COLLEGE OF INTENSIVE CARE MEDICINE
OF AUSTRALIA AND NEW ZEALAND

REPORT OF THE
INTENSIVE CARE FIRST PART EXAMINATION

SEPTEMBER / NOVEMBER 2016

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:	49
Number of candidates scoring > 50% in the written:	29
Number of candidates scoring 45 – 50% in the written:	8
Number of candidates carrying a written score:	1
Total number invited to the Oral section based on written marks:	38
Total number of candidates successful at the CICM First Part:	37

SUCCESSFUL CANDIDATES

Dr Jonathan Ash
Dr Azizi Bin Azizan
Dr Chandra Balakrishnan
Dr Anup Bansal
Dr Andrew Car
Dr Mitul Chavda
Dr Sophie Connolly
Dr Gemma Dashwood
Dr Muesser Eminoglu
Dr David Gale
Dr Josephine Gard
Dr Owen Gray
Dr Tamishta Hensman
Dr Thomas Hughes
Dr Kelly Jones
Dr Ilma Khan
Dr Wenfei Kwok
Dr Alexander Lin
Dr Muhammad Manzoor
Dr Thomas McCall
Dr Sanjeev Naidu
Dr Mitchell Nolan
Dr Rohit Paliwal
Dr Rajneel Kunaal Prasad
Dr Gayathri Premkumar
Dr Sandeep Rakhra
Dr Manisha Rojha
Dr Alexander Scott
Dr Christof Slawomirski
Dr Erfana Thashneem
Dr Vladana Vukadinovic
Dr Timothy Weir
Dr Simon Wong
Dr Teresa Wong
Dr Hamish Wright
Dr Alice Young
Dr Zhiwei Stephanie Zhu

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. Candidates are encouraged to attempt all questions as even incomplete answers provide an opportunity to gain some 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, particularly of level I topics such as cardiovascular and respiratory physiology. Reading widely is strongly encouraged to gain a high level of understanding in these key areas. 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. Candidates should read the question carefully and answer the question asked as marks is only awarded for facts that answer the question.

SHORT ANSWER QUESTIONS (SAQs) – PAPERS 1 AND 2

1. Outline the distribution of calcium in normal plasma (20% of marks). Describe the hormonal control of the calcium concentration in the plasma (80% of marks).

53 % of candidates passed this question.

As stated in the question, the distribution in plasma (not body) was expected. Candidates are reminded to include units [mmol/l].
Many candidates spent considerable effort describing the roles of calcium and particularly its role in excitation contraction coupling – which was not asked and hence scored no marks.

It was expected that candidates were able to identify the roles of parathormone (PTH), 1,25 OH vitamin D and calcitonin as the major hormonal regulators. Better answers were able to describe the physiology and integration of these hormones at the gut, kidney and bone. Calcitonin and its transient and (probable) minor opposite role were also identified in these answers.
Better answers were also able to identify the permissive roles of growth hormone, cortisol and thyroxine.

2. Compare and contrast the mechanisms of action and toxicity of sodium nitroprusside and glyceryl trinitrate (GTN).

55% of candidates passed this question.

Some excellent responses to this question showed a clear understanding of the pharmacology of these agents – the differing mechanisms of action involving both involving nitric oxide. Better answers were able to use this to explain the altered vascular specificity.

Toxicity was similarly well prepared for with a good understanding of the role of cyanide in SNP and the low rates of toxicity with GTN. This question was best handled in a tabular format which minimised omissions.

Some candidates focused on pharmaceutics, indications and side effects which were not allocated any marks.

'Compare & contrast' means the similarities; differences & unique features need to be related to each other. Several candidates confused ‘nitrous oxide’ with nitric oxide.

3. Describe the factors that determine glomerular filtration rate (GFR) in the kidney (70% of marks). Outline methods by which GFR can be measured (30% of marks).

57% of candidates passed this question.

Good answers included a description of Starling forces acting at the glomerular basement membrane. A description of the local and systemic factors influencing each component was expected.

It was expected candidates would discuss autoregulation of GFR & RBF, tubuloglomerular feedback, and integrated responses the body uses to keep GFR steady.

Confusion about the nature of induced effects on afferent or efferent arteriolar dilation and constriction limited marks for some candidates. Many failed to mention the effects of mesangial surface area, Bowmans space pressure or serum protein content.

