COLLEGE OF INTENSIVE CARE MEDICINE
OF AUSTRALIA AND NEW ZEALAND

REPORT OF THE
INTENSIVE CARE FIRST PART EXAMINATION

SEPTEMBER / NOVEMBER 2014

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 guides to what was expected. Candidates should discuss the report with their tutors so that they may prepare appropriately for the future examinations.

The exam included two, 2.5 hour written papers, each comprising of twelve short answer questions and twenty short fact 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:	26
Number of candidates scoring > 50% in the written:	9
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:	14
Total number of candidates successful at the CICM Primary:	12

26 candidates sat the written component of this examination and 12 were invited to the viva examination based on their performance in the written paper. 14 candidates attended the viva component of the examination and 12 were successful (46.2% pass rate).

SUCCESSFUL CANDIDATES

Dr David Bowen
Dr Judith Askew
Dr Jason Chapman
Dr Bride Cruickshank
Dr Gul Gul-r-rana
Dr Patricia Hurune
Dr Barry Johnston
Dr Aashish Kumar
Dr Robert Olver
Dr Harshel Parikh
Dr Deshani Walisundara
Dr Cyveen Weeraratna

WRITTEN SECTION

EXAMINERS' COMMENTS

Candidates are reminded that all questions are worth equal marks and so time should apportioned accordingly. On occasions it appeared some questions were completed in haste or not attempted at all and this denies the candidate an opportunity to gain valuable marks.

Questions from previous examinations may be repeated and candidates are encouraged to review prior papers and examination reports.

Some answers failed to appreciate key concepts and in particular often lacked the depth expected. Candidates are expected to have a detailed knowledge and depth of understanding of level I topics such as respiratory physiology. As a guide, the level of detail expected goes beyond that often outlined in a general physiology textbook and candidates are strongly encouraged to read widely so as to gain high level understanding. Some candidates scored full marks in some questions illustrating it is possible.

SHORT ANSWER QUESTIONS – PAPER 1 AND 2

1. Classify commonly used inotropic agents. (40% of marks) Outline four different mechanisms of action for inotropic agents. (60% of marks)

65% of candidates passed this question.

This question was generally well answered. The poorer answers suffered for want of a useful classification system that enabled them to separate the various drug classes.

2. Describe the pharmacology of Phenytoin (75% of marks) and Levetiracetam (25% of marks).

35% of candidates passed this question.

The knowledge of phenytoin was often superficial and many answers were too brief and didn't adequately cover the required material. The knowledge around levetiracetam seemed very limited with many candidates guessing (incorrectly) what the pharmacokinetics might be. Most answers demonstrated a structured approach to this type of question.

Better answers were able to distil major issues such as the narrow therapeutic window for phenytoin or the potential clinical impact of differing ordered kinetics or altered metabolism. Candidates are reminded to read each question carefully; levetiracetam should not be confused with levosimendin.

3. Describe the physiological consequences of Positive End-Expiratory Pressure (PEEP).

27% of candidates passed this question.

Most answers were quite brief and superficial. They simply did not cover enough of the required knowledge base to gain a pass mark. A definition of PEEP is a useful way to start this answer and this was missing in more than half the answers. Deficiencies in knowledge included even the primary respiratory and cardiovascular effects of PEEP. Many candidates incorrectly concluded that PEEP would increase afterload and decrease pulmonary vascular resistance. Some candidates provided description of the cardiovascular effects of Valsalva, which was not part of the question. It was expected candidates would also mention physiological effects on other organ systems such as potential cerebral and renal effects.

This topic (Level 1) requires a detailed knowledge and candidates should read widely to gain the depth of understanding required. The core material is covered in texts such as Nunn's' Applied Respiratory Physiology and additional applied information can be found in a variety of texts such as Textbook of Critical Care by Fink et al, Irwin and Rippe's Intensive Care Medicine or Miller's Anaesthesia.

4. Outline the anatomy and physiology of the parasympathetic nervous system.

0% of candidates passed this question.

