COLLEGE OF INTENSIVE CARE MEDICINE
OF AUSTRALIA AND NEW ZEALAND

REPORT OF THE
INTENSIVE CARE FIRST PART EXAMINATION

March/April 2021

This report is prepared to provide candidates, tutors and their supervisors of training with information about the examination. Answers provided are not model answers but a guide as to what was expected.

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

2021.1

Total number of candidates presenting for the written examination:	91
Number of candidates scoring > 50% in the written:	57
Number of candidates scoring 45 – 50% in the written:	3
Number of candidates carrying a written score:	1
Total number invited to the oral section based on written marks:	61
Total number of candidates successful at the CICM First Part Exam:	58

SUCCESSFUL CANDIDATES

Dr Nithin Abraham Raju
Dr Thomas Anderson
Dr Geoffrey Balean
Dr Mominah Bhatti
Dr Emma Browne
Dr Niamh Buckley
Dr Stewart Carmichael
Dr Benjamin Cole
Dr Milan Edinger-Reeve
Dr Hannah Glenn
Dr Audrey Guo
Dr Adam Joghee
Dr Alok Kumar
Dr Alex Lesser
Dr Zhou Lu
Dr Jayanand Mahendra Raj
Dr Joshua McLarty
Dr Sarah Myers
Dr Sarah Neumann
Dr Kirsty O'Keefe
Dr Robert Pocklington
Dr Claire Raper
Dr Jake Schmidt
Dr Huiling Tan
Dr Alfred Van Der Walt
Dr Rengan Vijayakumar
Dr Thomas Vos
Dr Benjamin Wilkinson
Dr Emma Wray

Dr Scott Ashby
Dr Manon Audige
Dr Brian Beaver
Dr William Blackburne
Dr Luke Brunton
Dr Robert Carmichael
Dr June Ee Chen
Dr Thomas Coleman
Dr Mohsin Ejaz
Dr Anastasi Gougoulis
Dr Karina Hall
Dr Murtaza Khanbhai
Dr Amanda Laurent
Dr Rose Lewis
Dr Thomas MacLaverty
Dr Shaney Maull
Dr Stephan Christian Mertes
Dr Michael Nelson
Dr Wai Hung Yu
Dr Daniel Owers
Dr Lachlan Poiner
Dr David Ross
Dr Shamsun Sultana
Dr Levent Uygur
Dr Amit Kumar Verma
Dr Ruvini Vithanage
Dr David West
Dr Samuel Wood
Dr Chinh Dam Nguyen

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 – for example cardiovascular and respiratory physiology. Candidates are strongly encouraged to read widely to gain a high level of understanding. Candidates are reminded to ensure writing is legible.

SHORT ANSWER QUESTIONS – PAPERS 1 AND 2

1. Describe the pharmacology of adrenaline.

90% of candidates passed this question.

Adrenaline is a level 1 drug and is commonly used in intensive care. A comprehensive explanation of the drugs MOA, PK, PD and side effect were expected. Candidates who scored well generally provided a factually accurate, detailed and well-structured answer. Overall, the quality of answer provided for this question was of a high standard.

2. Describe the work of breathing and its components.

24% of candidates passed this question.

This is a core topic within respiratory physiology. There was a very low pass rate for this question. Expected components of the answer included: a definition of WOB as a product of pressure and volume or force and distance including the units of measurement; followed by a detailed explanation of the following three broad components – elastic resistance, viscous resistance and airflow resistance. Further marks were awarded to situations where the energy for expiration increases beyond stored potential energy as well as the impact of respiratory rate and tidal volume on different aspects of the WOB. For example, the changes in TV will have relatively greater impact on the elastic component, whereas RR will impact the resistance component. Additional marks were awarded for describing the efficiency of breathing. A common area where candidates missed out on marks was producing a diagram of WOB without a description; many diagrams were often incorrectly drawn or had no axes labelled. There were many incorrect definitions or respiratory equations provided without any link to the written answer. Factual inaccuracy and limited depth of knowledge were also prevalent in poorly performing answers. Marks were not awarded for a description of the control of breathing.

3. Outline the formation, structure, and function of the platelet.

79% of candidates passed this question.

