COLLEGE OF INTENSIVE CARE MEDICINE
OF AUSTRALIA AND NEW ZEALAND

REPORT OF THE
INTENSIVE CARE FIRST PART EXAMINATION

AUGUST / OCTOBER 2019

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 our 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

Total number of candidates presenting for the written examination:	83
Number of candidates scoring ≥ 50% in the written:	46
Number of candidates scoring 45 – 50% in the written:	1
Number of candidates carrying a written score:	1
Total number invited to the oral section based on written marks:	48
Total number of candidates successful at the CICM First Part Exam:	48

SUCCESSFUL CANDIDATES

Dr Ahmed Abdelsalam
Dr Ali Alobaidy
Dr Renju Cherian
Dr Alexandre David
Dr Martin de Bakker
Dr Nilesh Anand Devanand
Dr Shilpa Reynal Dsa
Dr Zachary Durkin
Dr Marwan Elmenyawi
Dr Malcom Foxcroft
Dr Benjamin Gardiner
Dr Demi Gray
Dr Matthew Guest
Dr Samuel Hewitson
Dr Karthic Jayanthi Chinnaiya
Dr Xiao Jiang
Dr Jeffrey Kam
Dr Suhaila Kamrani
Dr Vishnu Kurup
Dr Matthew Laraghy
Dr Luke Lau
Dr Bruce Lavarack
Dr Christopher Lee
Dr Phoebe Lepper
Dr Hoi Ki Katy Li
Dr Latifa Mah
Dr Jarrard Martland
Dr David McNeil
Dr Thomas Melhuish
Dr Brigitte Mol
Dr Lewis Mullens
Dr Sukey Pan
Dr Ivor Popovich
Dr Christopher Pryke
Dr Jarrod Rawson
Dr Mark Rowland
Dr Michael Russell
Dr Kris Salaveria
Dr Christina Hiu Yi So
Dr Kate Speakman
Dr Yaodong Tang
Dr Martin Thomas
Dr George Townsend
Dr Alexandra van Rijn
Dr Anumeha Verma
Dr Humphrey Walker
Dr Jeremy Weiss
Dr Alexander Zehnwirth

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.

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

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 physiological consequences of the oral ingestion of 1 litre of water in a young adult.

28% of candidates passed this question.

It was expected candidates would provide details the consequences of water ingestion from its rapid absorption in the small intestine to the resultant impact on plasma osmolarity and the minimal impact of plasma volume of this volume. Some detail on the mechanisms of absorption (transcellular vs osmosis) was expected and the distribution of water across body fluid spaces. Many candidates accurately described the small drop in plasma osmolarity that is sufficient to trigger osmoreceptors with better answers providing details of the locations and mechanisms involved. The physiological consequences of inhibition of ADH, including the renal effects of decreased water permeability in distal renal tubules and collecting ducts. The volume load after distribution would be lower than the plasma volume triggers for the circulatory reflex responses.

2. Describe renal blood flow and its regulation (80% of marks). Outline the impact of adrenoreceptor agonists on renal blood flow (20% of marks).

64% of candidates passed this question.

This question was well answered by most candidates. The description of renal flow involves a brief comment of the anatomy including interlobar, arcuate, interlobular arteries, then afferent and efferent arterioles – 2 sets of capillaries and then corresponding veins and better answers made the distinction better cortical and medullary flow and went on to detail the consequence of this. Renal blood flow is autoregulated and most candidates describe well the various mechanisms around myogenic and tubuloglomerular feedback. Additional marks were gained with by discussing renal vascular resistance and how this may be varied. The impact of adrenoreceptor agonists is varied but generally sympathomimetic agents will vasoconstrict and therefore increase renovascular resistance and result in a decrease renal blood flow. The relative impact on afferent vs efferent arteriolar tone may alter glomerular perfusion pressure.

