COLLEGE OF INTENSIVE CARE MEDICINE
OF AUSTRALIA AND NEW ZEALAND

# SECOND PART EXAMINATION

# EXAM REPORT MARCH / MAY 2014

This report is prepared to provide candidates, tutors and Supervisors of Training with information regarding the assessment of candidates' performance in the CICM Second Part Examination. Answers provided are not necessarily model answers but guides as to what was expected. Candidates should discuss the report with their tutors so that they may prepare appropriately for future examinations.

The exam comprises a written section and an oral section. The written exam consists of two 2.5hr papers of 15 ten-minute short answer questions each. Candidates are required to score at least 50% in the written section to be eligible to sit the oral section. The oral exam consists of eight interactive vivas and two separate clinicals "hot cases".

The tables below provide an overall statistical analysis as well as information regarding performance in the individual sections. A comparison with data from the four previous exams is provided.

**In all sections of the exam the candidate has to demonstrate performance consistent with that of a competent senior registrar / junior consultant, i.e. demonstrate the ability for safe, effective, independent practice as an Intensivist. Candidates who are not at this level are encouraged to defer their attempt at the exam.**

| Overall Performance | May 2014 | October 2013 | May 2013 | October 2012 | May 2012 |
|---|---|---|---|---|---|
| Presenting for written (Including OTS) | 35 | 53 | 27 | 43 | 41 |
| Carrying a pass from a previous attempt | 8 | 11 | 7 | 13 | 11 |
| OTS Exempt | 0 | 0 | 0 | 0 | 0 |
| Total number presenting (written + carry + OTS) | 43 | 64 | 34 | 55 | 52 |
| Invited to orals (>50% in written section)** | 15 | 28 | 18 | 29 | 26 |
| Total number invited to oral section | 23 | 39 | 25 | 42 | 37 |

| Analysis of Performance in Individual Sections | May 2014 | October 2013 | May 2013 | October 2012 | May 2012 |
|---|---|---|---|---|---|
| Successful in the written section | 15/35<br>43% | 28/53<br>53% | 18/27<br>67% | 29/43<br>67% | 26/41<br>63% |
| Successful in the Hot Case section | 15/23<br>65% | 22/39<br>56% | 9/25<br>36% | 21/41<br>50% | 15/37<br>40% |
| Successful in both Hot Cases | 6/23<br>26% | 10/39<br>26% | 7/25<br>28% | 10/41<br>24% | 7/37<br>19% |
| Successful in the Viva section | 22/23<br>96% | 30/39<br>77% | 15/25<br>60% | 36/41<br>86% | 22/37<br>59% |

| Sectional Pass Rates | May 2014 | | October 2013 | | May 2013 | | October 2012 | |
|---|---|---|---|---|---|---|---|---|
| | Pass rate | Highest individual mark | Pass rate | Highest individual mark | Pass rate | Highest individual mark | Pass rate | Highest individual mark |
| Hot Case 1 | 43% | 70% | 54% | 80% | 52% | 75% | 40% | 100% |
| Hot Case 2 | 61% | 85% | 49% | 90% | 44% | 90% | 50% | 93% |
| | | | | | | | | |
| Viva 1 | 91% | 85% | 56% | 70% | 48% | 75% | 90% | 90% |
| Viva 2 | 83% | 90% | 85% | 90% | 88% | 81% | 88% | 75% |
| Viva 3 | 61% | 89% | 62% | 90% | 56% | 75% | 40% | 80% |
| Viva 4 | 87% | 85% | 85% | 95% | 52% | 76% | 81% | 93% |
| Viva 5 | 87% | 85% | 54% | 80% | 60% | 90% | 98% | 95% |
| Radiology Viva | 74% | 90% | 72% | 100% | 64% | 83% | 48% | 90% |
| Communication Viva | 61% | 94% | 49% | 87% | 44% | 88% | 67% | 100% |
| Procedure Viva | 78% | 100% | 79% | 76% | 20% | 98% | 71% | 100% |

| Oral Section Pass Rates | May 2014 | October 2013 | May 2013 | October 2012 | May 2012 | October 2011 |
|---|---|---|---|---|---|---|
| Candidates who scored >50% in written section and passed the overall exam | 15/15<br>**100%** | 18/27<br>**67%** | 11/18<br>**61%** | 24/29<br>**83%** | 19/26<br>**73%** | 36/45<br>**80%** |
| All candidates invited to oral section and passed the overall exam (written + carry + OTS) | 19/23<br>**82%** | 28/39<br>**72%** | 13/25<br>**52%** | 31/42<br>**74%** | 20/37<br>**54%** | 43/56<br>**76%** |
| Overall Pass Rate | 19/43<br>**44%** | 28/64<br>**44%** | 13/34<br>**38%** | 31/56<br>**55%** | 20/52<br>**38%** | 43/66<br>**65%** |

# EXAMINERS' COMMENTS

## Written Paper

Twelve of the thirty questions had an overall pass rate of less than 50%. Topics covered by questions with a pass rate of less than 40% related to discussion of the Surviving Sepsis Guidelines, diagnostic tests for PE, management of broncho-pleural fistula in a ventilated patient, the role of CVP monitoring in the critically ill, positioning of the patient with multi-trauma, interpretation of clinical signs, management of anastomotic leak post-oesophagectomy, broad concepts of ECMO and quantitative acid-base analysis.

