COLLEGE OF INTENSIVE CARE MEDICINE
OF AUSTRALIA AND NEW ZEALAND

REPORT OF THE
INTENSIVE CARE PRIMARY EXAMINATION

MARCH / MAY 2012

This report is prepared to provide candidates, tutors and their supervisors of training with information about the way in which the Examiners assessed the performance of candidates in 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 sit 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:	10
Number of candidates scoring >50% in the written:	3
Number of candidates scoring 45-50% in the written:	3
Number of candidates carrying a written score:	0
Total number invited to the Oral section based on written marks:	6
Total number of candidates successful at the CICM Primary:	6

Successful candidates:

Dr Christopher Ross Andersen
Dr Binila Chacko
Dr Siddharth Goswami
Dr Alice Claire Henschke
Dr Anil Ramnani
Dr April Win

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WRITTEN SECTION

SAQ PAPER 1

1. Outline the physiological detection and response to an acute decrease in PaO_2

Candidates were expected to focus on the physiology (including mechanisms) involved with detection of hypoxia (e.g. peripheral chemoreceptor stimulation) as well as response. Examples of response included sympathetic stimulation, the respiratory centre and organ specific (e.g. cardiac, CNS, blood, cellular, etc) responses. This topic is well covered within a number of fundamental texts, in particular, Nunn's Respiratory Physiology. In general candidates' answers were not "broad" enough, lacked detail and were too focused on chemoreceptors only.

0 (0%) of candidates passed.

2. Outline the physiological consequences of therapeutic hypothermia at 32 degrees Celsius

It is well documented and often stressed that the Primary Exam is focused upon the basic sciences that underpin clinical Intensive Care. It will examine a candidates understanding of, for example, the physiology associated with a clinical circumstance. Many candidates discussed *why* we use therapeutic hypothermia after cardiac arrest rather than outline the physiological consequences of hypothermia at 32 degrees Celsius, for which they would not have scored any marks. A good answer was expected to outline changes in metabolism as well as specific organ responses such as cardiovascular (e.g. bradycardia; vasoconstriction; decreased cardiac output, etc), respiratory (decreased minute volume; haemoglobin-oxygen dissociation curve moves left; increased anatomical dead space; diminished HPV; increased pulmonary vascular resistance, etc), renal (e.g. diuresis, changes to GFR, etc) as well as other organs. Again candidates failed to synthesize a coherent and detailed answer.

0 (0%) of candidates passed.

3. Describe the pharmacology of phenytoin

Many candidates scored well in this question by using a standardised approach such as: Pharmacoceutics, Pharmacokinetics and Pharmacodynamics. This topic is well covered in the reference texts and a high degree of content was expected.

6 (60%) of candidates passed.

4. Describe the factors that affect the flux of potassium across the cell membrane

Candidates were required to synthesize knowledge across a number of areas and have a good overview of the topic. This included the following - Insulin (acts to up-regulate Na/K ATPase activity promoting intracellular shift of potassium in adipose and muscle tissue); catecholamines (beta2 stimulation up-regulates Na/K ATPase activity promoting intracellular shift of potassium); aldosterone; pH (acidosis promotes H^+/K^+ exchange (via H^+/K^+ antiport), and reduces the activity of the Na K ATPase pump); osmolality (cellular dehydration increases intracellular K+ concentration promoting diffusion of potassium out of the cells); exercise; plasma potassium; temperature.

0 (0%) of candidates passed.

5. Compare and contrast the pharmacology of dexmedetomidine and propofol.

A basic and fundamental pharmacology question which required candidates to present their answer in a coherent fashion (a table worked best) as well as demonstrate sufficient knowledge. The majority of candidates did so, and so scored well. Candidates tended to struggle with the pharmacokinetic properties of these drugs.

7 (70%) of candidates passed.

6. Describe the carriage of carbon dioxide (CO_2) in blood

For a good answer candidates were expected to mention values for CO2 content in blood as well as the various ways it is carried (e.g. dissolved, as bicarbonate, combined with haemoglobin, etc) and a description of these modes. Wherever possible candidates are encouraged to illustrate their answer, in particular if those illustrations are core knowledge. Candidates who didn't, were not penalised if they were still able to provide the required responses. However, candidates who did appeared to better synthesize a response. Candidates are reminded to include, and know, what are the appropriate units for any values they mention.