3. Describe the relationship between muscle length and tension (50% of marks). Outline the physiologic significance of this relationship in cardiac muscle (50% of marks).

41% of candidates passed this question.

Some detail was expected on a general description that tension is variable with the length of muscle. It was expected answers would describe that there is a resting length at which tension developed on stimulation is maximal. Many candidates omitted that differences exist between muscle types with smooth muscle behaving differently. Additional credit was given for the distinction about active tension vs resting tension. It was expected a description of the potential mechanism would be included with discussion of sliding filament theory, overlapping fibres and optimal sarcomere length. Some candidates utilised a diagram effectively to convey understanding and more detail was rewarded with additional marks.

The second half of the question involved describing how this relationship is particularly important in cardiac muscle and underpins the Frank Starling relationship and all the cardiac physiology that follows. Initial length of fibres is determined by the diastolic filling of the heart, so pressure developed is proportionate to the total tension developed. The developed tension increases as diastolic volume increases to a maximum (the concept of Heterometric regulation). Better answers appreciated that the physiology may be different for a while heart rather than isolated muscle fibres.

4. Outline the pharmacology of intravenously administered magnesium sulphate.

55% of candidates passed this question.

Overall answers were well structured. However, a lack of detail and inaccurate pharmacokinetics was common. Better answers included a discussion of the mechanism of action of Mg++ including Ca++ antagonism, presynaptic cholinergic effects and NMDA receptor antagonism. Adverse effects were not discussed in detail by many candidates and contraindications were commonly omitted.

5. Describe the anatomical course and relations of the trachea and bronchial tree (to the level of the segmental bronchi).

24% of candidates passed this question.

Better answers included details of the significant structures related to the cervical and mediastinal trachea and bronchi. The lobar branches and bronchopulmonary segments requiring naming to attract full marks. Many answers lacked sufficient detail or contained inaccuracies regarding vertebral levels and key structural relations. Some candidates discussed the general anatomy of the airway, including the larynx, structure of the airways, blood supply and innervation. This did not attract marks.

6. Outline the factors that determine central venous pressure and explain how it is measured.

18% of candidates passed this question.

It was expected that answers include central venous blood volume, central venous vascular compliance, intrathoracic pressure and tricuspid valvular function. Good answers outlined how each of these factors determine CVP and whether it was increased or decreased. Many candidates incorrectly described the effect of venous return.

7. Define closing capacity (10% of marks). Describe the factors that alter it (30% of marks), its clinical significance (30% of marks) and one method of measuring it (30% of marks).

49% of candidates passed this question.

Many candidates confused the factors that affect closing capacity (CC) with factors which affect functional residual capacity (FRC). Some candidates confused airway closure with expiratory flow limitation secondary to dynamic airway compression.

A good answer would have included the following:

Small airway closure occurs because the elastic recoil of the lung overcomes the negative intrapleural pressure keeping the airway open. Thus, airway closure is more likely to occur in dependant parts of the lung where airways are smaller. Normally closing capacity is less than FRC in young adults but increases with age. Closing capacity becomes equal to FRC at age 44 in the supine position and equal to FRC at age 66 in the erect position. Closing capacity is increased in neonates because of their highly compliant chest wall and reduced ability to maintain negative intrathoracic pressures. In addition, neonates have lower lung compliance which favours alveolar closure. Closing capacity is also increased in subjects with peripheral airways disease due to the loss of radial traction keeping small airways open.

The consequences of airway closure during tidal breathing include shunt and hypoxaemia, gas trapping and reduced lung compliance. In addition, cyclic closure and opening of peripheral airways may result in injury to both alveoli and bronchioles. Closing volume (CV) may be measured by the single breath nitrogen washout test or by analysis of a tracer gas such as xenon during a slow exhaled vital capacity breath to residual volume. Residual volume (RV) cannot be measured directly but is calculated as follows: the FRC is measured using one of three methods: helium dilution, nitrogen washout or body plethysmography. The expiratory reserve volume (ERV) may be measured using standard spirometry. Using the measured FRC and ERV we may calculate RV from the equation:

RV = FRC – ERV. Then CC = RV + CV.