Generally there was a lack of detailed knowledge, incorrect facts and at times confusion between the sympathetic and parasympathetic nervous system functions. A lack of anatomical detail was common (the origin of preganglionic cell bodies was not described clearly, and parasympathetic ganglia were not often named and located). It was expected an answer would mention the central role of Acetylcholine as a neurotransmitter at preganglionic and post ganglionic neurons in the parasympathetic system. Target organs were identified correctly but the exact action was not specified e.g. pupillary constriction vs. dilatation, GI sphincter/bladder - contraction vs. relaxation. Detail concerning receptor physiology was not required.

This is a question covering a core topic that no candidate passed. An overview of the arrangement and function of the autonomic nervous system is provided in several core physiology texts, including Ganong and Guyton.

5. Describe the effects of V/Q inequality on the partial pressure of oxygen (PaO_2) and carbon dioxide ($PaCO_2$) in arterial blood.

8% of candidates passed this question.

Very few candidates demonstrated understanding of this core topic. Candidates did not accurately define V/Q inequality and the physiological factors causing this phenomenon. V/Q scatter as well as true shunt (V/Q=0) and dead space (V/Q=∞) needed to be considered. The inability of high V/Q areas to compensate for low V/Q zones owing to the relatively small contribution of blood flow from these high V/Q units was not discussed. The differential effect of FiO2 on true shunt versus V/Q scatter was seldom explained. The shape of the oxy-Hb dissociation curve and CO2-dissociation curve were sometimes mentioned but their effect on arterial gas tensions not well explained.

Often graphs were reproduced inaccurately and contradictory statements made, leaving the impression that candidates did not understand the basic concepts. It is core knowledge for

Intensive Care Specialists managing respiratory failure. A sophisticated knowledge based on the chapter in Nunn is a minimum standard expected for this topic.

6. List the mechanisms involved in heat production and loss by the body. (80% of marks) Define thermoneutral zone and inter-threshold range. (20% of marks)

23% of candidates passed this question.

Many candidates did not read the question carefully and misinterpreted what was being asked. Candidates often digressed into a discussion of thermoregulation. Several candidates wrote about body's response to cold and heat rather than mechanisms of heat production and loss as was asked.

There was confusion between mechanisms of endogenous heat production and measures to conserve heat. "Behaviour" only attracted marks in relation to voluntary muscle activity for heat production. Changing clothes or seeking a warm environment does not increase heat output by the body. Behaviour can reduce heat loss. Many candidates did not specify ambient or core body temperature. The definitions of Thermoneutral Zone and Interthreshold Range were not clear.

Knowledge generally lacked detail and this was most evident when precise definitions were asked.

7. Outline the mechanisms that potentiate the action of non-depolarising muscle relaxants and give examples.

15% of candidates passed this question.

A structured approach would work well for this question but was often lacking. Many answers were superficial providing short lists of factors affecting NDMRs without reference to mechanism. Candidates failed to differentiate factors which potentiate NDMRs from those which inhibit the action of the drugs. Some confusion also existed confusing speed of onset kinetics with potentiation kinetics. Candidates who structured their answer into pharmacokinetic and pharmacodynamic factors generally scored better marks. Candidates who used pre-post synaptic type structure tended to omit kinetics completely from their answers. Incorrect facts were common.

8. Outline how the following tests assess coagulation:

a) Prothrombin Time (PT)

b) Activated Partial Thromboplastin Time (APTT)

c) Activated Clotting Time (ACT)

d) Thromboelastogram (TEG or ROTEM)

0% of candidates passed this question.

It was expected candidates would cover all aspects of testing for each test listed. This would include normal, abnormal or therapeutic values, a comment on methods (either laboratory or point of care) and coagulation pathway assessment. General statements about the overall purpose of the test, collection methods, plasma vs whole blood as sample scored additional marks. Diagnoses or errors associated with abnormalities in each test would also have scored marks but were not mentioned in most answers.

Overall there was a lack of depth of knowledge and incorrect facts. Many candidates knew about TEG, but did not know details about the other tests.

