COLLEGE OF INTENSIVE CARE MEDICINE
OF AUSTRALIA AND NEW ZEALAND

REPORT OF THE
INTENSIVE CARE FIRST PART EXAMINATION

SEPTEMBER / NOVEMBER 2015

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:	48
Number of candidates scoring > 50% in the written:	14
Number of candidates scoring 45 – 50% in the written:	12
Number of candidates carrying a written score:	0
Total number invited to the Oral section based on written marks:	26
Total number of candidates successful at the CICM First Part:	24

48 candidates sat the written component of this examination and 26 were invited to the viva examination based on their performance in the written paper

24 candidates were successful following the viva component of the examination.

SUCCESSFUL CANDIDATES

Dr Ben Baldacchino
Dr Julia Coull
Dr Adam Drenzla
Dr Meyrelle Fernandes
Dr Ashley Garnett
Dr Denzil Gill
Dr Melissa Johnston
Dr Montaha Wajid Khan
Dr Girish Kumar
Dr Ji Seon Lee
Dr Prashant Maan
Dr Daire McGee
Dr Philippa McIlroy
Dr Steven Musca
Dr Sridhar Nagepalli Venkataramireddy
Dr Claire Pickering
Dr Jennifer Porteous
Dr Benjamin Silbert
Dr Julian Sunario
Dr Michael Toolis
Dr Elizabeth Tran
Dr Katherine Vautin
Dr Ajay Vidyasagar Venkatapathy
Dr Elizabeth Winson

WRITTEN SECTION

EXAMINERS' COMMENTS

Candidates are reminded that all questions are worth equal marks and so time should be apportioned accordingly. On occasions some questions were not attempted 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 cardiovascular and 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. Candidates are reminded to ensure writing is legible. If the examiner cannot read the writing, the candidate cannot be awarded marks.

SHORT ANSWER QUESTIONS – PAPERS 1 AND 2

1. Compare and contrast 0.9% saline and 4% albumin.

21% of candidates passed this question.

It was expected answers would include a comparison of the composition, physicochemical features and relevant physiology. Many candidates failed to adequately describe the differences in distribution across the body compartments or differences in physical properties of both fluids. In particular, how albumin is manufactured did not appear to be well understood by candidates.

2. Describe the consequences of mild hypothermia in the early post-operative setting.

35% of candidates passed this question.

A well organised answer would provide details on domains of physiology, pharmacology and "other", such as patient centred effects. Few answers mentioned pharmacology. Providing a definition of "mild" was often overlooked but doing so assisted a focused answer. Many answers spread beyond "mild" hypothermia or address the "causes" rather than the consequence – neither of which gained marks as they were not answering the question asked.

3. Compare and contrast renal and hepatic blood flow, and their regulation.

54% of candidates passed this question.

It was expected candidates would describe the salient features of the anatomy, distribution and content of blood flow and influences on each circulation. Answers with a clear organisation and context for the normal influences of blood flow on the functioning of each organ system scored highly. Anatomy was often sufficiently covered, but candidates often did not take advantage of that by linking the anatomical features to the functional concepts. Figures should be clearly and

accurately labelled to score well. Many answers failed to demonstrate a depth of understanding of key concepts. For example tubuloglomerular feedback, relationship between hepatic arterial and portal venous flows and autoregulation within both those systems was often poorly described.

4. What is functional residual capacity and describe how it is measured.

25% of candidates passed this question.

This question requested a definition AND a description of measurement (one method if correctly discussed could and did generate a pass mark) although additional marks were awarded if multiple measurement methods were mentioned or described. Detailed descriptions of the factors effecting FRC and its functions were NOT requested and scored no marks. "Fowlers method" uses 100% oxygen and nitrogen analysis to calculate anatomical dead space - NOT FRC - so scored no marks. Both Helium dilution and nitrogen washout (with 100%oxygen) enable calculation of FRC using C1V1=C2V2 where V2 = V1+FRC. Body plethysmography requires more complex calculations of P1V1= P2V2 (Boyles Law) applied twice = for the box and then the lung. Few candidates had a clear understanding of this method.