8. Outline the pharmacology of drugs used to treat asthma.

29% of candidates passed this question.

Answers should have included the most important aspects of the pharmacology of the most commonly used drugs e.g. class, mechanism of action, pharmacodynamics and important adverse reactions. More information on beta-agonists and corticosteroids (mainstays of management) was expected than drugs like magnesium, ketamine and other adjunctive treatments.

9. Compare and contrast the pharmacology of propofol and midazolam.

77% of candidates passed this question.

Highlighting important similarities and differences between the drugs scored higher marks than listing the pharmacology of each drug separately. More pharmacokinetic information was required than simply stating both drugs “are metabolized in the liver and excreted by the kidney”.

10. Describe the principles of capnography, including calibration, sources of error and limitations.

31% of candidates passed this question.

Answers that scored well followed the structure outlined in the question and explained the principles of each component of the question.

11. Outline the composition of plasma (50% of marks). Describe the functions of albumin (50% of marks).

30% of candidates passed this question.

A good answer began with a definition of plasma and then listed the components - water, albumin, globulins, fibrinogen and other proteins before mentioning the lipid content, nutrient content, wastes and electrolytes. Frequently the breakdown of the globulin component was inaccurate. A common omission was dissolved gas components. Descriptions of the calculation of oncotic pressure and GFR were not asked and hence did not attract marks.

The functions of albumin may be subdivided into: Osmotic pressure, transport function, acid-base buffer, anti-oxidant, anticoagulant effect, protein store, metabolism and 'other'.

12. Define pain. Outline the processes by which pain is detected in response to a peripheral noxious stimulus.

33% of candidates passed this question.

Starting with the WHO definition of pain, followed by a brief description of the nature of noxious stimuli (thermal, mechanical, chemical) then proceeding to mention the nature of the cutaneous receptors would have been a very good start to this question. Following this, a description of the various substances involved in pain (K, prostaglandins, bradykinin, serotonin, substance P) and outlining the types of nerve fibres involved in pain transmission and how they synapse in the spinal cord and cortex was expected. The presence and nature of the descending inhibitory pathways was mentioned by very few.

13. Describe the exocrine functions of the pancreas.

33% of candidates passed this question.

Most candidates were able to mention some pancreatic enzymes, though often in insufficient detail to attract full marks. The amount, type, pH, etc. of pancreatic secretions was often not included. Many candidates did not describe the stimuli for pancreatic secretion. Better answers described the cephalic, gastric and intestinal phases of pancreatic secretion.

14. Outline the classification and effects of beta-blocking drugs with examples (505 of marks). Compare and contrast the pharmacokinetics of metoprolol with esmolol (50% of marks).

47% of candidates passed this question.

Beta-blocking drugs were generally well classified. Selectivity, membrane stabilising activity and ISA should have been mentioned. Many candidates omitted or poorly answered the ‘effects’ of

beta blockers. Candidates who performed well answering the pharmacokinetics of metoprolol and esmolol provided a table of the two drugs. Superficial statements such as “hepatic metabolism and renal excretion” attracted minimal marks. The mechanism of action of beta blockers was not requested.

15. Define clearance and hepatic extraction ratio (30% of marks). Describe the role of the liver in drug clearance with examples (70% of marks).

70% of candidates passed this question.

Clearance was generally well answered.

It is the volume of plasma cleared of a drug per unit time, not the mass of drug cleared. An equation was helpful in identifying the relevant components of hepatic clearance.

$Cl_{Hep}=Q_H$ X ER_{Hep}
ER_{Hep}= FU x Cl_{Int} / Q_H + FU x Cl_{Int}

Q_H = hepatic blood flow
ER_{Hep} = hepatic extraction ratio
FU = fraction of drug unbound in plasma
Cl_{Int} = hepatic enzymatic capacity

Many candidates did not describe the effects of hepatic blood flow and intrinsic clearance on drugs with high and low hepatic extraction ratios. Some discussion of Phase I and II reactions was also expected.