9. Outline the fate of the triglyceride component of orally ingested fat.

8% of candidates passed this question.

Triglycerides (TGs) consist of a 3 carbon glycerol backbone with 3 fatty acids attached. It was expected candidates would detail the fate from digestion and absorption, through distribution to storage and metabolism. Most candidates knew the absorptive processes very well but knowledge of TGs fate once it was packaged into a chylomicron was lacking. Some detail was expected on the passage to the liver via the portal circulation, packing and unpacking and distribution to the body. Very few candidates mentioned appropriate hormones and enzymes, target cells or ketogenesis. Some discussion was expected on the possible fate of acetyl Co A. Comment on the synthesis of lipids and the existence of essential fatty acids gained additional marks.

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

65% of candidates passed this question.

This question was generally well answered. Some candidates did not mention the factors which are peculiar to the coronary circulation and answered in a generic manner, as if for any vascular bed. The coronary circulation has a high O2-ER and flow-dependence. Many candidates seemed to lack a perspective that metabolic demand dominates control of the coronary arterial flow. The phasic nature of flow was best shown with a diagram and whilst "publication-level" graphs are not expected, the graph drawn must be factually correct and convey the principal similarities and differences. While this topic is covered in both Guyton and Ganong, additional detail can be found in the Mosby physiology monograph series: Cardiovascular Physiology, 10th Edition by Pappano and Wier,(the replacement of Berne and Levy).

11. Describe the mechanisms of action of drugs used to treat acute severe asthma and give examples.

54% of candidates passed this question.

Asthma involves reversible bronchospasm, inflammation, and airway hyper-responsiveness to inhaled stimuli. The main classes of drugs for acute therapy include sympathomimetics,

antimuscarinic agents, corticosteroids, methylxanthines and magnesium. Candidates should have a detailed knowledge of the mode of action of these mainstream drugs. Information about drugs used for prevention and for chronic asthma was not asked for and answers which provided details about long term inhaled steroids or leukotriene antagonists did not gain extra marks.

This question was well covered by some candidates in a semi-table format. A structured approach worked well with details about drug class, mechanism of action and example(s).

12. Describe the role of the kidneys in the excretion of non-volatile acid.

27% of candidates passed this question.

This is a complex but essential area of physiology for intensive care practice. It was expected candidates would indicate that non-volatile acids are those not able to eliminated by the lungs (lactate, sulphate, phosphate and ketone bodies). The kidney plays a central role via bicarbonate (resorbing filtered bicarbonate and generating "new" bicarbonate = acid excretion). It was expected candidates could detail the processes in various parts of the renal tubules and the role or urinary buffers (dibasic phosphate and ammonia).

While a number of candidates were able to provide some of the details of ion transports in the kidney, few showed understanding of the overarching concepts of the proximal bicarbonate reabsorption being necessary to allow the distal acid excretion.

13. Outline the pharmacology of amiodarone.

77% of candidates passed this question.

This was a repeat question and was generally answered well. Some candidates lost marks for being too approximate on the pharmacokinetics.

14. Draw and describe a box and whisker plot. (50% of marks) What is this used for? (50% of marks)

15% of candidates passed this question.

Candidates either knew this topic or knew nothing about it. Some confused this with a Forrest plot which scored no marks. This topic is well covered in many standard statistics books such as *Statistical methods for anaesthesia and intensive care* / P S Myles, T Gin – 1st Ed - Oxford: Butterworth-Heinemann, 2001 ISBN: 9780750640657

15. Define the terms tolerance and tachyphylaxis. (20% of marks) Describe the different mechanisms by which tolerance can develop, and give examples for each. (80% of marks)

15% of candidates passed this question.

Tolerance is the requirement of higher doses of a drug to produce a given response. When this develops rapidly (with only a few administrations of the drug) this is termed tachyphylaxis. Various mechanisms exist by which tolerance occurs and these include cellular tolerance (e.g. neuronal adaptation to opioids or alcohol), enzyme induction and depletion of neurotransmitters.

