Joint Faculty of Intensive Care Medicine

Australian and New Zealand
College of Anaesthetists
ABN 82 055 042 852

The Royal Australasian
College *of* Physicians

REPORT OF THE
INTENSIVE CARE PRIMARY EXAMINATION

MARCH / APRIL 2009

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	2
Number of candidates scoring 45-50% in the written	1
Total number invited to the Oral section based on written marks	3
Total number successful at the Oral section	3

Successful candidates:
Dr Russel Laver
Dr Yi Ching Lee
Dr Soumya Ray

WRITTEN SECTION

To score the best marks candidates should attempt all the short answer questions. Writing out the question does not score any marks and wastes time.
The following are the examiners general comments about each short answer question.

PAPER 1

1. Relate the surface ECG to the events of the cardiac cycle (60% of mark). Describe how the PR, QRS and QT intervals may be prolonged by the action of drugs.

The first part of the question is best answered by a labelled and annotated diagram of the ECG with the pressure events of the cardiac cycle. Common errors included mistiming of the ECG with the pressure waveform. The second part of the question could be answered in a tabular format such as:

Interval	Drug	Mechanism
PR	Digoxin	Increases refractory period of AV node probably by increased vagal activity
QRS	Tricyclic antidepressants	Quinidine like effect, decreasing sodium influx into cells
QT	SSRI's	Malfunction of calcium ion channels

Syllabus Cib2c, C2c2b
References:
Power and Kam 2nd edition p129 – 131
Stoelting and Hillier 4th edition p403, 409, 415

Pass rate: 50%

2. Describe the production of carbon dioxide in the body (60% of marks). What are the physiological reasons why the $PaCO_2$ may be high? (40% of marks)

The main points for a pass include a brief description of the citric acid cycle and a list of facts such as storage of CO_2 (120L), production (200ml/min) and that 2 molecules of CO_2 are produced for 1 molecule ATP. A statement that $PaCO_2$ is proportional to CO_2 production/alveolar ventilation would help answer the second part. An example of increased CO_2 production is fever, and of decreased alveolar ventilation is increased anatomical dead space.

Syllabus B1h 2e
References:
Power and Kam 2nd edition p78-79,101
Stoelting and Hillier 4th edition p790-791
Nunn 6th edition p148-156

Pass rate: 10%

3. Outline the factors which affect the onset, duration of action and toxicity of local anaesthetic agents.

Marks were equally divided between all three parts. Structure to the answer using a table and list of facts gained credit. Factors affecting onset would be well described by stating Ficks law of diffusion and followed with an explanation of the equation. Factors affecting duration such as protein binding, regional blood flow, metabolism and use of vasoconstrictors scored marks.

Regarding toxicity, an explanation of the CC/CNS ratio was required (the ratio of plasma levels at which CVSCollapse vs. Convulsions occur). Other factors included structure of agents, accumulation e.g. due to liver disease. A mention of features of particular agents' toxicity such as prilocaine and methaemoglobinaemia was expected.

Syllabus G2b 2a-c
References: Peck, Hill and Williams 2nd edition p163-174
Stoelting and Hillier 4th edition p179-203
Evers and Maze p507-533

Pass rate: 10%

4. Explain how a normal, healthy adult regulates their body temperature (70% of marks). Explain how paracetamol exerts an antipyretic effect in a febrile patient (30% of marks).

Most candidates mentioned sweating, shivering, vascular response, and behavioural response to cold environment. Outlining the requirements of the temperature sensors, control processing area, and the effectors is, however, essential in order to pass this question. Most candidates did not mention where the temperature sensors are and the possible hormonal response to changes in the temperature of the environment. The interaction between interleukin-1 (and other pyrogens) and prostaglandin production in the hypothalamus was also not discussed.

Syllabus section L1.
Reference: Guyton & Hall 11th Edition page 894-901.

Pass rate: 40%

5. Outline the mechanism of action of drugs used to promote haemostasis.

Most candidates mentioned factor VIIa, Vitamin K, and desmopressin in their answers. Outlining the mechanism of action of the drugs used is essential in order to pass this question. The answers may include which coagulation factors are affected by warfarin and Vitamin K, the mechanism by which desmopressin promotes haemostasis and the multiple effects of Aprotinin. Topical treatment (e.g. adrenaline, glue) and drugs such as protamine, oestrogen, and tranexamic acid were common omissions.

Syllabus J 2a 2
Reference: Stoelting and Hillier 4th edition page 449 and 607.