Most answers did not demonstrate the depth of understanding of the measurement techniques that was required to score highly.

5. Explain the oxyhaemoglobin dissociation curve and the factors that may alter it.

77% of candidates passed this question.

Marks were awarded for an appropriate curve with values, an explanation of the nature of positive cooperatively and notes on those factors causing changes in the p50 or "shifts" in the curve.

Most candidates were able to provide the required sigmoid shaped curve with appropriate key value points (p50, venous and arterial points). Better candidates were able to identify p50 as a measure of avidity or affinity for oxygen and commented on T- Tense and R- Relaxed states, the role and production of 2,3 DPG , binding to the beta chains (nature of the lack effect on foetal haemoglobin). Describing the mechanisms associated with factors shifting the curve and commenting on changes in oxygen content over the steep and flatter parts of the curves gained additional marks. Candidates are reminded to answer the question asked - no marks were awarded for a description of dissolved oxygen delivery. Some answers confused the Bohr and Haldane effects.

6. Describe the formation and the metabolic fate of lactate. Outline its role in energy production.

21% of candidates passed this question.

It was expected that the answer would include comments on lactate generation from glucose via pyruvate and the metabolic linkage of nicotinamide adenine dinucleotide (NAD). Lactate regenerates NAD^+ (pyruvate is reduced to lactate while NADH is oxidized to NAD^+). The citric acid cycle and the electron transport chain occur in the mitochondria of cells, and will only proceed in the presence of oxygen.

One molecule of glucose produces 2 ATP anaerobically (pyruvate to lactate) vs 26 aerobically (pyruvate enters TCA cycle) .Total production is about 1500 mmols/day with blood levels resting value of 1–1.5 mmol/L to a peak of 10–15 mmol/L.

Lactate can be used in 3 ways:

1. Conversion to glucose via gluconeogenesis in the liver and release back into circulation (Cori cycle). This is the fate of 80 % circulating lactate from tissues low in oxygen (e.g. exercising muscle with low pO2) or red blood cells (no mitochondria). The production from glucose in RBC's is the Embden-Meyerhoff pathway.
2. Consumed as a fuel e.g. heart (20% of circulating lactate)
3. Mitochondria and oxygen

   Oxidation back to pyruvate by well-oxygenated muscle cells, heart cells, and brain cells pyruvate is then directly used to fuel the Krebs cycle (generating 28 mmols ATP)

Lactate generation from muscle is increased with B1 mediated stimulation e.g. from adrenalin.

This topic is well covered in Power and Kam *Principles of Physiology for the Anaesthetist, 3rd Edition*, although some of the details are in several different sections.

Most candidates showed some understanding of the role of glucose in the production of pyruvate to lactate. However, the differential ATP production, the role of NADH availability and how oxygen and the role of mitochondria were involved was less well handled. Better answers described the normal generation of lactate in some tissues (e.g. RBC) and role of muscle and liver in metabolism back to glucose (Cori cycle) and the role of lactate as a metabolic substrate in some organs. Marks were awarded for normal production values and blood levels.

7. Draw and label a cross section of the lumbar epidural space (50% of marks). Describe the pharmacology of bupivacaine (50% of marks).

35% of candidates passed this question.

It was expected answers would include a diagram of a cross section and label the lumbar epidural space and the key landmarks namely dura, subarachnoid space, epidural space. Most candidates were able to give a schematic representation even if not being able to draw. Some candidates confused the subdural space with the epidural space. Pharmacology of bupivacaine needed to cover both pharmacokinetics and pharmacodynamics. Several candidates addressed only one of these components and so missed the opportunity to score marks.

8. Compare and contrast the physiological changes in the cardiovascular system in pregnancy at term and morbid obesity (BMI > 30).

2% of candidates passed this question.

