COLLEGE OF INTENSIVE CARE MEDICINE
OF AUSTRALIA AND NEW ZEALAND

REPORT OF THE
INTENSIVE CARE FIRST PART EXAMINATION

August/October 2024

This report is prepared to provide candidates, educators and supervisors of training with information about the First Part examination. The report acts as a guide as to what examiners expected for each question. Unsuccessful candidates should read and then discuss the report with their supervisors to prepare for future exam sittings.

The written component included two 2.5-hour papers, each comprising fifty multi-choice questions and ten short answer questions. The MCQ pass mark was 50% and the SAQ pass mark was derived by the Angoff method and was 44.52%. To progress to the oral exam a candidate needed to achieve above the pass mark for both the MCQ and SAQ components of the exam.

The oral component was comprised of eight ten-minute oral examination stations. The pass mark for the oral exam was 50%.

OVERALL STATISTICS

Total number of candidates presenting for the written examination: 100
Number of candidates successful in the written component: 48
Number of candidates carrying a written pass: 1
Total number invited to the oral component: 49
Total number of candidates successful at the CICM First Part Exam: 49

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.

Candidates are expected to have 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 encouraged.

SHORT ANSWER QUESTIONS

Question 1

(a) Describe the work of breathing and its components (85% of marks).

(b) Briefly outline the efficiency of the lung (15% of marks).

29% of candidates passed this question.

This question required candidates to provide a detailed description of the work of breathing and its components. A good answer divided the components into elastic and inelastic/resistive work and provided an overview of the factors that affected each of them. This description was allocated the majority of marks. A thorough answer also discussed the role of expiration on work of breathing, whilst usually a passive process it can be active under some conditions and good answers touched upon these. The second section of the question required an overview of the fate of the energy utilised by the respiratory muscles, with a large proportion lost as heat, or through hysteresis and airway resistance.

Question 2

Describe the regulation of systemic vascular resistance (SVR).

38% of candidates passed this question.

This question integrated knowledge from different sections of cardiovascular physiology. High scoring answers gave a definition of SVR, site of highest resistance, equation and correct units. This was then followed by a structured answer that included descriptions of: inputs, both peripheral and central; the central integrator (vasomotor centre) and controllers such as neural output, hormones and local factors. Inputs included carotid and cardiopulmonary baroreceptors, peripheral and central chemoreceptors and other factors such as visceral distention. Neural outputs included the autonomic nervous system and their contribution to basal tone. Hormones included angiotensin II, Vasopressin, ANP and progesterone Local regulation included myogenic, metabolic, enothelin and endothelium derived hyperpolarisation factors. Given the significant breadth of this question it was expected that each of these factors required only a brief explanation of how they contribute to SVR and the conditions under which they operate.

Question 3

(a) Describe the factors that determine the glomerular filtration rate (GFR) in the kidney (70% of marks).

(b) Outline the methods by which GFR can be measured (30% of marks).

44% of candidates passed this question.

The GFR equation provides a logical basis to structure an answer to the first part of this question. A discussion of the factors that affect each part of the equation provides a complete answer. For example, comprehensive answers used the following headings: glomerular hydrostatic pressure, Bowman's capsule hydrostatic pressure, glomerular capillary oncotic pressure and the filtration coefficient providing information on what is responsible for each of these factors and how they may change therefore affecting GFR.

In the second section a strong answer provided a definition of clearance and description of the use of inulin versus creatinine, touching on advantages and disadvantages. This question asked for the methods of measurement of GFR thus methods used to estimate GFR such as the Cockcroft and Gault equation were not included.

Question 4

Compare and contrast the anatomy and physiology of smooth and skeletal muscle.

53% of candidates passed this question.

The anatomy component of this question required a detailed description of both the macro and microstructure of skeletal and smooth muscle, noting the differences and similarities between them. For skeletal muscle specific detail on the fibre arrangement, subtypes (I/IIA/IIB) and their innervation as well as the structure of the sarcomere, thick and thin bands and associated proteins was required. It was then expected that candidates would provide a description of how these components are similar or different in smooth muscle including details of unitary and multi-unit smooth muscle arrangements.