16. Compare the structure, function and coronary circulation of the right and left ventricles.

27% of candidates passed this question.

The question sought information on the structure (anatomy), function (physiology) and vascular supply of the right and left ventricle. Good answers provided detail in each section e.g. values for ventricular pressure rather than simply stating “high- and low-pressure systems”.

Many marks may be gained by a simple anatomical description & labelled PV loop for each ventricle. Many candidates focussed solely on the coronary circulation, to which only a proportion of the marks were allocated.

17. Explain respiratory compliance and outline the factors that affect it.

51% of candidates passed this question.

Answers were generally well structured. Better answers described lung and chest wall compliance and the pressures which are used to calculate compliance. Better answers displayed an understanding of dynamic, static and specific compliance and provided a reasonably comprehensive list of the physiological factors affecting chest and lung compliance.

18. Compare and contrast the pharmacology of metaraminol and noradrenaline.

71% of candidates passed this question.

Marks were distributed across pharmaceutics, uses, dose & administration, mechanism of action, Pharmacokinetcs and Pharmacodynamics. Common omissions were doses/rates of infusion, effects other than on heart/SVR (e.g. splanchnic, renal blood flow), indirect effect of metaraminol, receptor effect of noradrenaline other than alpha 1 and tachyphylaxis.

19. SAQ 19 Describe the pharmacology of atropine.

53% of candidates passed this question.

Most candidates used a good structure to compose their answer. Better candidates understood that CNS effects occur as atropine is a tertiary amine that crosses the blood brain barrier. The mechanism of action was required. Indications for use should have included bradycardia, organophosphate poisoning, drying of secretions etc. Reasonably extensive details regarding pharmacodynamics was expected, including potential toxic effects. There was limited knowledge regarding pharmacokinetics.

20. Compare the pharmacology of piperacillin-tazobactam and ciprofloxacin.

58% of candidates passed this question.

This question was most effectively answered using a tabular format. Only a minority of candidates demonstrated a comprehensive knowledge of these level 1 drugs and very few candidates compared the two in areas which lent themselves to comparison. The spectrum of activity generally lacked detail. Few candidates mentioned that piperacillin-tazobactam had superior gram-positive cover, both have extensive gram-negative cover including Pseudomonas. Piperacillin-tazobactam is effective against anaerobes; whilst ciprofloxacin has some atypical cover against Mycoplasma.

The mechanism of action was generally well described for piperacillin; many candidates incorrectly stated the mechanism of action for ciprofloxacin, confusing the drug with a macrolide. Better answers included time- dependant and concentration-dependent killing. The concept of half-life was frequently confused with the dosing interval.

Minimal marks were awarded for “allergy” and “gastrointestinal side-effects”. Better candidates mentioned Liver function derangement, neutropenia, interstitial nephritis for piperacillin and tendonitis for ciprofloxacin.

MULTIPLE CHOICE QUESTIONS – PAPERS 1 AND 2

96% of candidates passed overall:

Paper 1	98% pass rate
Paper 2	96% pass rate

ORAL SECTION

DAY 1

VIVA 1

This viva will test your knowledge of the autonomic nervous system.

Briefly describe the autonomic nervous system using the diagram.

(Image removed from report.)

95% of candidates passed this question.

VIVA 2

This viva will explore the rate of administration on pharmacodynamics of sedative drugs.

Would you anticipate a different response to an IV bolus of 100 mg of propofol versus a slow infusion of the same dose over 5 minutes?

85% of candidates passed this question.

VIVA 3

This viva will test your knowledge of cerebral blood flow.

90% of candidates passed this question.

VIVA 4

This viva will explore your understanding of acid base balance.