8 (80%) of candidates passed.

7. Compare and contrast the characteristics of B and T lymphocytes.

A structured response was required for this question. Candidates were expected to mention the origin of the cells, sites of differentiation (foetal liver, lymph nodes, bone marrow in early childhood for T lymphocytes and thymus for B lymphocytes), antigen receptors and what they bind with (highly specific IgM surface antibodies that bind with extracellualr antigens for T lymphocytes and surface receptors that bind to antigen presenting cells for B

lymphocytes), type of activation cell, type of immunity (humoral for T lymphocytes, cell mediated for B lymphocytes), their functions and life span (T lymphocytes much shorter than B lymphocytes. Although some candidates found this question challenging, of those who passed it, most achieved a high score.

4 (40%) of candidates passed.

8. Compare and contrast adrenaline and levosimendan

A basic and fundamental question which required candidates to present their answer in a coherent fashion (a table worked best), as well as demonstrate sufficient knowledge. The majority of candidates did so, and so scored well. Candidates tended to struggle most with levosimendan. Candidates also confused the use of the terms “elimination” and “metabolism”, often using them interchangeably.

6 (60%) of candidates passed.

9. Describe the changes to cardiovascular physiology in a healthy elderly person.

It is clearly stipulated in the syllabus that candidates would be expected to understand physiology as it applies at the extremes of age. In the past, questions have been asked relating to foetal and neonatal physiology as well as for the elderly. This question was poorly answered as candidates lacked a detailed and coherent knowledge of this topic. For a good answer candidates were expected to at least mention the effects on the heart, e.g. increases in size due to concentric ventricular hypertrophy (LVH), hypertrophy of myocytes but a decrease in the number of myocytes, cardiac output decreases, the increase in cardiac output in response to severe exertion is attenuated, ventricular filling is particularly dependent on diastolic relaxation which is impaired, greater contribution of atrial contraction, increase in left ventricular afterload, effects on vasculature, e.g. intima and media thickening result in less distensibility, effects on endothelial function, e.g. nitric oxide release is decreased, effects upon autonomic and integrated responses, e.g. decline in receptor numbers, down regulation of post-receptor signalling and decreased receptor density and impaired baroreceptor reflexes.

1 (10%) of candidates passed.

10. Describe the anatomy of the neck and trachea relevant to the insertion of a tracheostomy

For a good answer candidates were expected to mention surface anatomy of the anterior of the neck from the superior to inferior aspects (e.g. hyoid bone, thyroid cartilage, cricothyroid

ligament, cricoid cartilage and thyroid gland with sternohyoid muscle just lateral to the midline structures, the pathway of the trachea from anterior at level of larynx to more posterior as it enters the chest behind the sternal notch, nature of the tracheal rings (C shaped cartilages (first cartilage is bigger than the others in the cervical trachea) joined vertically by fibro-elastic tissue and connected posteriorly by the trachealis muscle, layers of dissection for tracheostomy (e.g. skin, subcutaneous tissue, fat, pre-tracheal fascia (superficial and deep), trachea and the relationship of thyroid to the trachea and surrounding vessels. There were some good answers amongst the successful candidates, whereas those who failed to pass this question did so because of a lack of detailed knowledge and relational anatomy. Candidates were not asked, and thus did not receive marks for, describing how to perform a tracheostomy.

4 (40%) of candidates passed.

11. Compare and contrast renal and hepatic blood flow and its regulation

Another fundamental physiology topic that required candidates to understand, and synthesize knowledge from multiple areas. Generally well done with some very good answers. A tabular format worked well. Candidates were expected to mention values for renal and hepatic flow (total flow, % of cardiac output and oxygen consumption), basic anatomical comparisons, distribution (e.g. renal cortex 95% , renal medulla 5%,), two capillary beds (glomerular and peritubular) for renal, and hepatic triad and sinusoids for the liver, function (filtration for renal blood flow and metabolic activity for hepatic) and regulatory mechanisms for each (e.g. myogenic, autonomic, metabolic and humoral for both and tubuloglomerular feedback for renal).

7 (70%) of candidates passed.