When comparing the physiology of skeletal and smooth muscle, better candidates discussed not only the process of AP generation, propagation and stimulus, but also detailed sources of ATP, and highlighted the differences in requirements for energy of each muscle type. Higher scoring candidates discussed specific membrane potentials, noting the unstable membrane potential of smooth muscle which does not exhibit a resting membrane potential.

Question 5

Describe the exocrine functions of the pancreas, including their function and regulation.

42% of candidates passed this question.

Unfortunately, this question had an error in the wording. It should have read “Describe the exocrine secretions of the pancreas including their function and regulation”. This error was considered during marking. Despite this most candidates realised that the functions of the exocrine pancreas are secretory and went onto to provide an overview of the exocrine pancreatic cells and their secretions including the usual volume per day. Expected information included descriptions of the digestive enzymes and their role in protein, fat and CHO digestion and a description of bicarbonate formation and its functions including stomach acid neutralisation and optimisation of pH for enzyme function. Regulation of secretion was best described using the structure of digestive phases; cephalic, gastric and intestinal and the events linked to each. Extra detail on the hormonal and PNS factors, their effects and how they're stimulated elevated the answer.

Question 6

Describe the following with respect to lactate:

(a) production (40% of marks).

(b) metabolism (30% of marks).

(c) and its role (30% of marks).

36 % of candidates passed this question.

A good description of lactate production should include the sites of production with some estimate of daily production. In addition, it was expected that answers would cover synthesis via glycolysis, pentose-phosphate pathway (HMP shunt), the chemical reaction catalysed by LDH along with conversion of NADH to NAD. Lastly an explanation of the mechanisms other than anaerobic conditions that lead to an increased lactate production was required.

The expected information for metabolism included an overview of hepatic uptake and the Cori cycle, the role of renal metabolism and excretion and mitochondrial tissue handling.

With regards to its role, marks were awarded for a discussion of its use as a fuel for cells (including the myocardium, erythrocytes, astrocytes and skeletal muscle). Lactate's role as a neurotransmitter and in autoregulation including cerebral vasculature rounded out this section.

Question 7

(a) Categorise bacteria by their gram stain appearance and shape. Give TWO examples of bacteria for each group (30% of marks).

(b) Provide TWO examples of antimicrobials used against each group and outline their mechanism of action (20% of marks).

(c) Outline the mechanisms of bacterial resistance with ONE example for each (50% of marks).

49% of candidates passed this question.

The first part of the question asked candidates to categorise bacteria by gram stain and shape. A description of the gram stain procedure or discussion of bacterial cell wall characteristics was not required. Grouping of bacteria into gram positive cocci, gram positive bacilli, gram negative cocci, gram negative bacilli and others was expected with appropriate examples. A list of two antimicrobials that can be used against each of these classifications followed and a brief outline of their mechanism of action was expected.

The largest weighting of marks was reserved for the third component of the question. Mechanisms of resistance included innate and acquired. Aspects of acquired resistance expected were genetic factors that alter the bacterial target, changes in bacterial permeability/efflux pumps and presence of enzymes that modify or negate the drug.

Question 8

Outline the following with respect to ultrasound:

(a) The physical principles when used for tissue imaging using the following headings:

i. generation and detection of the ultrasound;

ii. reflection and scattering;

iii. attenuation;

iv. refraction.

(35% of marks)

(b) The relationship between transducer properties, image resolution and tissue penetration. (35% of marks).

(c) The principles of the doppler effect and its applications. (30% of marks).

75% of candidates passed this question.

In this context an "outline" question requires a definition of the principle followed by a brief description or overview. Good answers used the structure of the question to provide a definition of the concepts of generation/detection/reflection/scattering/attenuation and refraction and then used this to describe how the ultrasound image is produced or disrupted due to these factors. The discussion around resolution required candidates to link how the transducer and its frequency affects axial, linear, contrast and temporal resolution. The principle underpinning this is the relationship between frequency/wavelength, tissue penetration and image resolution. The doppler effect component of this question required an

explanation of the doppler effect and how it is used in medical ultrasound for example measurement of blood flow and direction. The Doppler equation was not required for full marks though did help some candidates explain the doppler effect.