Candidates were expected to outline the methods of GFR estimation. Better responses described the rationale behind the use and limitations. Creatinine clearance, inulin and nuclear medicine techniques all scored marks. Some candidates made no attempt at this section and missed the opportunity to score marks. *Estimates* of CrCl/GFR [eGFR by formulae such as Cockcroft Gault, and serum Cr] are not *measurement* of GFR.

4. **Categorise the drugs used in the treatment of asthma, give examples and outline their mechanisms of action.**

71% of candidates passed this question.

Asthma drugs are typically categorised according to mechanism of action. A reasonable alternative is to categorise by clinical use, e.g. short acting, long acting, preventer, rescue etc.

A lot of emphasis in marking was placed on an understanding of the beta-adrenergic pathway, its secondary messenger system and how this medicates smooth muscle relaxation. Candidates whose answers had structure as well those who described the wide range of drugs used to treat asthma scored well.

5. **Describe the physiological factors that affect pulmonary arterial pressure (65% of marks). Write short notes on the use of inhaled nitric oxide as a pulmonary vasodilator (35% of marks).**

51% of candidates passed this question.

Pressure in a system is generated by the interaction between flow and resistance. A structured approach to defining and describing the many factors that influence fluid flow and resistance was required to score well. Poiseuille's law describes the determinants of resistance to laminar fluid flow and provides a useful answer structure. It is also necessary to describe factors that determine flow. This includes factors that determine venous return, as well right and left heart output.

A standard structured answer to the pharmacology of nitric oxide enabled concise and high scoring answering of this question.

6. **Describe the factors that affect airways resistance.**

47% of candidates passed this question.

Candidates who used a structured approach of using formulae that describe resistance fluid flow scored well. Poiseuille's law describes the determinates of resistance to laminar fluid flow and provides a useful answer structure. The most common mistakes were confusion between resistance and compliance as well as failure to describe turbulent as well as laminar flow.

7. **Compare and contrast the supply and demand of oxygen for the right and left ventricle.**

29% of candidates passed this question.

An integrated answer to supply and demand of oxygen was expected, as a comparison between the right and left ventricles. Many candidates concentrated on differences not similarities. Myocardial oxygen demand was in general poorly described.

About 85 - 90% of oxygen demand is for internal work (major determinants wall tension 30 - 40%, heart rate 15 - 25%, myocardial contractility 10 - 15%, basal metabolism 25%). 10 - 15% of oxygen demand for external work or pressure volume work, determined by MPAP x CO.

It was expected answers would comment on the phasic nature of coronary blood flow which differs between left and right and the consequence of this to subendocardial oxygen supply during systole usually. Coronary blood flow is affected by coronary perfusion pressure (determined by aortic pressure and RV pressure) & coronary vascular resistance (determined by autoregulation, metabolic factors, humoral factors, nervous control interacting with local endothelial factors)

Generally, coronary blood flow is tightly coupled to oxygen demand/consumption due to high basal oxygen consumption (8 - 10 ml/ min/100g) and high oxygen extraction ratio (75%). Better answers noted that oxygen supply can only be increased to cope with increased demand only by increased coronary blood flow.

8. Compare and contrast the pharmacology of ranitidine and omeprazole.

14% of candidates passed this question.

These agents are both commonly used in the ICU. The expectation was weighted towards the interesting and important aspects of pharmacology as outlined for category B drugs.
It was expected candidates could detail that both drugs are used to suppress acid secretion in the stomach. Ranitidine is a competitive, reversible inhibitor of the action of histamine at the histamine H_2 receptors found in gastric parietal cells. This results in decreased gastric acid secretion and gastric volume, and reduced hydrogen ion concentration.

In contrast to Omeprazole which is a proton pump inhibitor that irreversibly blocks the hydrogen potassium ATPase the gastric parietal cells.

Some general description of dosing, route of administration, pharmacokinetics and possible adverse effects was expected.

9. Describe the immunology and drug treatment of anaphylaxis.

32% of candidates passed this question.

It was expected candidates would detail the process of IgE mediated type I hypersensitivity reaction with some discussion of the mediators (Histamine / tryptase and others) and their consequences. Some detail describing time frame of response and the pre-exposure to Antigen (or a similar Antigen) was expected. Drug treatments would include oxygen and fluids as well as more specific agents such as adrenaline and steroids. Adrenaline is the mainstay of therapy and some comment on its haemodynamic role and prevention of ongoing mast cell degranulation was required.