What is the anion gap?

100% of candidates passed this question.

VIVA 5

This viva will test your knowledge of drug action.

With regards to the action of a drug, what does this graph tell us?

(Image removed from report.)

85% of candidates passed this question.

VIVA 6

This viva will test your understanding of glucose metabolism.

Describe how glucose is moved from the intestinal lumen to the blood.

90% of candidates passed this question.

VIVA 7

This viva will test your knowledge of the liver.

Describe the blood supply of the liver.

90% of candidates passed this question.

VIVA 8

This viva will test your knowledge of metabolism and thyroid hormone.

Define basal metabolic rate.

95% of candidates passed this question.

DAY 2

VIVA 1

This viva will explore your knowledge of renal physiology and diuretics.

Describe how sodium is handled in the nephron.

100% of candidates passed this question.

VIVA 2

This viva will test your knowledge on acid-base physiology.

Describe the buffer systems.

65% of candidates passed this question.

VIVA 3

This viva will explore opioid pharmacology.

In what parts of the body do opioids act?

95% of candidates passed this question.

VIVA 4

This viva will explore your understanding of basic pharmacology and oxygen.

Why are dose-response curves often represented on “Log[dose]” scales?

95% of candidates passed this question.

VIVA 5

This viva will initially test your knowledge on structure-activity relationships.

Can you name this chemical compound?

(Image removed from report.)

80% of candidates passed this question.

VIVA 6

This viva will examine your understanding of arterial blood gases and carbon dioxide.

Interpret this arterial blood gas.

pH	7.27
pCO_2	55 mmHg (7.3 kPa)
pO_2	144 mmHg (19.1 kPa)
HCO_3	24 mmol/L
BE	1 mEq/L

100% of candidates passed this question.

VIVA 7

This viva will assess your knowledge of the central nervous system.

Describe the Monro-Kellie doctrine.

100% of candidates passed this question.

VIVA 8

This viva will test your knowledge of cardiovascular physiology and oxygen.

Explain the mechanical events shown in the left ventricular pressure-volume loop below:

(Image removed from report.)

100% of candidates passed this question.

DAY 3

VIVA 1

This viva will test your knowledge of the pharmacology of neuromuscular blocking drugs, and local anaesthetics.

100% of candidates passed this question.

VIVA 2

This viva will explore the pharmacology of resuscitation fluids.

What is the effect of the infusion of 5 litres of normal saline on Acid-Base in-vivo?

100% of candidates passed this question.

VIVA 3

This viva will explore hypoxia.

Interpret this arterial blood gas.

Patient is breathing O_2 at 6 litres/minute via a Hudson mask.

pH	7.50
PaO_2	55 mmHg
$PaCO_2$	30 mmHg
HCO_3^-	22 mmol/L
BE	-2

100% of candidates passed this question.

VIVA 4

This viva will explore your understanding of anticoagulation and arterial pressure.

Describe the physiology of coagulation after tissue trauma.

100% of candidates passed this question.

VIVA 5

This viva will test your knowledge on contractility.

Define contractility as it relates to cardiac function.

63% of candidates passed this question.

VIVA 6

This viva will test your knowledge of potassium.

How is total body potassium regulated?

88% of candidates passed this question.

VIVA 7

This viva will assess your knowledge of pulmonary physiology.

This is spirometry from a young adult during a vital capacity breath.

Can you describe the volumes and capacities?

(Image removed from report.)

100% of candidates passed this question.

VIVA 8

This viva will test your knowledge of renal physiology.

What are the functions of the kidney?

100% 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 based on 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.

This is a challenging exam; however, the pass rate was excellent once candidates achieved a sufficient mark to attend the vivas.

Candidates must allow sufficient time to prepare (typically approximately 1000 hours or 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.

A/Prof David Austin
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Dr Roslyn Purcell
Deputy Chair
CICM First Part Examination Committee

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