Question 9

Compare and contrast metoprolol and verapamil using the following headings:

- **(a) Class and indications for use (20% of marks).**
- **(b) Mechanisms of action (25% of marks).**
- **(c) Pharmacodynamics and adverse effects (55% of marks).**

21% of candidates passed this question.

The most effective format for this question was to split information into the headings provided. The higher scoring responses were done as a table, with headings as per the question, concise facts and clear comparisons. Information on pharmaceutics, dose and pharmacokintetics were not required. When effects of the drugs were discussed detail regarding the mechanism of pharmacodynamics and adverse effects was expected. Cardiovascular effects of these drugs required specificity in their description and included their action on the duration and slope of the cardiac action potential thus affecting the HR, as well as effects on SVR and BP. Other adverse effects included respiratory, neurological and gastrointestinal actions.

Question 10

Outline the mechanisms of action and adverse effects of the following:

- **(a) Biguanides (35% of marks).**
- **(b) Sodium-Glucose cotransporter – 2 (SGLT-2) inhibitors (SGLT-2) (35% of marks).**
- **(c) Sulfonylureas (30% of marks).**

52% of candidates passed this question.

The information required for this question was largely self-explanatory. Higher scoring answers were able to demonstrate understanding by providing some discussion and context with regards to adverse effects rather than a simple list.

Question 11

(a) Explain the mechanisms responsible for the cell resting membrane potential (70% of marks).

(b) Describe the Gibbs Donnan effect (30% of marks).

57% of candidates passed this question.

This question required a description of the separation of charge across the cell membrane due to selective ion permeabilities and concentrations. The equilibrium voltage of an individual ion was best expressed using the Nernst Equation and of multiple ions by the Goldman-Hodgkin-Katz equation. Better responses were able to use the correct eponym, constants and/or logarithmic transformation (from the ln to log10). The fundamental role of potassium conductance and the Na/K ATPase was also expected. The Gibbs-Donnan relationship was allocated 30% of marks so an explanation of the role of negatively charged intracellular proteins and the effect on ionic flux was expected.

Question 12

Describe the physiological factors that affect the arterial partial pressure of carbon dioxide.

(Measurement factors are not required).

30% of candidates passed this question.

This question was broad and required content from several areas of the syllabus. Given this breadth less detail expected. A good answer used a structured approach discussing CO2 production, carriage in the blood, CO2 elimination and the control of ventilation, providing specific detail on how each of these affected arterial partial pressures of CO2.

“CO2 production” should include an overview of CO2 as a product of aerobic respiration, an approximation of the rate of production, how it varies with metabolic activity and finally the concept of RQ with its determinants. "Carriage" should include an estimate of CO2 content, how PaCO2 depends upon the amount dissolved (as per Henry`s Law), how CO2 is carried in the blood enabling more total content relative to the amount dissolved, the influence of the Haldane effect, and how CO2 is more soluble at lower temperature lowering PaCO2. "Elimination" should emphasise the importance of minute ventilation, dead space (including effective dead space due to high VQ lung units), and the effect of rebreathing CO2). "Control of ventilation" required a brief overview of the sensors, including central and peripheral chemoreceptors, integrators and effectors that influence the minute ventilation and ultimately PaCO2.

Question 13

(a) Define ventricular diastole, including its usual duration (15% of marks).

(b) Describe the cardiovascular events that occur during this period (85% of marks). (ionic and cellular events not required).

38% of candidates passed this question.

A thorough response to this question provided an accurate definition of ventricular diastole providing detail about duration (either duration at a certain heart rate or the usual ratio with changes due to tachycardia). The second part was best structured by dividing the events into cardiac mechanical and electrical events and circulatory changes. Mechanical events included a description of isovolumetric relaxation, early filling, atrial ejection and isovolumetric contraction, with an explanation of what marks the beginning and end of each of these phases as well as what happens to pressures within the cardiac chambers. Electrical events included the correlation of diastole with ventricular repolarisation and refractory periods as well as the corresponding ECG waves. Finally, an overview of the changes that occur in the coronary, pulmonary and systemic circulations during diastole was expected.