12. Outline the pharmacology of vancomycin

A basic and fundamental pharmacology question which required candidates to present their answer in a coherent fashion, as well as demonstrate sufficient knowledge. Candidates were expected to mention spectrum and mechanism of action, pharmacokinetics (including dose, distribution, elimination, etc) and adverse effects, activity profile e.g. time-dependent, antimicrobial activity depends on the duration that the serum drug concentration exceeds the minimum inhibitory concentration (MIC) of the target organism and not concentration dependence.

6 (60%) of candidates passed.

SAQ PAPER 2

13. Draw (include labels and normal values) a normal spirometry trace in a young adult (20% of marks). Describe the changes seen in the spirometry, and the respiratory system overall, in pregnancy at term (80% of marks).

This question was generally handled well. Significant variation exists in normal values between textbooks, and examiners took account of this variation. Some candidates failed to provide any normal values or gave values not in accord with the traces they provided. Some candidates confused spirometry (volume/time) with flow volume loops or even a forced expiratory volume trace. These scored no marks. The second part was not well answered by some candidates with failure to describe changes - or even contradicting correctly graphed changes (for example the reduction in residual volume with pregnancy described as increased). Memorising curves needs to be accompanied by understanding. No marks were awarded for detailed discussion of the Haldane effect, as this was not asked. Candidates are reminded to read and answer the question.

5 (50%) of candidates passed.

14. What is an adverse drug reaction? Classify (with drug examples) the different types.

This question was very poorly answered. Textbooks give different classifications so some largesse was allowed, but both immunologic and physicochemical (kinetic and dynamic) were expected. Marks were allocated for both type and an example - some candidates failed to provide examples or listed a drug side effect without explanation. Some candidates were 'creative' with classification systems but where appropriate examples were given marks were awarded. No marks were gained for detailed descriptions of LD50 and therapeutic ratios.

1 (10%) of candidates passed.

15. Briefly outline the production and fate of Red Blood Cells (RBC) (40% of marks). Describe the breakdown of haemoglobin (Hb) (60% of marks).

The production and fate of red blood cells was well known to most candidates. Marrow production and its change with development, the sequence of haematogeny and RBC lifespan were well known. Some candidates failed to mention the role of erythropoietin and its stimulus by oxygen tension. The breakdown of haemoglobin caused much confusion. Globin (protein), Fe and haem (porphyrin ring) were all expected to be considered separately – many candidates omitted one or all. The steps were often confused as was the nature of transfer in blood, conjugation and release into bile. Conversion to stercobilinogen or urobilinogen (with reabsorption from the gut and excretion in urine) caused similar

confusion. No marks were awarded for discussion of bile salt metabolism from cholesterol (not haem) or the differences between direct and indirect acting bilirubin.

6 (60%) of candidates passed.

16. Describe the biochemical abnormalities, and the mechanisms by which they arise, that may be observed in a patient who is taking frusemide.

This was a relatively straightforward question with marks available for listing the abnormality and then discussing its origin. Many candidates simply listed an abnormality or confused the direction of electrolyte change. Few candidates went beyond hypokalaemia, hyponatraemia and hypochloraemia. Several candidates gave confused answers as to the mechanism(s) or drew pictures of a tubule with directional arrows for electrolytes with inadequate explanation. Some candidates simply ran out of time and wrote very little – this is a pity as a list would have generated marks. Candidates are reminded to practise the exams to time and attempt all questions.

3 (30%) of candidates passed.

17. Define afterload and describe the physiological factors that may affect afterload.

Definitions for afterload vary slightly amongst common physiology textbooks, and candidates were expected to mention any one commonly accepted definition. Essentially afterload is the resistance to ventricular ejection - the "load" that the heart must eject blood against and is related to ventricular wall stress (Law of Laplace, T=Pt.r/u). Candidates were expected to mention aortic valve and systemic vascular resistance, aortic impedance, blood viscosity, intathoracic pressure and relationship of ventricular radius and volume. Candidates generally did well, but few substantially good answers, with a lack of detail being the biggest limiting factor.

6 (60%) of candidates passed

18. Describe the processes of excitation and contraction within a smooth muscle cell (60% of marks). Briefly outline the mechanism by which nitric oxide affects smooth muscle cell activity (40% of marks).