Pass rate: 10%

6. Describe the pharmacology of oxygen.

Oxygen can be regarded as a 'drug' and the best answer will describe oxygen with such a perspective in mind. A good answer would require good understanding and integration of knowledge from different parts of the syllabus.

Most candidates mentioned the oxygen is an odourless and colourless gas and its effects on pulmonary pressure and atelectasis. Common omissions included the clinical uses oxygen other than reversing hypoxia, pharmaceutic properties of oxygen, pharmacodynamic response of different body systems (CVS, CNS, RESP) to hyperoxia, and pharmacokinetics of oxygen including distribution & transfer of oxygen between body systems and the metabolism of oxygen.

Syllabus: B1f, B1h, B1i, B2a, C1f, O1.
Reference: Nunn's applied respiratory physiology.

Pass rate: 20%

7. Define afterload (10% of mark). Describe the factors that can affect left ventricular afterload (90% of mark).

Many definitions of afterload were accepted. The main factors affecting left ventricular afterload are systemic vascular resistance, aortic impedance and ventricular radius. Other factors include blood viscosity and positive intrathoracic pressure. Good answers expanded on the points above. Candidates who failed this question did not have enough facts.

Syllabus C1c C2c
Reference: Bray 4th edition p 342-344 and p 360-361

Pass rate: 20%

8. Outline the anatomy relevant to performing a percutaneous tracheostomy.

Surface landmarks, anatomy of the trachea and its important relationships with the thyroid, carotid sheath and oesophagus were required to pass this question. Several candidates described the procedure of percutaneous tracheostomy in great detail. Descriptions of the procedure gained no marks.

Syllabus B1b2g
Reference: Anatomy for the Anaesthetist, Ellis and Feldman.

Pass rate: 20%

9. Explain the causes of the difference between measured end tidal and arterial partial pressures of carbon dioxide.

Points required to pass this question included the normal difference between end-tidal and arterial partial pressure of $C0_2$ and the reasons for this. The patient factors that increase the difference include increases in alveolar dead space and a slow rise of expired $C0_2$. Mention of pathology e.g. pulmonary embolism and cardiac arrest gained extra marks. Equipment factors needed to be included e.g. leaks, occlusion of sampling line. Candidates who failed did not discuss alveolar dead space and very few adequately explained how it increased the end tidal to arterial partial pressure difference.
There is an excellent graph of expired $C0_2$ in "Physiology for the Anaesthetist" by Power and Kam which helps understand alveolar dead space.
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Syllabus S2g B1g2
Reference: Power and Kam 1st edition p 84-88

Pass rate: 10%

10. Describe the calculations involved in determining the loading dose and maintenance dose for an intravenous infusion (50% of marks). What factors may affect these values in the critically ill (50% of marks)?

Main points for a pass included the equations for determining the loading and maintenance doses. Points were awarded for explaining the rationale for giving a loading dose and for relevant diagrams.

Answers to the second part of the question often lacked detail. Candidates should have mentioned alterations in volume of distribution, plasma proteins, renal & hepatic function. Examples of drugs illustrating an understanding of pharmacokinetics attracted extra marks.

Syllabus II 2 f
Reference: Rang Ritter Dale p120-123

Pass rate: 30%

11. Describe the control of cerebral blood flow.

Good answers included an equation and then explored the various components of the equation. Main points for a pass included pressure and metabolic autoregulation and the various factors that affect cerebral vascular resistance. Graphs were a useful way to answer this question but were generally underutilised. Several candidates wrote about the Monroe-Kellie doctrine which was not directly relevant to the question.

Syllabus C1d2a
Reference: Power and Kam 1st edition p 42-43
Guyton and Hall 11th edition p 761-3

Pass rate: 50%

12. Outline the pharmacology of an opioid injected into the spinal intrathecal space.

Though it would be unusual for patients to receive spinal opioids whilst they are in intensive care, the complications of spinal opioids are not an uncommon reason for admission to intensive care thus it is important candidates understand their pharmacology. Answers generally lacked structure. Outlining pharmacology should include pharmacokinetics, pharmacodynamics and side effects (both common and dangerous). An explanation of the effect of lipid solubility was expected. Following a structure will ensure a more complete answer.