Question 14

Explain how the kidney handles an acid load.

34% of candidates passed this question.

This question was best answered through a description of how the entire nephron excretes acid. This required a detailed description of bicarbonate reabsorption, ammonium excretion and titratable acidity including phosphate. Explanations were expected to describe the locations, cells and the mechanisms or transporters involved in the resorption of bicarbonate or excretion of acid and how these changes depending on acid load.

Question 15

(a) Outline the general classification of nerve fibres including details on their function, size and conduction speed (30% of marks).

(b) Describe the mechanisms of action potential generation and propagation along a myelinated peripheral nerve fibre (70% of marks).

47% of candidates passed this question.

The first component of this question required a list of the different nerve fibre types including the breakdown of A, B and C fibres along with their primary function, for example motor/sensory/parasympathetic/sympathetic, presence of myelin, size and velocity of conduction.

The second component of this question required the mechanism by which an action potential arises and is propagated in a myelinated nerve. This required a detailed overview of electrolyte movement across the neuronal membrane during depolarisation, timing and explanation of the refractory period, the basis for unidirectional movement and the mechanism of saltatory conduction which occurs in a myelinated nerve.

Question 16

Outline the following with respect to platelets:

(a) Formation (15% of marks).

(b) Structure (40% of marks).

(c) Function (45% of marks).

58% of candidates passed this question.

Good candidates structured their answers into formation, structure, and function of the platelets. The structure should be divided into the surface of the platelets, including the receptors and antigens, and contents of the platelets. The function should be divided into adhesion, activation, and aggregation in that order with an explanation of the triggers and events during these phases followed by a discussion of the interaction between platelets and the coagulation system in haemostasis.

Question 17

Describe the physiological changes that occur in the pregnant person during parturition (labour). (Changes that occur within the foetus are not required).

39% of candidates passed this question.

This question required consideration of the alterations of the uterus, and the hormonal changes during labour, as well as discussion of the effects of this on the other body systems. Cardiovascular and respiratory changes held most of the mark weighting however gastrointestinal, metabolic and neuronal changes were also required.

A good answer was structured using the 3 stages of labour to **explain the** hormonal changes that initiate and maintain labour (oxytocin and positive feedback the primary but not the only factor described), changes to the cervix, uterine muscle and active muscular effort, delivery of neonate and placenta and uterine mechanisms to limit blood loss. Using this structure a description of cardiovascular and respiratory changes should follow with some detail about pain/endorphins, abdominal pressure/LOS

sphincter and metabolic changes (lactate/glucose utilisation) also expected. The question was specific to parturition. Physiological changes throughout pregnancy were not required.

Question 18

Describe the anatomy relevant to the insertion of an intercostal catheter.

36% of candidates passed this question.

This anatomy question reflects the knowledge base of a common ICU procedure. Good answers included insertion sites (lateral and anterior approaches) with the rationale and the relevant surface anatomy including the anatomical boundaries and neighbouring structures (pleural space, heart, liver and spleen) in relation to ICC insertion. A description of the layers of tissues traversed during ICC insertion including mention of the skin, subcutaneous tissues, superficial fascia, external - internal - innermost intercostal muscles, endothoracic fascia and parietal pleura was also required. Specific details describing the importance of the neurovascular bundle including its contents, the origin, trajectory and termination is important as this educates procedural considerations examined in other parts of the curriculum.

Question 19

Describe the pharmacology of oxygen.

33% of candidates passed this question.

Candidates were expected to describe the pharmacology of oxygen under the following headings: pharmaceutics/preparation, mechanism of action, indications/uses, administration methods, pharmacokinetics, pharmacodynamics and toxicity. Given the breadth of the question the detail of answers will be inherently limited by time however some specific details were important.