Insufficient breadth and depth of knowledge limited candidates' performance to this question. Candidates were expected to mention mechanisms of muscle cell membrane activation (e.g. Ca2+ channel mediated action potential, Pacemaker potential, etc), sources of rise in intracellular Ca2+, intracellular Ca2+ binding to calmodulin in cytoplasm Ca2+calmodulin complex binding to, and activation of myosin light chain kinase, energy dependent myosin cross bridges and cycling and mechanism of smooth muscle relaxation.

Nitric Oxide (NO) activates guanylyl cyclise which in turn catalyzes the dephosphorylation of GTP to cyclicGMP which in turn induces smooth muscle relaxation, and the various mechanisms by which this occurs..

2 (20%) of candidates passed.

19. Outline the distribution, clearance and physiologic functions of magnesium in the body.

Insufficient breadth and depth of knowledge limited candidates' performance to this question. Candidates were expected to mention normal plasma (0.7 – 1.1 mmol/l) and intracellular (20mmol/l) levels, distribution (approximately 50% of total body magnesium is in bone & 20% in skeletal muscles), clearance (almost solely renal, approaches GFR, renal threshold set at just above normal serum Mg concentration, below which get almost complete reabsorption), activity (e.g. co-factor in metabolism), effects on muscles (reduces muscle excitability, inhibits excitation-contraction coupling, reduced contractility / weakness / depressed reflexes), effects on nerves (e.g. reduces nerve excitability, blocks NMDA receptors), systemic and coronary vasodilation and inhibits platelet function.

2 (20%) of candidates passed.

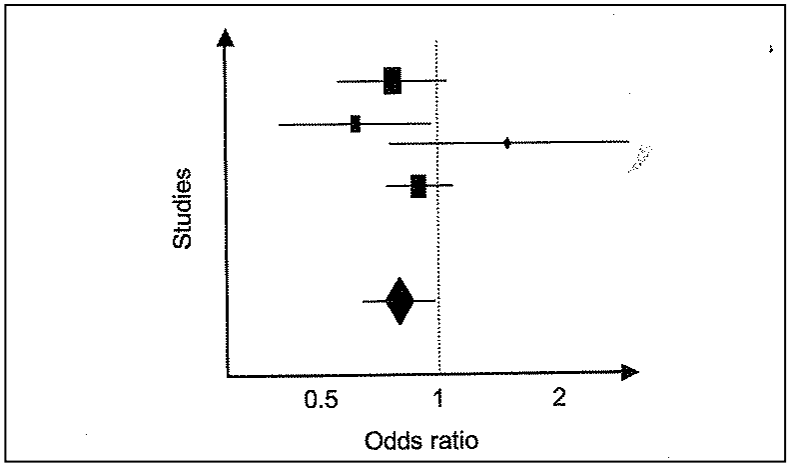
20. List the physiological factors affecting the diffusion of oxygen across the alveolar membrane (70% of marks). Describe how this changes with exercise (30% of marks).

The first section of this question was generally well done, but few really good marks, whereas the second section was poorly understood. The diffusing capacity is defined as the volume of gas that will diffuse through the membrane each minute for a partial pressure difference of 1mmHg. Factors affecting the rate of gas diffusion through the respiratory membrane include those related to the Fick equation (e.g. thickness of the membrane, surface area of the membrane, diffusion coefficient of the gas in the substance of the membrane, partial pressure difference of the gas between the two sides of the membrane, gas's solubility), rate of combination of oxygen with reduced haemoglobin and factors affecting surface area (e.g. lung volume, age, posture).

During strenuous exercise the oxygen diffusion is increased as pulmonary blood flow is greatly increased and there is opening up of previously dormant pulmonary capillaries increasing the surface area of blood into which oxygen can diffuse. Also, alveolar ventilation increases and there is better matching of ventilation and perfusion increases from 21ml/min/mmHg up to 65ml/min/mmHg.

5 (50%) of candidates passed.

21. The following is a Forest plot representing the results of a meta-analysis.



Explain the meaning of all the components of the Forest plot

Candidates struggled to identify, and differentiate the various symbols (e.g. significance of diamond compared to the square symbol, as well as their relative sizes). Essentially candidates were expected to include in their answer that the X axis is the Odds ratio, the vertical line from 1 on the x axis is the line of no effect, the results of the individual trials are shown as boxes with the size of the box relating to the size of the trial, the position of the box relates to the result of the trial, the horizontal lines are the 95% confidence intervals, the diamond at the bottom of the diagram represents the combined result of the trial, the size of the diamond represents the combined numbers from all the trials and that the results can be considered statistically significant if the confidence intervals of the combined result do not cross the line of no effect.