Few candidates knew a comprehensive list or had a classification system for the different types of tolerance. No candidate had a good definition of tachyphylaxis.

16. Describe baroreceptors and their role in the control of blood pressure.

62% of candidates passed this question.

This is a core topic and a detailed knowledge was expected. Baroreceptors are stretch receptors located in the walls of the heart and blood vessels and are important in the short term control of blood pressure. Those in the carotid sinus and aortic arch monitor the arterial circulation. Others, the cardiopulmonary baroreceptors, are located in the walls of the right and left atria, the pulmonary veins and the pulmonary circulation. They are all stimulated by distention and discharge at an increased rate when the pressure in these structures rises. Better answers provided some detail on the innervation for these receptors. It was expected candidates would describe that increased baroreceptor discharge inhibits the tonic discharge of sympathetic nerves and excites the vagal innervation of the heart. This results in vasodilation, venodilation, a drop in blood pressure, bradycardia and a decreased cardiac output.

Some candidates had a major misunderstanding around the purpose of "low pressure baroreceptors" with many believing that these are the ones that respond to lower blood pressures, while the "high pressure baroreceptors" respond to higher blood pressures.

17. Describe the pharmacology of oxygen.

35% of candidates passed this question.

Use of a general "pharmacology" structure to answer this question would help avoid significant omissions such as only discussing pharmacokinetics or only discussing pharmacodynamics. Oxygen has a well described list of pharmacodynamics effects that includes, cardiovascular, respiratory and central nervous system effects. Candidates' knowledge of the pharmaceutics was limited for a routine drug. It was expected candidates would mention the potential for oxygen toxicity including a possible impact on respiratory drive in selected individuals, retrolental fibroplasia and seizures under some circumstances.

Many candidates did not answer the question asked, and instead focussed on the physiology of oxygen delivery and binding of oxygen to haemoglobin

18. Explain the similarities and differences between myoglobin and adult haemoglobin (60% of marks) and their physiologic relevance (40% of marks).

23% of candidates passed this question.

Both are globular proteins that bind and deliver O_2. Due to myoglobin containing a single globin chain its dissociation curve is hyperbolic in shape. Haemoglobin contains 4 globin chains and is a quaternary structure which exhibits cooperatively resulting in a sigmoid shaped dissociation curve. The differing dissociation curves mean that when the PO_2 is high, as in the lungs, both myoglobin and haemoglobin are saturated with oxygen. However, at the lower levels of PO_2 in the tissues, haemoglobin cannot bind oxygen as well as myoglobin. Myoglobin can bind the O_2 released by haemoglobin, which it stores to meet the demands of muscle contraction. This means haemoglobin (with its higher p50) can offload O2 to myoglobin. Comments on the synthesis and degradation gained additional marks but were a common omission.

The physiological relevance was poorly explained. The similarities and differences mean that haemoglobin is the primary means of O2 transport from the lungs to the tissues and myoglobin is the primary O_2 carrying pigment of skeletal muscle and acts as local O_2 reserve for times of intense muscle activity.

19. Describe the factors that determine right and left ventricular afterload.

31% of candidates passed this question.

This is a big question and required some structure to cover the material required. A Definition of afterload, factors specific to left ventricle, right ventricle and both were required. The question asked to describe and not merely list factors affecting afterload.

Marks were not given for describing pathologies rather than physiological processes that affect afterload. Candidates seemed to lack depth and understanding on this topic.

20. Describe the pharmacology of magnesium sulphate.

4% of candidates passed this question.

This was a repeat question and very poorly answered for such a commonly used agent. A structured approach to describing any drugs pharmacology was often not used.

Most answers were lacking depth and detail. The questions asked the pharmacology NOT physiology of magnesium sulphate. This was best answered with a standard template addressing: Presentation, Uses, Main actions, Pharmacodynamics, Pharmacokinetics, Mode of Action, Toxicity, and any Special Points

21. Compare and contrast the pharmacology of haloperidol and diazepam.

50% of candidates passed this question.