This question was divided in three sections to help candidates formulate an answer template. The first section required a brief outline of the formation of platelets from pluripotent stem cells via megakaryocytes. The second section required an outline of platelet structure highlighting the special features such as, an absence of a nucleus, the presence of an external glycocalyx layer, specific surface receptors, contractile proteins, dense tubular system and granules. The third section was about platelet function where the expected focus was on the role of platelets in haemostasis. This required outlining the mechanism of platelet plug formation by adhesion-activation-aggregation, interactions with the coagulation cascade and role of platelets in clot contraction as well as fibroblast invasion. Although many candidates were able to answer the first section reasonably well, there was a noticeable knowledge deficit in the latter two sections. A significant proportion of answers had missing information on platelet structure and lack of structure in outlining platelet function.

4. Outline the dose (10% marks), composition (60% marks) and side effects (30% marks) of total parenteral nutrition (TPN).

59% of candidates passed this question.

The pharmacology of enteral and parenteral nutrition is a level 1 topic in the first part syllabus. The TPN dose in terms of daily calorie and other nutritional requirements were key expectations in first part of the question. A detailed list of all macro and micronutrients was required under TPN composition. Expected information about macronutrients were their forms in the TPN solution (e.g., carbohydrate in the form of glucose, protein in the form amino acids), their relative calorie contributions and their essential components (e.g., the names of the essential amino acids). Identification of potential variability in composition and dose based on specific patient factors scored extra marks. Side effects included metabolic derangements (refeeding syndrome, over or under-feeding, hyperglycaemia, hyperlipemia), biochemical disturbances (fluid and electrolyte imbalances), organ injury (liver, pancreas) and vascular access related complications. Limited breadth and depth of information as well as incorrect facts were prevalent in the answers that scored lower marks.

5. Outline the factors that determine central venous pressure (60% marks) and explain how it is measured (40% marks).

57% of candidates passed this question.

This question examined a core area of cardiac physiology and measurement. Considering this, candidates overall, scored poorly in this section. There was a common misunderstanding around the relationship between cardiac output and CVP. A decrease in cardiac output (e.g. due to either decreased stroke volume or heart rate) will cause an increase in CVP as blood backs up in the venous circulation, increasing venous volume as less blood moves through to the arterial circulation; the resultant increase in thoracic volume increases central venous pressure. Several candidates confused the direction of their arrows, for example "increased right atrial compliance increases CVP". Double negatives were used by several candidates which then resulted in the incorrect relationship described. (e.g., "arrow down compliance and arrow down CVP"). The measurement section should have included an explanation of the components of an invasive pressure monitoring system relevant to the measurement of CVP.

6. Describe the pharmacology of vecuronium, including factors that prolong its action of neuromuscular blockade.

13% of candidates passed this question.

Vecuronium is a commonly available and regularly used amino-steroid neuromuscular blocking agent. It is a level 1 drug in the 2017 syllabus. A simple template utilising the headings; pharmaceutics, PK, PD, uses in ICU and adverse reactions with associated relevant important facts would have scored well. Expected information regarding the factors prolonging neuromuscular blockade included electrolyte abnormalities, drug interactions and patient factors. Overall, the level of understanding and knowledge demonstrated in the answers was below an expected standard for a level 1 drug.

7. Outline the anatomy of the blood supply (arteries and veins) of the gastrointestinal system (oesophagus to anus)

48% of candidates passed this question.

This question was answered best if the main arteries and veins were discussed first and then their corresponding supply outline in reasonable detail. Very few candidates were able to achieve this. Listing the names of vessels with no context and in a random non-sequential order did not attract many marks. The physiology of the blood supply to the liver also did not attract marks.

8. Describe renal handling of potassium (60% marks), including factors that may influence it (40% marks).

33% of candidates passed this question.

This question covers a core physiology topic. The detail required is well described in the recommended reference texts. Generally, this question was poorly answered. From an answer template perspective, a "describe question" in this context involves both the stating the relevant potassium handling mechanism and then giving a description of how it occurs and how this system is regulated. Many answers that scored poorly simply listed sites of potassium handling but excluded the details surrounding the specific receptors and channels involved as well as the processes that exist to perpetuate and regulate these biological processes. Simple identification as to whether the potassium was being secreted or reabsorbed as well as the location as to where this may occur within the nephron, were often not specifically detailed or used interchangeably. Such answers scored poorly.

9. Outline the mechanisms by which normal body temperature is maintained and regulated.

59% of candidates passed this question.

This question was relatively well answered by most candidates. There was significant variation in the temperatures expressed as normal and few candidates mentioned CORE temperature as a concept. Several candidates gave a detailed description of thermo-neutrality for which there were no marks.