4 (40%) of candidates passed.

22. Outline the importance of the citric acid cycle in metabolism

Only an outline of the importance of the citric acid cycle (CAC) was expected, and not a detailed understanding. Candidates struggled to appreciate its importance. For a good answer candidates were expected to mention that the CAC has two main functions: energy production and biosynthesis. Some understanding of the overall reaction (AcCoA + 3NAD+ + FAD + GDP + Pi + 2H2O → 2CO2 + 3NADH + FADH2 + GTP + CoA), the link between oxidation of metabolic fuel (carbohydrates, lipids and protein) and aerobic energy production (oxidative phosphorylation), that Acetyl CoA is final common product of these oxidations (Glucose via glycolysis (cytoplasm), Free fatty acids via β oxidation (mitochondrial matrix) and Amino acids – glucogenic and ketogenic reactions), that CAC is first stage of aerobic respiration, requires oxygen to proceed, that the CAC together with oxidative phosphorylation accounts for 2/3 to 3/4 of ATP generated from fuel oxidation and anabolic involvement, whereby several biosynthetic pathways utilize CAC intermediates, e.g. Glucose biosynthesis (gluconeogenesis) via malate then oxaloacetate,

fatty acid and cholesterol biosynthesis via citrate + CoA → AcCoA, Amino acid biosynthesis via reductive amination and transamination reactions, Porphyrin (organic component of haeme) via succinyl CoA and Purine and pyrimidine biosynthesis – precursors of nucleotide bases for DNA and RNA.

2 (20%) of candidates passed.

23. Classify antiemetic drugs and give an example from each group (60% of marks). Outline the gastrointestinal effects of metoclopramide (40% of marks).

Antiemetics, as a topic has been frequently asked, in various formats in the past. Candidates who performed well had a good depth and breadth of knowledge as well as sufficient integration of knowledge to be able to classify and understand the basis to the various classifications. Essentially it was expected that candidates mention the classifications of Anticholinergics, Antihistamines, Anti 5HT, Antidopaminergics (benzamides, butyrophenones, phenothiazines), Steroids and other agents with known antiemetic activity (e.g. propofol, benzodiazepines, etc). In relation to metoclopramide it was expected that candidates would mention that it lowers pressure threshold for occurrence of intestinal peristaltic reflex, reduces intestinal muscle fatigue, enhances frequency and amplitude of longitudinal muscle contraction, coordinates gastric, pyloric and duodenal activity to improve GI motility, mechanism of action appears to depend on intramural cholinergic neuron, acts primarily by augmenting release of ACh and perhaps by inhibition of 5-HT release, increases lower oesophageal sphincter pressure, relaxes the pyloric sphincter and antagonize the inhibitory neurotransmitter, dopamine.

4 (40%) of candidates passed.

24. Describe the potential causes, and effects, of resonance and damping on an invasive arterial blood pressure trace.

For a good answer candidates were expected to mention that **the** arterial pressure waveform is made up of many different sine waves (as determined by Fourier Analysis) with each sine wave having a specific frequency. Every system has its own natural oscillatory frequency, or resonant frequency. The pressure measuring system has a resonant frequency at which oscillations occur, and if this is less than 40 Hz, it falls within the range of frequencies present in the blood pressure waveform and oscillations may produce a sine wave which is superimposed on the blood pressure wave form. The resonant frequency can be increased by using a short, wide, stiff catheter. In respect to damping, some damping is inherent in any system and acts to slow down the rate of change of signal between the patient and pressure transducer. Mention of causes of damping and the optimal damping coefficient (0.677) were expected. An under-damped system is one whereby resonance occurs causing the signal to oscillate and overshoot (damping factor <0.7) and an over-damped is one whereby the signal takes a long time to reach equilibrium but will not overshoot. It may not reach equilibrium in time

for a true reading to be given (damping factor >1.0). Both resonance and damping can alter the measured systolic and diastolic values but the mean pressure is not affected

3 (30%) of candidates passed.

PAPER 1 and 2 CLOZE QUESTIONS

7 (70%) of candidates passed.

PAPER 1 and 2 RANK QUESTIONS

5 (50%) of candidates passed.