Syllabus G2d2e
Reference: Neural Blockade. 3rd edition Cousins and Bridenbaugh

Pass rate: 30%

PAPER 2

1. Outline the factors that determine the composition and volume of glomerular filtrate in a normal person.

The volume and composition of the glomerular filtrate are best explained by referring to the equation: Glomerular Filtration = K_f x net filtration pressure. Then describing the factors that affect each part of the equation e.g. hydrostatic pressure, oncotic pressure, factors that influence the filtration coefficient e.g. surface area
Glomerular filtrate is an ultrafiltrate of plasma and factors that affect the passage of proteins and other molecules should be discussed
Extra marks were given for an explanation of filtration fraction and short facts about GFR in paediatric patients and the elderly.
No marks were given for any discussion of drugs.

Syllabus D2b
Reference; Power and Kam 1st edition p 197-199

Pass rate: 30%

2. Describe the factors that determine the sample size of a randomised clinical trial (60% of marks). Describe the differences between a parametric and a non-parametric statistical test and give one example of a parametric test and one example of a non-parametric test

The factors included the power of the study, variability of outcomes, acceptable p value, the incidence of the outcome and the study design. An explanation of how each of these factors affected sample size was required e.g. if the incidence of the outcome is rare, a larger sample size is required. Candidates failed because of lack of knowledge.

Syllabus EBM 2c
Reference: Gin and Myles p 24-29.

Pass rate: 30%

3. Outline the physiology of excitation and conduction in nerve axons (60% of marks). List the factors which delay axonal conduction (40% of the marks).

The following points were expected to be outlined in this question
1. The resting membrane potential (RMP) and its physiological basis
2. How the RMP changes rapidly after a stimulus e.g. electrical or chemical and reaches a threshold potential and an all or none action potential results
3. The ionic basis of the action potential
4. How the action potential is propagated
5. Factors that delay axonal conduction such as fibre size, myelination and electrolyte abnormalities e.g. hypermagnesaemia.

Syllabus G2a
Reference: Power and Kam 1st edition p 6-9

Pass rate: 30%

4. Outline the role of platelets in blood clotting following an injury to a blood vessel.

The main points expected in this answer were descriptions of platelet activation following exposure to collagen, platelet adhesion to the endothelium and ADP release and platelet aggregation secondary to activation of the GP11b/111a, COX-1 and other agents e.g. prostaglandin E_2
Factors that interacted with platelet receptors e.g. platelet activating factor which increase aggregation and factors that inhibited platelet activation e.g. Prostaglandin I_2 and nitric oxide gained marks.

Syllabus J2c
Reference: Power and Kam 1st edition p 247-249

Pass rate: 40%

5. Describe the physiological consequences of positive end expiratory pressure.

Points required included a definition of PEEP, both intrinsic and extrinsic.
The important physiological consequences that need to be discussed are respiratory including increased FRC, increased compliance and decreased work of breathing.
Cardiovascular consequences include decreased venous return and subsequently decreased cardiac output and an increased pulmonary vascular resistance.
Renal consequences include decreased renal blood flow and increased ADH
Effects on intra-abdominal pressure, hepatic blood flow and the beneficial effects in cardiac failure earned marks.

Syllabus B1k.2a
Reference: Nunn 6th edition p. 431.

Pass rate: 40%

6. Describe the factors that affect airway resistance.

Important factors to be discussed in this answer were anatomical site, laminar versus turbulent flow, airway calibre and factors that affect it such as oedema and sympathetic tone. The effect of lung volume on airway resistance is usefully described in a diagram.
The differences in infants earned extra marks

Syllabus B1d, 2h
Reference: Nunn 6th edition p39-47.

Pass rate: 30%

7. Describe the functions of the gastric secretions.

Candidates were expected to list and briefly define the role of the various substances produced and secreted by the stomach. These included the hormones gastrin and somatostatin, the enzymes pepsin, lipase and gelatinase, the electrolytes Na+, K+ and HCO3-, HCl and water, prostaglandins and mucus, and intrinsic factor.

For example: HCl secreted by parietal cells to produce a very acidic environment pH 1-3.5. This optimizes proteolytic activity of pepsin, has a direct proteolytic role, aids ferric iron conversion to the more soluble ferrous ion, and is important for bactericidal activity and innate immunity. It also stimulates pancreatic and biliary secretions.
Good answers divided the functions into digestive, hormonal, mucosal protection, immunity etc. Marks were not gained for mention of the secretions of other GIT organs.

