds to PBP and inhibits final step in peptidoglycan) to its spectrum of activity. Dosing would also include indications for higher dosing, and consideration of the fact that ceftriaxone is available as an IM administration. Details on hypersensitivity (fever, nephritis, haemolytic anaemia) and consideration of C.diff infection was a main part of its pharmacodynamics. For pharmacokinetics, a structural approach is recommended, important points included excretion through both kidneys and bile and absence of liver metabolism.

20. Outline the anatomy (60% marks) and synaptic physiology (40% marks) of the vagus nerve.

25% of candidates passed this question.

The vagus nerve anatomy was best broken down into a description of the fibers it carries (visceral, parasympathetic and somatic sensory fibres) and then origin and course from the parasympathetic, sensory and motor nuclei in the medulla as the tenth cranial nerve to its branches; the pharyngeal, cardiac, pulmonary and laryngeal branches. Pre and post-ganglionic physiology involved a detailed description of the Muscarinic Ach receptor and events. This would also include the 5 subtypes of the muscarinic receptor, with the locations and downstream effects of the M1-M3 locations being the most important to note.

MULTIPLE CHOICE QUESTIONS – PAPERS 1 AND 2

92% of candidates passed overall.
97% of candidates passed Paper 1.
93% of candidates passed Paper 2.

ORAL SECTION

DAY 1 – Wednesday 11th October 2023

VIVA 1

This viva will examine temperature measurement. Define heat and temperature.

What devices are used to measure temperature?

VIVA 2

This viva will examine respiratory physiology.

Using the diagram describe the regional variability of ventilation and perfusion in the lung.

(Image removed from report.)

VIVA 3

This viva will examine muscle physiology and monitoring.

Describe the events that lead to skeletal muscle contraction in response to a motor neurone action potential.

VIVA 4

This viva will examine cardiovascular physiology.

Describe the features of this left ventricular pressure volume loop.

VIVA 5

This viva will examine antibiotic pharmacology and hepatic physiology.

Describe the mechanisms of action of antibiotics with examples.

VIVA 6

This viva will examine sympathomimetic pharmacology.

How does the activity and metabolism of metaraminol compare to adrenaline and why?

VIVA 7

This viva will examine neuroanatomy and related physiology and pharmacology.

Describe the pupillary light reflex, including the anatomical pathways involved.

VIVA 8

This viva will examine renal acid base physiology and pharmacology.

Describe what happens to bicarbonate once it reaches the kidney.

(Image removed from report.)

DAY 2 – Thursday 12th October 2023

VIVA 1

This viva will examine oxygen delivery systems and measurement.

What are the physical principles behind the use of this device?

(Image removed from report.)

VIVA 2

This viva will examine cardiovascular physiology.

Describe the important features on this left ventricular pressure volume loop, including the shape of the loop, and the values on both axes?

(Image removed from report.)

VIVA 3

This viva will examine cellular physiology.

What are the concentrations of sodium potassium and chloride in the extracellular and intracellular fluid of a skeletal myocyte?

(Image removed from report.)

VIVA 4

This viva will examine renal potassium handling and channel physiology.

How is potassium handled at the numbered sites?

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VIVA 5

This viva will examine neurophysiology.

Describe the pathway of CSF flow from production to absorption.

VIVA 6

This viva will examine haemostasis.

Tell me about the structure of a platelet.

VIVA 7

This viva will examine pain physiology and pharmacology.

Describe the events that lead to the perception of pain following a laceration to the hand.

VIVA 8

This viva will examine nutrition and endocrine pharmacology.

What are the daily nutrient requirements for a healthy adult?

DAY 3 – Friday 13th October 2023

VIVA 1

This viva will examine on acid base physiology.

Define pH and its physiological importance.

Describe how pH is measured by the blood gas machine.

VIVA 2

This viva will test your knowledge of foetal, placental and neonatal physiology.

What determines the rate of gas transfer across the placenta?

VIVA 3

This viva will examine renal physiology and pharmacology.

What is normal renal blood flow?

Outline the anatomy of the renal blood supply.

VIVA 4

This viva will examine haematological physiology and pharmacology.

How is blood typed or grouped?

VIVA 5

This viva will examine respiratory physiology and pharmacology.

Define work of breathing and describe the determinants.

VIVA 6

This viva will examine cardiovascular physiology and pharmacology.

Please draw the relationship between baroreceptor output and mean arterial pressure and describe the important features.

VIVA 7

This viva will examine cardiorespiratory physiology and pharmacology.

Describe the cardiovascular effects of positive end expiratory pressure (PEEP).

(Image removed from report.)

VIVA 8

This viva will examine the electrocardiogram and local anaesthetic pharmacology.

Label the components of the ECG trace and explain the x and y axis.

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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.

Dr Andrew Semark
Chair
CICM First Part Exam Committee

Dr Naomi Pallas
Deputy Chair
CICM First Part Exam Committee

October 2023