The question was very specific for the cardiovascular system and therefore answers that described respiratory changes and airway modulation failed to score marks. This answer leant itself to a tabular format. Candidates are reminded to ensure they document the facts in the correct column i.e. obesity facts in the obesity column. The cardiovascular changes associated with term pregnancy are well described in various texts. Those associated with morbid obesity required some integration from various sources and would include a structured series of

comments such as heart rate (unchanged), blood pressure (tendency for hypertension), stoke volume (increased), cardiac output (increased), blood volume (increased – although perhaps decreased on a ml/kg basis), systolic function (preserved or increased), LV wall thickness increased. The pathological changes seen with the diseases associated with obesity are difficult to tease out and better answers identified this. Morbid obesity has a specific definition and stating this aided focus of the answers.

9. Describe the principles of measurement of end-tidal CO_2, including the sources of error.

19% of candidates passed this question.

Candidates were expected to be detail the principles required to measure carbon dioxide in expired gas. This would involve some comment on ways to sample end tidal gas (in line vs side stream) and also ways to measure carbon dioxide. It was expected candidates could provide a detailed description of infrared analysis including the apparatus design and principles such as the asymmetric nature of CO_2 as a polyatomic gas allowing absorption if infrared radiation with some discussion of response times and equipment design. It was expected these principles would be related to the potential errors (e.g. other gases, collision broadening).

10. Describe the pharmacology of magnesium sulphate.

27% of candidates passed this question.

The standard “pharmacology template” approach would have served well to cover this question. Answers were generally lacking in detail and focussed on extraneous physiology rather than pharmacology. Toxicity and side-effects were important to emphasise, especially in the context of infusions for treatment of asthma and/or pre-eclampsia.

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

23% of candidates passed this question.

It was expected answers would describe in detail the role of troponin, tropomyosin and calmodulin in mediating muscle contraction. Detail on the structure (histology) of the skeletal and smooth muscle cells was often lacking. Many answers omitted the mechanism of muscle relaxation.

12. Define “volume of distribution” and describe the factors that influence it.

35% of candidates passed this question.

A definition was required that included reference to plasma concentration, total body content / dose, and the theoretical nature of the volume which can exceed the physical volume of the body.

A broad answer listing patient and drug-related factors was required. Patient factors could include age, gender, muscle mass, fat mass and abnormal fluid distribution (oedema, ascites,

pleural effusion). The drug factors would include tissue binding, plasma protein binding and physicochemical properties of drug (size, charge, pKa, lipid solubility, water solubility).

13. Describe the control of alveolar ventilation.

42% of candidates passed this question.

The most comprehensive answers were those structured as sensor-controller-effector with an explanation of each part and how homeostasis was maintained. Insufficient detail was generally provided as to how central and peripheral chemoreceptors were stimulated. A description of central control was required, rather than listing nuclei or areas.

Many failed to address all three components of a control question and focused primarily on the sensors. Many answers were just too brief and did not present enough information to demonstrate understanding.

14. Describe the pharmacology of propofol.

60% of candidates passed this question.

Those candidates who did poorly lacked any structure for answering a pharmacology question. Pharmacokinetics was generally poorly handled and many answers revealed a lack of knowledge about this drug. Adverse effects and mechanism of action were generally well known. Doses of the drug were often incorrectly stated.

Important aspects such as dose or pharmacodynamics were often omitted and a structured approach helps avoid this.

15. Define cardiac preload and describe its determinants.

29% of candidates passed this question.

This question required synthesis and application of knowledge derived from multiple sources rather than regurgitation of a published list in a text. Many candidates failed to recognise that venous return is not the only determinant of preload. Most candidates failed to discuss determinants of venous return. Factors such as contractility, afterload or chamber filling and emptying can all impact preload. In addition to listing determinants the question required an explanation of their relationship with preload (e.g. the direction of change).

A discussion about the determinants of cardiac output was not asked for as did not score marks.