SyllabusQ12b
Reference: Guyton and Hall 11th edition p791-799

Pass rate: 40%

8. Describe the pharmacological basis of the management of organophosphate poisoning.

Organophosphates (OGP) bind irreversibly to acetyl cholinesterase. They produce a cholinergic crisis and muscle paralysis due to excess Acetyl choline (ACh) at all muscarinic and nicotinic receptors.
Candidates were required to discuss the pharmacology relevant to treating OGP poisoning, including active decontamination/staff protection due to high lipid solubility, use of antimuscarinics with central and peripheral action to treat cholinergic symptoms, supportive therapy for muscle weakness (there is no antinicotinic agent available which does not exacerbate muscle weakness), and finally the use of the cholinesterase regenerator,

Pralidoxime, which may prevent the OGP-AChE complex ageing and becoming an irreversible bond if given in a timely fashion.

Good answers included a discussion of the mechanism of action of the therapeutic agents, the time course of therapy, the large doses/infusions of atropine required and the titration of therapy to reversal of muscarinic effects. Long lists of signs and symptoms were not required to pass this question.

Syllabus H2b2c
Reference: Rang Dale Ritter 6th edition p 164-166
Katzung 10th edition p 116-117, 968.

Pass rate: 40%

9. Compare and contrast the mechanism of action and side effects of tricyclic antidepressants, selective serotonin reuptake inhibitors and monoamine oxidase inhibitors.

Good answers were in tabular format.

The antidepressant action is similar for each agent. Initial increase in 5HT and NA, followed in 2-3 weeks by a down regulation or change in efficiency of 5HT transmission. The agents produce elevated neurotransmitters via different mechanisms, either reuptake blockade or enzyme inhibition. MAOIs can be competitive or non-competitive. Mention of the different neurotransmitters affected by each agent was required.

A description of significant side effects at therapeutic doses, and in overdose was expected with explanations provided. These should have included - the anticholinergic effects and cardiotoxicity of TCAs, postural hypotension, the catecholamine, pethidine and tyramine related complications of MAOIs, and serotonin syndrome with SSRI/MAOI use and or overdose. More marks were gained for mention that side effect profiles can be beneficial e.g. analgesic properties of TCAs, sedation with TCAs/ SSRIs and energizing benefits of SSRIs/SNRIs. SSRI's safety and efficacy have markedly reduced the use of MAOIs and to a lesser extent TCA's..

Syllabus G2f2d
Reference: Stoelting p 398-407
Katzung p 476-487.

Pass rate: 40%

10. Outline the mechanism of action of drugs used to control raised intracranial pressure.

The answers to this question were generally not broad enough. Only one or two drugs were discussed rather than the range of drugs used in this situation. Discussion should have

included benzodiazepines, intravenous induction agents, opioid narcotics, diuretics including loop diuretics and mannitol. Hypertonic saline also gained marks. Generally the discussions on the drugs mentioned were done well.

Some candidates discussed the physiological control of intracranial pressure which was not required and gained no marks.

Syllabus G2g, G2a2a E2a2a

Pass rate: 20%

11. Describe the mechanism of action, antibacterial spectrum and pharmacokinetics of aminoglycosides.

This answer was generally well done. Most answers showed good understanding of mechanism of action. The antibacterial spectrum and pharmacokinetics were done less well. Clinical observation guiding your study would help in answering this question, such as renal dosing, monitoring drug levels and situations in which aminoglycosides are used.

Syllabus M2 2d
Reference: Katzung 10th edition p 755-762

Pass rate: 50%

12. Explain the factors which influence the transfer of drugs across the placenta to the foetus.

Good answers showed an understanding of diffusion, the influence on transfer of lipid solubility, molecular size, degree of ionisation and protein binding. They also made reference to placental transporters and placental metabolism. Extra points were scored for mentioning that the real concern is teratogenicity to the foetus.

Syllabus O2 2d
Reference: Katzung 10th edition p 971-973.