PAPER 1 and 2 MATCH QUESTIONS

9 (90%) of candidates passed.

ORAL SECTION

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

Candidates were presented with the following information (shown in *Italics*) during the two-minute reading time.

VIVA 1

This Viva will explore your knowledge of the cerebral circulation and its measurement.

What is normal cerebral blood flow?

Subsequent questions explored knowledge of differences in grey and white matter blood flow, EEG activity in relation to blood flow, measurement and factors that affect CBF and changes at CBF in response to altitude induced changes in physiology.

VIVA 2

This Viva will test your knowledge of common β-blockers, and their pharmacology.

How would you classify β Blockers?

Subsequent questions explored knowledge of haemodynamic properties, receptor mediated effects, esmolol pharmacokinetics and sotalol as an antiarythmic drug. Following which, candidates were asked about the Pressure-Volume loop of the cardiac cycle and changes in that loop following administration of esmolol and labetalol.

VIVA 3

This Viva will explore your understanding of the physiology of transition at birth.

What is the normal haemoglobin saturation of a newborn breathing air?

Subsequent questions explored knowledge of foetal haemoglobin oxygen dissociation curve, foetal/newborn circulation, changes at birth, normal values of newborn vital signs such as respiratory rate, heart rate, blood pressure, oxygen saturation.

VIVA 4

This Viva will examine your understanding of blood and blood transfusion.

What are the main components of blood?

Subsequent questions explored knowledge of human blood groups, common blood group antigens, storage of blood, and changes to stored blood over time and process of group and screen for transfusion.

VIVA 5

This Viva will explore your knowledge of microbiology and antibiotics

What do these pictures show?
(Candidates were shown pictures of Gram +ve cocci above; Gram –ve bacilli)

Subsequent questions explored knowledge of classification of bacteria, examples of medically important bacteria, classification of antibiotics and pharmacology of gentamicin.

VIVA 6

This Viva will explore your knowledge of the pulmonary circulation.

Briefly describe the vascular anatomy of blood flow in the lungs.

Subsequent questions explored knowledge of venous admixture and anatomical shunts, differences between systemic and pulmonary circulations, changes in pulmonary circulation and drugs used to treat pulmonary hypertension.

VIVA 7

This Viva will explore your knowledge of fluids and colligative properties.

What is in a bag of 0.9% Saline?

Subsequent questions explored knowledge of osmolality, osmolarity, mannitol, colligative properties of fluids, anion gap, classification of diuretics and mechanism of actions.

VIVA 8

This Viva will examine your knowledge of the pharmacokinetics of thiopentone.

What factors determine how quickly a patient becomes unconscious with an induction dose of thiopentone?

Subsequent questions explored knowledge of serum concentration vs time curves and the information derived from them, volume of distribution (factors that affect it and how it is measured), clearance (definition, calculation, relationship to volume of distribution), elimination (first and zero order) and half-life.

Summary of the Examination

The CICM Primary Examination explores the knowledge of the basic sciences that forms the basis to Intensive Care practice. A detailed syllabus has been developed and forms the foundation for the knowledge required for this examination. All questions are sourced directly from that syllabus. Following each examination a detailed report, such as this one, is produced which outlines the level of understanding that is expected.

The Syllabus reflects the basic sciences as they apply to Intensive Care practice. It is important that Candidates follow the Syllabus closely, and in its entirety. The Primary Examination will be based from within any section of the Syllabus. The level of understanding required to be successful at this examination, can be ascertained from the past examination reports, the syllabus, the examination guides to candidates and the suggested texts. To succeed Candidates must read widely, beyond any one textbook, and develop a level of knowledge that allows them to accurately discuss, explain, translate and illustrate essential aspects of the basic sciences. It is also necessary for candidates to be able to collate and synthesize knowledge across many topics. This will require time. Although the amount of time required may vary amongst candidates, as a guide, candidates should plan for approximately 12 months to study, and to prepare, for this examination.

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The examination report no longer lists reference texts, as answers are often sourced from, and candidates are expected to refer to, multiple texts.

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.

On behalf of the Examination Panel, I would like to once again congratulate the successful candidates at this CICM Primary Examination and wish them every success in their future training in Intensive Care, and preparation for the College of Intensive Care Medicine Fellowship examination.

A/Prof Arthas Flabouris
Chair, Primary Examination Committee
May 2012

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