10. How does warfarin exert its pharmacological effect (40% marks)? Write brief notes on the pharmacology of the agents that can be used to reverse the effects of warfarin (60% marks).

43% of candidates passed this question.

Warfarin is listed as a level 1 drug in the 2017 syllabus and as such a detailed knowledge of its mechanism of action would be expected from candidates sitting the exam. The reversal agents for warfarin are collectively classed as level 2 drugs and hence the knowledge required would be at a write short notes level. The following topics were expected: what drugs may be used, how they work, in what dose, any common side effects, why/when would one be used in preference to others etc. The use of reversal agents for warfarin is a common practice in ICU. Generally, answers demonstrated a lack of a precise and detailed knowledge with respect to warfarin’s mechanism of action and had a very superficial knowledge with incorrect facts regarding the reversal agents.

11. Describe the buffer systems in the body.

57% of candidates passed this question.

This is a core physiology topic; a detailed knowledge of buffering and the available buffer systems is crucial to ICU practice.
A candidate presenting for the first part exam should have a detailed understanding of all aspects of the buffer systems. Higher scoring answers provided both technical details of the buffer systems, the context for their normal function and their relative importance. Efficient answers dealt with the buffers by chemical rather than by site, but many answers categorising buffers by site also scored well. Many low scoring answers simply failed to provide detail, some provided incorrect information. Very few candidates demonstrated an understanding of the isohydric principle.

12. Describe the pharmacology of oxycodone.

54% of candidates passed this question.

There were many exceptional answers which provided extensive detail on the drug. The best of these gave context for the drug characteristics, such as by referring to oxycodone relative to other opioid drugs that might be chosen, or to considerations for safe and effective administration. Some answers, however, provided generic information on opioid drugs, which could not gain all the available marks.

13. List the cell types in the anterior pituitary gland. Outline their secretions, control and target organ effects.

40% of candidates passed this question.

Few candidates described cell types as chromophils and chromophobes. There were many errant references to chromaffin cells which are found mainly in the adrenal medulla, and to staining on H&E. Chromophil cells stain by absorbing chromium salts. Few candidates mentioned that the hormones secreted by the anterior pituitary are peptides. Most candidates outlined the hypophyseal-portal system well. Knowledge of TSH and ACTH control and target organ effects were good. Similar knowledge for LH, FSH, PRL and GH was much more sporadic.

14. Describe the pharmacology of sodium bicarbonate.

29% of candidates passed this question.

This question was best answered with a structured approach as per any pharmacology question. It nonetheless required good understanding of various aspects of physiology. Many candidates failed to gain marks by omitting to mention facts which could have been prompted by a defined structure. A good response mentioned the pharmaceutic features including formulation and the hypertonicity of IV bicarbonate, pharmacodynamics including indications for use, mode of action, adverse effects (systemic and local), pharmacokinetics and dose. Pleasingly a few candidates stated that sodium bicarbonate's mechanism of action to cause alkalosis involved increasing the strong ion difference in plasma. Credit was also given for stating the mechanism of action as providing bicarbonate ions to augment the extracellular buffer system.

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

36% of candidates passed this question.

This question required detail on those factors affecting gas exchange at the level of the alveolus. A description of the components of the Fick equation was expected - and how this related to oxygen and carbon dioxide transfer **at the alveolar capillary membrane**. The rapid rate of equilibration (developed tension) was the limiting factor in of blood/alveolar exchange that rendered some gases **perfusion limited** (examples - N_2O, O_2 under usual conditions but not all) and the slower rate of others **diffusion limited** (examples CO and O_2 under extreme conditions e.g., exercise, altitude). Estimates of time taken for each gas to equilibrate relative to the time taken for the RBC to travel across the interface was also expected for full marks. CO_2 despite rapid equilibration and higher solubility was correctly described as perfusion limited (unless in disease states). Better answers described CO_2 as ventilation limited. Some answers also correctly included the component of interaction with the RBC and haemoglobin. Ventilation/perfusion inequalities over the whole lung were not asked for and scored no marks.

16. Describe the pharmacology of piperacillin-tazobactam.

62% of candidates passed this question.

Most candidates used a structured approach with the usual major pharmacology headings. Mechanism of action was well described by most, with better answers including mechanisms of resistance. Higher scoring candidates included an explanation as to the combination of the drugs. Likewise, better answers included detailed information on spectrum of activity beyond "gram positive and gram negative", including relevant groups of organisms which are not covered. There also seemed to be some confusion about coverage for anaerobes, which piperacillin tazobactam covers well.
Specific detail about adverse reactions, other than 'allergy, rash, GI upset, phlebitis, etc', is expected for commonly used antibiotics.