These are both commonly used agents and a tabulated format worked well. Subheadings covering the “general” pharmacology approach ensured core areas were addressed. Vague terms such as "good" or "moderate" did not allow a detailed comparison between the agents. Repetition of facts between sections such as uses, pharmacodynamics, effects and adverse effects did not gain further marks.

22. Describe how the values for PaO_2, $PaCO_2$, pH and bicarbonate are determined on a blood gas sample.

23 % of candidates passed this question

A correct description of the Clarke electrode, Severinghaus and the pH electrode was expected to attain a pass. Candidates who used correct depictions of these electrodes with annotated description attracted higher marks. Most candidates didn't comment on the temperature correction and standardization to 37 degrees. There was partial understanding on the calculation of HCO3 by most candidates. In general the question was poorly answered considering the wide spread use of blood gas analysis.

23. Describe the regulation of sodium in the body.

19% of candidates passed this question.

This question was generally poorly answered. Total body sodium is regulated within 2% in normal individuals. The vast majority is contained in the extracellular compartment. While any physiological regulation involves a balance of input and output, sodium intake is essentially unregulated in humans. Output is regulated via renal, gastrointestinal and skin losses. Candidates needed to present the renal handling of Na including hormonal control and present factual knowledge about the level of absorption and GFR effects to attain a pass mark. Many candidates focused on osmolality and tonicity and some on the use of diuretics thereby not gaining marks on regulation of sodium. Most candidates didn't mention either the skin and GIT role in sodium balance.

24. Describe the control of gastric emptying.

23% of candidates passed this question.

An understanding of the physiology of gastric emptying has direct relevance to intensive care practice as it influences enteral feed tolerance, helps inform regarding risk of aspiration and has important pharmacologic implications.

Candidates' answers were superficial and the role of intrinsic reflexes and local hormonal responses poorly understood and described. A simple and clear coverage is provided in Principles of Physiology for the Anaesthetist / P. Kam, I. Power – 3rd Ed.

SHORT FACT QUESTIONS – PAPER 1 AND 2

100 % of candidates passed this section.

Cloze Questions	100 % pass rate
Rank Questions	65 % pass rate
Match Questions	100 % pass rate

ORAL SECTION

14 candidates were invited to attend the oral section based upon their written marks.

VIVA 1

85.7% of candidates passed this question.

This Viva tested knowledge of cerebral physiology and aspects of pharmacology. It explored topics such as cerebral blood flow, autoregulation and moved on to vasopressin pharmacology.

VIVA 2

92.8% of candidates passed this question.

This Viva tested knowledge of respiratory physiology and measurement. It explored understanding of capnography and moved on to discuss dead space.

VIVA 3

100% of candidates passed this question.

This Viva tested knowledge on intravenous fluids. It explored understanding about colligative properties, anion gap and moved on to the pharmacology of frusemide.

VIVA 4

78.6% of candidates passed this question.

This Viva tested knowledge on cardiovascular physiology and measurement. It explored understanding of cardiac pressure waves, alterations in these with vasopressor infusion and an understanding of invasive pressure measurement.

VIVA 5

71.4% of candidates passed this question.

This Viva tested knowledge on obstetric and neonatal physiology. It explored the cardiovascular changes in pregnancy, factors that influence gas exchange across the placenta, the changes with the first breath and went on to aspects of humidity.

VIVA 6

71.4% of candidates passed this question.

This Viva tested knowledge on basic pharmacology of dose response curves and moved on to concepts around renal clearance.

VIVA 7

92.8% of candidates passed this question.

This Viva tested knowledge on nerve action potentials and the pharmacology of local anaesthetic agents.

VIVA 8

64.3% of candidates passed this question.

This Viva tested knowledge on liver physiology and blood flow and then explored understanding of nutrition, including the changes seen with fasting and stress.

SUMMARY OF THE EXAMINATION

The CICM Primary 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 directly from that 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 to also 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.

This is a challenging exam. 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 Primary Examination. The examination reports are available a guide to areas that are covered but do not provide model answers and should be read as such.

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