Better answers noted steroids take time to work and some also discussed the role of histamine blocking agents.

10. Discuss the stages in designing a clinical trial.

12% of candidates passed this question.

An outline of the background literature review, defining the hypothesis, study design, ethics, funding, consent, conduct and follow-up was expected.
Common omissions related to details on study design e.g. minimising bias and error.
Some candidates misinterpreted the question as phases of clinical research (0-IV).

11. Compare the action potentials of a sino-atrial node cell and a myocardial cell.

75% of candidates passed this question.

A good answer included a well labelled sketch with a description of ion channels and relative directional flow. When using sketches in an answer they should be correctly labelled, and when used as a comparison with another sketch, the differences should be clear e.g. shape, duration and voltage difference.

12. Compare and contrast the pharmacokinetics and adverse effects of morphine and fentanyl.

20% of candidates passed this question.

This question is best answered in a tabular form, comparing absorption, distribution, metabolism, excretion and the adverse effects.

Common omissions were lack of details on distribution, and not relating lipid solubility to effect. A description of the relative adverse effects was expected, e.g., more histamine release, less bradycardia, rather than listing similar adverse effects, e.g. respiratory depression.

Comparisons of pharmaceutics and pharmacodynamics did not attract any additional marks.

13. Outline the anatomy and physiology of liver blood flow (60% of marks). Explain the changes to drug metabolism when liver blood flow decreases (40% of marks).

55% of candidates passed this question.

A statement regarding the quantum of hepatic blood flow with recognition of the contributions made by the Hepatic Artery and Portal Vein, drainage into the sinusoids before entering the hepatic vein which drains into the IVC would have been a good start. Discussion was then expected to revolve around how the liver blood flow is controlled. Answering this with respect to intrinsic and extrinsic factors along with an understanding of the semi-reciprocal relationship

between hepatic arterial and portal venous blood flow would have rounded out a good answer to the first part of the question.

The second part of the question required recognition that hepatic clearance is the product of hepatic blood flow and the hepatic extraction ratio and considering the impact on drugs with a high or a low extraction ratio.

Many answers failed to adequately mention how hepatic blood flow was controlled/regulated thus limiting the marks available. Similarly, in the second part of the question, many candidates spent considerable time mentioning the principals of drug metabolism rather than focusing on the question asked.

The concept of hepatic drug clearance as the product of blood flow and its extraction ratio was poorly appreciated.

14. Describe the features of a red blood cell that facilitate oxygen transport.

33% of candidates passed this question.

This question was best answered by considering form and then function. Detailing red cell size, that it is a biconcave disc, contains haemoglobin A (Hb F in-utero), has a central Fe moiety and demonstrates positive cooperativity in binding oxygen would be a good start. Additionally, noting that the RBC has a flexible membrane with shape maintained by structural proteins and that it lacks a nucleus, organelles and mitochondria, but contains carbonic anhydrase would pass this question.

A complete answer would mention the3 shunts that come off the anaerobic glycolytic pathway (RBC's only means of ATP generation), namely the production of 2-3 DPG via the Rapoport-Luebering shunt, generation of NADPH by the hexose monophosphate shunt (protects RBC from oxidative damage) and the reduction of metHb back to Hb by way of the NADH.

Many answers lacked sufficient information to pass this question.

Many answers included lengthy discussions about the production of RBC's, the Oxy-haemoglobin dissociation curve or calculated the oxygen content of blood. RBC metabolic adaptations (e.g. 2, 3-DPG, NADPH production by the HMP shunt/ G6phosphatase to regenerate glutathione and metHb reductase) were rarely mentioned, as were vasodilatory mediators released by RBCs.

15. Compare and contrast the pharmacology of noradrenaline and dobutamine.

84% of candidates passed this question.

The best answers used tables and key pharmacological headings for comparisons, and avoided long sentences/ paragraphs.

An answer that correctly considered the following sections would be awarded a very good pass: Presentation, pharmacodynamics, mechanism of action, organ effects, side effects and pharmacokinetics.

Many candidates failed to identify agents as natural / synthetic catecholamines.

Few answers correctly mentioned the available preparations of these drugs or considered the structure activity relationships. Only 3 candidates commented that dobutamine is a racemic mixture.

Intracellular second messenger pathways were often incorrectly recounted or not mentioned at all. Pharmacodynamic effects on all organ systems, and all CVS parameters (HR, inotropy, PVR, SVR, SBP/DBP/MAP, regional circulations) should be considered. Metabolic fate and clinical dosage ranges were frequently incorrectly quoted.