17. Describe the principles of measurement of arterial haemoglobin O_2 saturation using a pulse oximeter (60% marks). Outline the limitations of this technique (40% marks).

74% of candidates passed this question.

Most candidates provided a reasonable structured sequence of how a pulse oximeter generates a value. Nearly all candidates described the Beer-Lambert laws correctly, but few specifically described the basic principles of absorption spectrophotometry. Most candidates had a reasonable list of extrinsic factors that can interfere with pulse oximeter performance, but few described the intrinsic/inherent limitations of the device that can cause SpO_2 to be different to SaO_2, such as functional versus fractional saturation.

18. Outline the pharmacology of intravenous magnesium sulphate.

57% of candidates passed this question.

The best answers appropriately addressed the pharmacology of magnesium sulphate, rather than diverting into physiology. They noted that the question concerned intravenous magnesium sulphate and did not discuss other routes. They included pharmaceutics, important examples of the wide-ranging indications, listed potential modes of action and considered the full range of body systems affected including potential adverse effects. Drug interactions, such as potentiation of neuromuscular blocking agents, and pharmacokinetics (including stating that magnesium is not metabolised) were described.

19. Describe the adult coronary circulation (50% marks) and its regulation (50% marks).

62% of candidates passed this question.

Good candidates described normal blood flow to the coronary circulation, including differences between the right and left ventricles. Coronary artery anatomy was outlined, including the regions of the heart supplied and the concept of dominance. In addition to epicardial vessels, strong answers also outlined penetrating arteries, subendocardial supply and venous drainage. Regulation of coronary blood flow required an explanation of flow-dependence of the heart given its high oxygen extraction rate. Metabolic autoregulation and its mediators needed to be described, along with the physical factors driving coronary blood flow. Less important mechanisms such as the role of the autonomic nervous system were also described, with an emphasis on indirect effects over direct effects.

20. Outline the physiological factors that influence cerebral blood flow.

19% of candidates passed this question.

Overall, this question was poorly answered with a high failure rate. A good answer gave a normal value, iterated that CBF is held relatively constant by autoregulation, and proceeded to divide factors affecting CBF into categories with an explanation/description of each. Those factors with the greatest influence were expected to have more accompanying information (e.g., pressure/myogenic autoregulation, metabolic). Systemic factors such as MAP, O_2, CO_2 were expected to be mentioned with detail of the impact (i.e., key values, relationships demonstrated with a description and/or labelled graph). Local factors within the brain such as H^+ concentration/pH, metabolic activity (including the impact of temperature, inclusion of mediators, regional variation based on activity & grey versus white matter) were also expected to be mentioned. Few answers mentioned impact of pH change independently of CO_2. Few answers mentioned how CO_2 changes the pH of CSF and that over time, this impact is buffered/reduces. The role of the sympathetic nervous system was required to be mentioned although not explored in detail (although many answers overstated the importance of the SNS on CBF or gave a simplistic concept such as increased SNS activity increases CBF). Many answers focussed on descriptions of the Monro-Kelly doctrine and ICP to the exclusion of the aforementioned factors or included detail on factors influencing MAP which were not required (and irrelevant when within the autoregulation range). Many answers were simplistic: e.g., increase MAP increase CPP therefore increase CBF, or by stating CO_2/O_2 without mentioning a relationship or the limits/patterns of the relationship. Many answers failed to separate the effect of systemic PaO_2 and $PaCO_2$ from metabolic autoregulation.

MULTIPLE CHOICE QUESTIONS – PAPERS 1 AND 2

90% of candidates passed overall.

ORAL SECTION

DAY 1

VIVA 1

This viva will explore your knowledge of respiratory physiology.

What is compliance?

76% of candidates passed this question.

VIVA 2

This viva will explore your knowledge of haemodialysis.

What are the principles of haemodialysis?

76% of candidates passed this question.

VIVA 3

This viva will explore your knowledge of invasive arterial monitoring systems.

What are the features of an invasive arterial monitoring system that improve accuracy of the waveform display? *(Image removed from report.)*

86% of candidates passed this question.

VIVA 4

This viva will explore your knowledge of maternofoetal physiology.