Pass rate: 30%

SHORT FACT QUESTIONS, PAPER 1 and 2

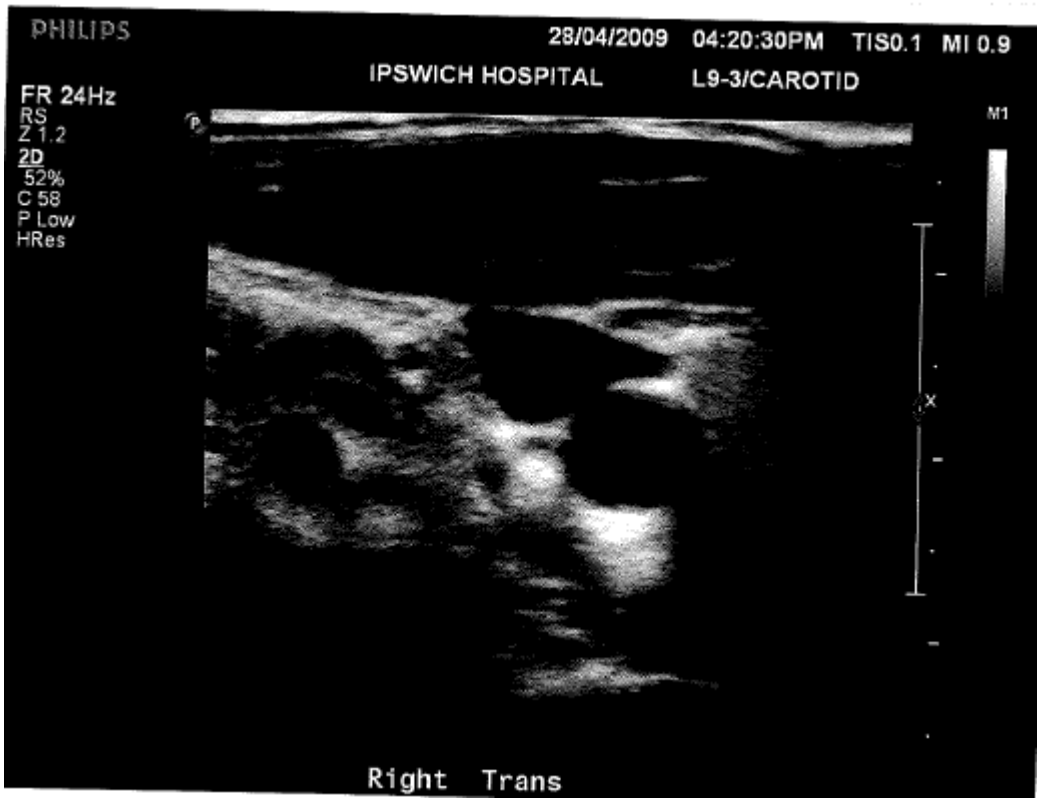
Some candidates did not attempt some of the short facts questions. There are no penalties for wrong answers in this section so candidates are strongly advised to attempt all the questions.

ORAL SECTION

3 candidates were invited to attend the oral section based on their written marks.
The following questions were the introductory questions posted outside the examination room.

VIVA 1

This image is of the carotid artery and internal jugular vein. How can you distinguish the two using this form of imaging?



VIVA 2

This viva will test your knowledge of the physiology and pharmacology of the Immune System.

Outline the body's defence mechanisms against infection.

VIVA 3

This viva will assess your knowledge of the action potential of the ventricle, sinus node and the atrioventricular node. It will also assess knowledge of anti-arrhythmic drugs.

From where does this action potential arise?

VIVA 4

This station will explore your knowledge of bacteria and anti-bacterial agents.

How do bacteria differ from the majority of normal human cells (eukaryotes)?

VIVA 5

This viva will test your knowledge of Red Blood Cells and the Clark electrode.

Outline the main functions of the red blood cell.

VIVA 6

This viva will explore your knowledge of the pharmacokinetics in two areas:

1. **Alcohol**
2. **Ageing**

What is the pharmacokinetics of alcohol metabolism?

VIVA 7

This information is from a patient with a pulmonary embolism

FIO2 0.5
PaO2 100mmHg
PaCO2 20mmHg

Calculate the A-a gradient.

VIVA 8

In this viva you will be asked to discuss cell membrane physiology and electrolyte disturbances.

Draw a cell membrane.

A detailed syllabus has been developed and forms the foundation for the knowledge base for the JFIC Primary Examination. All questions are sourced directly from that syllabus and candidates should have a sound understanding of those topics, and confidence to express their understanding of the subject material in both written and oral form. The candidates should be able to integrate and express basic physiological and pharmacological principles as to how the relate to various scenarios relevant to Intensive Care practice. Candidates would find it valuable to develop strategies and standard formats to answer typical questions, eg compare and contrast the pharmacology of Drugs X and Y. Candidates are also strongly encouraged to use accurate and labelled figures and tables wherever possible to help display their knowledge and to describe basic principles.

Dr Gill Bishop
Chair
Primary Examination Committee

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