16. Outline the influence of pregnancy on pharmacokinetics.

47 % of candidates passed this question.

Most candidates divided the answer into effects on absorption, distribution, metabolism and elimination, which is a good way of presenting the answer. However, the good candidates also mentioned effects on the foetus due to ion trapping caused by the more acidic foetal blood.

Many candidates forgot to include effect on epidural administration of drugs in pregnancy caused by engorged epidural veins during labour.

Candidates lost marks for omitting the effect of increased cardiac output on the rate of distribution of IV drugs to effector sites, the effect of increased hepatic blood flow on drugs with high intrinsic clearance, the increased clearance of drugs with renal clearance due to increased GFR & renal plasma flow.

17. Draw a labelled diagram of both the aortic root and radial artery pressure waveforms in a young adult using the same axis (60% of marks). Explain the factors that account for the differences between these two waveforms (40% of marks).

41% of candidates passed this question.

A well labelled diagram drawn clearly to demonstrate the salient features of the aortic and radial arterial pulses was expected. This would include the different systolic pressure, the absence of a dicrotic notch in the radial pulse (instead a diastolic hump), the narrowness and the delay of the radial pulse, garnered many marks.

Marks were lost for insufficient explanation such as the distance needed to travel for the pressure wave accounting for the delay, the sharper rise and decline of the radial pulse due to loss of the WIndkessel effect and the different compliance and the loss of the dicrotic notch due to summation and damping out of high frequency components of the pressure wave.

18. Discuss the determinants of intracranial pressure (80% of marks). Outline how it can be measured (20% of marks).

55% of candidates passed this question.

It was expected answers would include an explanation of the Monro-Kellie Doctrine. Many candidates gave insufficient details of compensatory mechanisms especially regarding decreased total cerebral blood volume (primarily venous) in response to increased intracranial pressure.

Most candidates had all the information but had difficulty synthesising the information to write a cohesive answer. Factors affecting ICP could be divided into factors affecting CBV, factors affecting CSF and factors affecting brain tissue. Under factors affecting CBV the effect of blood gases, autoregulation, temperature, metabolism, drugs and venous obstruction could have been detailed.

19. Describe how Starling forces determine fluid flux within the pulmonary capillary bed.

25% of candidates passed this question.

The equations for nett fluid flux and for nett filtration pressure were incorrect in many answers.

Better answers presented the equations and discussed each of the elements as relevant to the pulmonary capillary bed, including difference from systemic capillary beds.

Mention of the role of lymphatics and of the effect of surfactant, left atrial pressure, gravity and posture gained marks, also.

20. Describe the mechanisms by which heat is lost from the body (40% of marks). Discuss the importance of each of these in a sedated and intubated adult patient (60% of marks).

59% of candidates passed this question.

A satisfactory answer required use of terms radiation, convection, conduction etc. in the manner defined in the texts, rather than the layman's use of the terms. Better answers displayed understanding of the meaning, relative importance and mechanism of methods of heat loss.

The second part of the question required application of these concepts in patients with artificial airway and sedatives, particularly change in control of vascular tone and voluntary behavioural control.

21. Classify anti-arrhythmic drugs by mechanism of action, giving examples of each (75% of marks). Describe the electrophysiological and ECG effects of sotalol (25% of marks).

88% of candidates passed this question.

Most answers displayed a good knowledge of the Vaughan Williams classification, classes I to IV and the relevant electrophysiological characteristics of the classes.

Answers should also have included mention of other antiarrhythmics, such as digoxin, magnesium and adenosine. The second part of the question required comment about K ion blockade and its effects. It was helpful to mention prolongation of QT and risk of torsade. Most answers omitted reference to its being a racemic mixture, with different actions of the isomers.

22. Outline the physiological factors that affect the diffusion of oxygen and carbon dioxide within the lung.

43% of candidates passed this question.

Good answers to this question were those that included a definition of diffusion; an outline of Fick's Law of Diffusion and then a further description how each of the variables in the this Law affect the diffusion of oxygen and carbon dioxide in the lung; and an outline of the other factors that affect diffusion not covered by the above. Most candidates included Fick's Law in their answers and at least briefly expanded on the associated variables.

Few candidates defined the process of diffusion. The other common omissions were the factors that affect diffusion that aren't directly encompassed in Fick's Law, such as cardiac output, capillary transit time, carbonic anhydrase (conversion of HCO_3 to CO_2) and combination of oxygen with haemoglobin.