16. Describe ammonia metabolism and excretion (70% of marks). Outline the pharmacology of lactulose (30% of marks).

37.5% of candidates passed this question.

It was expected candidates would identify sources of ammonia (colon from metabolism of proteins, kidney, small amounts from breakdown of red blood cells and metabolism in muscles). The liver converts all circulating ammonia to urea (the urea cycle) ($2NH_3+CO_2$ = urea $+H_2O$).

Urea then undergoes enterohepatic circulation (25%) or is excreted by kidneys (75%). Ammonia (NH_3) is lipid soluble and diffuses into the interstitial cell and tubular fluid by non-ionic diffusion where is buffers H+ to become non diffusible NH_4+. No candidate mentioned enterohepatic circulation and most answers had very little detail on the metabolism and excretion and lacked depth.

Lactulose is a non absorbable synthetic, non-digestible disaccharide. It is an osmotic laxative fermented by gut flora producing metabolites (such as acetate) which have osmotic and peristalsis-stimulating effects, and methane causing in flatulence.

Few could describe how lactulose decrease absorption of ammonia and a surprising number of people did not even state that lactulose was an osmotic laxative.

17. Classify and describe the different types of data, including <u>two</u> examples of each.

33% of candidates passed this question.

Any reasonable classification was awarded marks. Standard textbooks well describe this topic, often in their opening chapter. Broadly, qualitative (defined by some characteristic) vs and quantitative (measured on some numerical scale) data exists. These can also be described as categorical or numerical with subdivisions including ordinal, interval and ratio scales. Numerical data may be described as discrete or continuous.

Appropriate examples and descriptions of each were required. For example: Categorical data - when each individual can only belong to one of a number of distinct categories of the variable.

1. Nominal – categories not ordered but simply have a name e.g. blood group (A,B, AB, O) and marital status (married, single, widowed)
2. Ordinal – categories are ordered in some way e.g. disease staging (advanced, moderate, mild) or degree of pain (severe, moderate, mild, none)

Numerical data:
When the variable takes some numerical value

1. Discrete – when the variable can only take certain whole numerical values e.g. the number of visits to GP in last year, or the number of episodes of illness.
2. Continuous – when there is no limitation on the values that the variable can take e.g. weight or height.

Understanding types of data allows appropriate description and comparison with parametric or non-parametric statistics and better answers highlighted this.

18. Describe the stages of sleep (50% of marks). Describe the respiratory physiological changes that occur in sleep (50% of marks).

29% of candidates passed this question.

Few candidates demonstrated a good knowledge of this topic. Few answers described the EEG changes associated with the stages of sleep. Respiratory changes in sleep were more commonly known though many candidates made no reference to the change in resistance associated with reduction in upper airway tone.

Confusion existed about the tidal volume changes in sleep. The question asked specifically for respiratory changes and marks were not awarded for discussion about cardiovascular or metabolic responses.

19. Describe the fibrinolytic pathway and identify areas of interaction with the coagulation pathway (80% of marks). List <u>two</u> anti-fibrinolytic agents and state their specific mechanism of action (20% of marks).

8% of candidates passed this question.

The fibrinolytic pathway is a cascade largely made up of proteolytic enzmes and other factors synthesized in the liver that circulate in inactive precursor forms. Marks were awarded for description of the principal members of the cascade and the pathway relations between them. Endothelium is also important in the fibrinolytic pathway.

Regulation of the pathway to localise the site and size of clot as well as delayed onset of action of fibrinolysis is central to any description. Regulation of fibrinolysis by the coagulation cascade and a description of this area of interaction were expected.

Many candidates provided a reasonable description of the fibrinolytic cascade. Marks were not awarded for description of the coagulation cascade that did not have relevance to fibrinolysis. Understanding of regulation of fibrinolysis and it's interaction with coagulation was poorly answered.

Most candidates were able to name two antifibrinolytic agents. Few were able to describe mechanism of action.

20. Compare and contrast the pharmacology of aspirin and clopidogrel.

46% of candidates passed this question.