Pharmaceutics included the properties of oxygen and its manufacturing and storage. Administration by inhalation may be via fixed and variable performance devices. Indications included causes of hypoxaemia but there are others such as de-nitrogenation of gas filled spaces, and various indications for hyperbaric O2 therapy.

Mechanism of action involved mentioning oxidative phosphorylation occurring in the mitochondria where O2 functions as the final electron acceptor. Other mechanisms include biochemical pathways requiring O2 as a substrate, and generation of reactive oxygen species by neutrophils and macrophages for antimicrobial purposes.

Pharmacokinetics required a description of diffusion across alveolar membrane, binding to Hb and the small amount in solution, metabolism in mitochondria and excretion subsequently of CO2 and H20. Answers were elevated by quantitation of O2 uptake, O2 carriage, mention of importance of pressure gradients (O2 cascade) and O2 stores.

Pharmacodynamics required mention of systemic vasoconstriction, effects on the respiratory system such as de-nitrogenation of gas filled spaced, absorption atelectasis, inhibition of hypoxic pulmonary vasoconstriction and risk of hypercapnia in select patients with COPD. Side effects involve reactive oxygen species, and awareness of dose and time of exposure as relevant factors. There is a risk of delirium/seizures in hyperbaric oxygen, and longer-term risks of pulmonary toxicity and to the premature neonate of retrolental fibroplasia and retinopathy.

Question 20

Explain the mechanism of action by which the following drugs exert their clinical and pharmacological effect when used to treat drug toxicity or overdose, including the time taken to exert this clinical effect:

(a) N-acetylcysteine (25% of marks).

(b) Digoxin FAb (25% of marks).

(c) Naloxone (25% of marks).

(d) Lipid emulsion (i.e. Intralipid) (25% of marks).

65% of candidates passed this question.

This question was best answered by using each drug as the heading with their subsequent mechanism of action and time of onset of their clinical effect. Brief discussion of what drug toxicity or overdose these agents offset and how is implied in the mechanism of action and was included in our marking rubric.

MULTIPLE CHOICE QUESTIONS – PAPERS 1 AND 2

97% of candidates passed overall.
98 % of candidates passed Paper 1.
95 % of candidates passed Paper 2.

ORAL SECTION

DAY 1 – Wednesday 16th October 2024

VIVA 1

This VIVA will examine respiratory physiology.

The following diagram represents the West zones of the upright healthy lung. Describe this model of pulmonary blood flow distribution.

VIVA 2

This VIVA will examine acid-base and renal physiology and pharmacology.

Outline the principles of the Stewart (physicochemical) approach to acid base disturbances. Using this approach interpret the arterial blood gas below.

(Image removed from report.)

VIVA 3

This VIVA will examine pharmacokinetics.

Describe the "single compartment model" of pharmacokinetics.
What properties of a drug mean that it can be described by a single compartment model?

VIVA 4

This VIVA will examine calcium physiology and pharmacology.

How does the body handle calcium, including its absorption, elimination and distribution?

DAY 2 – Thursday 17th October 2024

VIVA 5

This VIVA will examine cardiovascular physiology and pharmacology.

This is a diagram of the pressure-volume loop of a healthy left ventricle before and after the administration of drug "X". Explain the phases of the normal loop (including derived information) and describe the changes following the administration of drug "X" with an example.

(image removed from report)

VIVA 6

This VIVA will examine neurophysiology.

Describe the production of cerebrospinal fluid (CSF), its pathway of flow and its absorption.

VIVA 7

This VIVA will examine hepatobiliary physiology and pharmacology.

This is a diagram of a liver lobule. Please identify the structures labelled A-J.

VIVA 8

This VIVA will examine haematological physiology, pharmacology and measurement.

Describe the mechanisms that keep a blood clot localized and prevent propagation through the vasculature.

SUMMARY OF THE EXAMINATION

The CICM First Part Examination explores the knowledge of the basic medical sciences that form the foundation 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 the level of information required. Some sections of the syllabus 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 providing answers 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 and information expected for each question but are not model answers and should be read as such.

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October 2024