23. Compare and contrast the mechanism of action, spectrum of activity and adverse effects of benzyl penicillin and fluconazole.

8% of candidates passed this question.

To pass this question each of the three components needed to be compared and contrasted for ***both*** agents. A tabulated answer helped in this regard but was not essential.
Some answers included information that could not gain marks, as it was not directly relevant to the question asked (e.g. presentation and dose).

In spectrum of activity, as well as what important organisms the agents were effective against, marks were also given for the important organisms that they were ***not*** effective against (e.g. MRSA and beta-lactamase producing organisms for penicillin G; and aspergillus for fluconazole).

In general, of the two agents, fluconazole was the least well answered. For example, a common omission either in mechanism of action or in adverse effects was that fluconazole inhibits microsomal P450 enzymes.

Some candidates confused fluoroquinalone with fluconazole.

24. Outline the tracheal (60% of marks) and left and right main bronchial anatomy (40% of marks) in an adult.

14 % of candidates passed this question.

To pass this question, the following were required for each section (*trachea* and *main bronchi*): landmarks; basic structural anatomy; and important relations (major vessels; major nerves; major structures).

Marks were also allocated for innervation, and blood supply and venous drainage of the trachea.

Most unsuccessful answers did not address a number of these areas. Overall, the answers were better for tracheal anatomy compared to bronchial anatomy.

A structured approach to anatomy questions works well and this was again the case (i.e. relations / blood supply / etc.

SHORT FACT QUESTIONS (SFQs) – PAPERS 1 AND 2

98% of candidates passed this section with an average mark of 72%.

Cloze Questions	98% pass rate
Rank Questions	90% pass rate
Match Questions	100% pass rate

ORAL SECTION

DAY 1

Viva 1

This viva tested knowledge of neuromuscular blocking drug pharmacology and physiology of the deep tendon reflex.

Viva 2

This viva tested knowledge related to cholinergic receptors. The pharmacology of Atropine was specifically discussed. The second part of the viva discussed the pharmacology of propofol including rationale for its use in ICU, contents of the ampoule and adverse effects.

Viva 3

This viva discussed cardiovascular physiology including measurement of cardiac output, the Valsalva manoeuvre and alterations with acute blood loss.

Viva 4

This viva tested knowledge of the measurement of arterial blood pressure and the pharmacology of beta blocking drugs.

Viva 5

This viva covered cerebral physiology and related pharmacology including factors that influence cerebral blood flow and the related pharmacology of propofol and ketamine.

Viva 6

This viva tested knowledge of physical principles around flow and viscosity. It went on to look at the venous anatomy of the upper limb and chest and in vivo blood clotting.

Viva 7

This viva tested knowledge of respiratory physiology including lung volumes and changes with obesity. It then went on to discuss physiology of the lower oesophageal sphincter and gastric emptying .It went to cover the pharmacology of metoclopramide.

Viva 8

This viva tested knowledge of physiology related to renal clearance and the pharmacology of diuretic agents.

DAY 2

Viva 1

This viva tested knowledge of dose response curves and Neuromuscular blocking drug pharmacology

Viva 2

This viva discussed humidity, oxygen measurement and concepts around partial pressure.

Viva 3

This viva tested knowledge of intravenous fluid physiology and pharmacology and concepts of osmolarity, osmolality and tonicity.

Viva 4

This viva tested knowledge of newborn physiology including the transitional circulation, temperature regulation and respiratory physiology. It went on to discuss principles of ultrasounds and central venous pressure measurement.

Viva 5

This viva tested knowledge of the renal handling of water and pharmacology of antihypertensive drug, in particular those the interact with the renin/ angiotensin system.

Viva 6

This viva tested knowledge of physiology around glucose utilization and the pharmacology of insulin.

Viva 7

This viva tested knowledge of blood grouping and cross match and went on to the events involved in blood clotting and some aspects of anticoagulant pharmacology.

Viva 8

This viva tested knowledge on pulse oximetry the physiology related to hypoxia and hypoxaemia.

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 reminded to spend time on all aspects of the syllabus. Examiners noted in this sitting some candidates seemed less well prepared on pharmacology topics. Physiology and pharmacology topics are represented across the examination and questions may appear on topics or drugs from any of the levels of understanding.

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 First Part 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
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December 2016