Both agents are principally used as anti-platelet agents. Aspirin however has wider clinical applications. Mechanism of action of both agents involves irreversible inhibitions of enzymes and/or receptors. The inability of platelets to regenerate these means that physiological effects can not be fully explained by pharmacodynamics or pharmacokinetics alone.

Candidates who followed a traditional template for pharmacology answers scored better, providing answers that covered the breath of the topic.

21. Outline the anatomy of the diaphragm (70% of marks). Describe the function of the diaphragm in respiration (30% of marks).

27% of candidates passed this question.

The diaphragm is the principal muscle of respiration. Important and unique features of its anatomy include a central tendon that blends with the pericardium above and the fibrous capsule of the liver below, arcuate ligaments and crura that are important points of muscle insertion. There are also three major and three minor openings that allow passage of structures

between the thoracic and abdominal cavities. Candidates who had studied anatomy of the diaphragm were clearly distinguishable from those who had not.

Candidates who followed a traditional template for anatomy answers scored better, providing answers that covered the breath of the topic.

22. Describe the counter-current mechanisms in the kidney (60% of marks) and in the skin (40% of marks).

48% of candidates passed this question.

Most answers gave a good account of counter currents in the kidney but few described the generation of the counter current multiplier arrangement. Many candidates did not discuss counter current mechanisms in the skin but instead, focussed on thermal control by the skin.

23. Describe the factors that affect the partial pressure of CO_2 in mixed venous blood.

15 % of candidates passed this question.

It was expected candidates would define key concepts, particularly 'mixed venous'. Many candidates knew some of the elements that contributed to mixed venous PCO_2 but few described all of the main factors. There was little mention of tissue capillary flow as a factor affecting mixed venous CO_2.

24. Compare and contrast the pharmacology of valproic acid and carbamazepine.

6% of candidates passed this question.

Both these agents are listed as “level B” in the syllabus pharmacopeia and as such a general understanding of each class and relevant pharmacokinetics and pharmacodynamics was expected. Most candidates had better knowledge of valproate than carbamazepine. Some description of the toxicological features for intensive care practitioners was expected.

SHORT FACT QUESTIONS – PAPERS 1 AND 2

79% of candidates passed this section:

Cloze Questions	81% pass rate
Rank Questions	56% pass rate
Match Questions	92% pass rate

ORAL SECTION

VIVA 1

This Viva tested the candidates understanding of the immediate and delayed response to a modest amount of blood loss (approx 10% blood volume). Candidates were expected to describe the volume receptors, barorecepetors and renin-angiotensin system. The viva went on to consider the mechanism amd limitations of automated non-invasive blood pressure (DINAMAP) and coronary artery blood flow and its regulation.

VIVA 2

This Viva tested knowledge of respiratory physiology. It explored the understanding of the oxygen cascade and humidity.

VIVA 3

This Viva tested knowledge of cerebral physiology and related pharmacology. It explored the understanding of the cerebral blood flow and its determinants. It went on to discuss aspects of mannitol and ketamine pharmacology.

VIVA 4

This Viva tested knowledge of the physiology of calcium and related pharmacology. It explored the role of calcium on the cardiac myocyte and the bodies' regulation of calcium.

VIVA 5

This Viva tested knowledge of the structure and function of the neuromuscular junction and the pharmacology of neuromuscular blocking drugs.

VIVA 6

This Viva tested knowledge of classification and mechanisms of resistance to antibiotics. It then explored the immunology related to anaphylaxis and immunoglobulins.

VIVA 7

This Viva tested knowledge of blood gas interpretation and insulin physiology.

VIVA 8

This Viva tested knowledge of opioid pharmacology including classification and mechanism of action. It then explored pharmacodynamics and dose response curves.

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 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 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.

A/Prof Peter Kruger
Chair
CICM First Part Examination Committee

Dr David Austin
Deputy Chair
CICM First Part Examination Committee

December 2015