This is a normal blood gas of a pregnant woman at term breathing room air.

Outline the changes and explain their physiological basis.

pH	7.45
pO_2	105 mmHg
pCO_2	30 mmHg
HCO_3^-	20 mmol/L
BE	-2

71% of candidates passed this question.

VIVA 5

This viva will explore your understanding of the cranial nerve reflexes.

Please describe the pupillary light reflex.

90% of candidates passed this question.

VIVA 6

This viva will explore your knowledge of haematological physiology and pharmacology.

Outline the different blood groups and explain what determines them.

90% of candidates passed this question.

VIVA 7

This viva will explore your knowledge of glucose physiology and related pharmacology.

Can you describe the storage of glucose in the body?

29% of candidates passed this question.

VIVA 8

This viva will explore your knowledge of measurement of cardiac output and the determinants of systemic vascular resistance (SVR).

How can the cardiac output be measured?

90% of candidates passed this question.

DAY 2

VIVA 1

This viva will explore your knowledge of propofol pharmacology.

What is in an ampoule or bottle of propofol?

57% of candidates passed this question.

VIVA 2

This viva will explore your knowledge of intravenous fluids and their effects on the body.

What are the biochemical effects of infusing large volumes (2 to 3 liters) of normal saline to an adult patient?

81% of candidates passed this question.

VIVA 3

This viva will explore your knowledge of measurement.

By what methods can the concentration of oxygen in inspired gas be measured?
(Image removed from report.)

81% of candidates passed this question.

VIVA 4

This viva will explore your knowledge of acid base physiology.

What is an acid and how much acid does the body produce daily?

67% of candidates passed this question.

VIVA 5

This viva will explore your knowledge of the physiology of oxygen.

Please outline the steps and numerical values of the oxygen cascade.
(Image removed from report.)

90% of candidates passed this question.

VIVA 6

This viva will explore your knowledge of cardiovascular physiology.

Describe the baroreceptor reflexes involved in the cardiovascular response to rapid onset hypovolaemia (for example, the loss of 20% blood volume over 10 minutes).

86% of candidates passed this question.

VIVA 7

This viva will explore your knowledge of viscoelastic measures of coagulation and pharmacology of antiplatelet drugs. *(Image removed from report.)*

Explain the principle behind the viscoelastic methods. What information can be obtained from them?

52% of candidates passed this question.

VIVA 8

This viva will explore your understanding of the anatomy of the liver.

This is the functional unit of the liver.

What are the structures labelled A to E? What is the significance of this arrangement?
(Image removed from report.)

86% of candidates passed this question.

DAY 3

VIVA 1

This viva will explore your knowledge of metabolism related to acid-base physiology.

What does this blood gas show?

pH	7.10
BE	-20.4
HCO_3^-	8 mmol/L
Na^+	145 mmol/L
K^+	4.4 mmol/L
Cl^-	113 mmol/L

95% of candidates passed this question.

VIVA 2

This viva will explore your knowledge of oxygen delivery devices. *(Image removed from report.)*

How does this device work?

81% of candidates passed this question.

VIVA 3

This viva will explore your knowledge of opioid pharmacology.

How do opioids produce analgesia?

81% of candidates passed this question.

VIVA 4

This viva will explore your knowledge of cardiovascular physiology and measurement.

This is an arterial waveform in a healthy young adult. Indicate the points from A to D, and what determines the shape of the waveform?
. *(Image removed from report.)*

52% of candidates passed this question.

VIVA 5

This viva will explore your knowledge of the physiology of carbon dioxide (CO_2).
(Image removed from report.)

How is CO_2 carried in the blood?

90% of candidates passed this question.

VIVA 6

This viva will explore your knowledge of haematology.

What is blood plasma and what are its non-protein components?

81% of candidates passed this question.

VIVA 7

This viva will explore your knowledge of neuromuscular transmission and neuromuscular monitoring.

How is the end plate potential generated? How is it different from the miniature end plate potential?

19% of candidates passed this question.

VIVA 8

This viva will explore your knowledge of the physiology of vomiting.

Define nausea and vomiting. Describe the sequential muscle contractions that occur when vomiting.

71% of candidates passed this question.

SUMMARY OF THE EXAMINATION

The CICM First Part Examination explores the knowledge of the basic sciences that form the basis to 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 follow 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 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 Roslyn Purcell
Chair
CICM First Part Examination Committee

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Deputy Chair
CICM First Part Examination Committee

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