Candidates who failed questions did so for one or more of the following reasons:

- Insufficient knowledge of the topic in question.
- Insufficient detail and/or depth of the answer.
- Poorly structured answer.
- Inadequate reference to supportive evidence where relevant.
- Failure to answer the question as asked.
- Omission of all or part of the question.

It was noted that some answers relating to discussion or critical evaluation of a topic were not at the required level in terms of synthesis of information and depth of discussion. It also appears that candidates do not always read the questions carefully and thoroughly. Candidates are advised to include in their answer only information that is relevant to the question and to write legibly.

Candidates who failed the written section passed an average of 14/30 questions compared with candidates scoring >50% and gaining an invitation to the oral section, passing an average of 21/30 questions.

## Hot Cases

The overall pass rate for the Hot Cases was higher than in recent exams, although the pass rate for candidates successful in both cases was comparable. Comments expressed by the examiners, relating to candidates' performance in the Hot Cases, included the following:

- Candidates should address and answer the question asked of them at the start of the hot case.
- Candidates need to interpret and synthesise information as opposed to just describing it.
- Candidates need to apply context and relate their answer to the clinical case in question and not just repeat a template answer.
- Candidates are not expected to arrive at a definitive diagnosis in every case but should be able to provide a sensible differential diagnosis and appropriate management plan.
- Candidates should give considered answers to questions and work through their reasoning as opposed to making guesses.

Candidates who performed well in the Hot Cases were able to demonstrate the following:

- A professional approach showing respect and consideration for the patient.
- Competent, efficient and structured examination technique and also able to appropriately adapt the examination to suit the clinical case in question.
- The seeking of information relevant to the case.
- Ability to interpret and synthesise their findings appropriately

- Presentation of their conclusions in a concise and systematic fashion, addressing the issue in question
- Listing of a differential diagnosis that is relevant to the clinical case in question
- Discussion of management issues in a mature fashion, displaying confident and competent decision-making
- Overall performance at the expected level (competent Senior Registrar / Junior Consultant)

Candidates who did not perform at the acceptable standard did so for reasons including the following:

- Missing key clinical signs on examination and/or on review of imaging
- Failure to fully expose the patient and so missing clinical signs
- Asking a large number of questions at the start of the case, of which many are not relevant or necessary for the case in question
- Incomplete or poor technique for examination of a system
- Poor synthesis of findings
- Poor interpretation of imaging and data
- Limited knowledge and uncertainty regarding core ICU topics such as brain death

Candidates are advised that they should not sit the Second Part Examination until they can confidently examine patients, present the relevant clinical findings and discuss management issues at the appropriate level, **i.e. demonstrate that they are capable of safe, effective, independent practice as a competent Senior Registrar / Junior Consultant.** Candidates are also encouraged to practice examination of individual systems.

**Vivas**

As in past exams, this is the section in which candidates tend to perform well. Only one candidate was unsuccessful in this section.

## SECOND PART WRITTEN EXAMINATION

(A) Write your answers in the blue book provided.

(B) Start each answer on a **new page** and indicate the **question number**. It is not necessary to rewrite the question in your answer book.

(C) You should aim to answer each question in **ten** minutes.

(D) The questions are worth **equal** marks.

(E) Record your **candidate number** and each **question number** on the cover of each book and hand in all books.

## GLOSSARY OF TERMS

| | |
|---|---|
| **Critically evaluate:** | Evaluate the evidence available to support the hypothesis. |
| **Outline:** | Provide a summary of the important points. |
| **List:** | Provide a list. |
| **Compare and contrast:** | Provide a description of similarities and differences (E.g. Table form). |
| **Management:** | Generic term that implies overall plan. Where appropriate, may include diagnosis as well as treatment. |
| **Discuss:** | Explain the underlying key principles. Where appropriate, this may include controversies and/or pros and cons |

## NOTE

Where laboratory values are provided, abnormal values are marked with an asterisk (*****).

*Please note that in this report images from the SAQs have been removed.*

### Question 1

**Outline the strengths and limitations of the current Surviving Sepsis Campaign Guidelines, using examples to illustrate your points.**

Answer Template

Strengths:

- The guidelines are formulated by an international panel of experts reviewing and grading the evidence.
- Use of the Grading of Recommendations Assessment Development and Evaluation (GRADE) for guideline development.
    - GRADE separates the assessment of the quality of the evidence from the ultimate strength of the recommendations (allows for strong recommendations when the quality of evidence is weak or weak recommendations when the quality of evidence is strong, particularly when patient values and preferences may strongly factor into the equation).

- Intensivists may use as a decision-making tool in their practice as:
- Information to aid practice
- An established source of references
- The current recommendations may generate areas for future research and consensus statements for this high-risk and high-cost patient group.

Limitations

- The GRADE system, although transparent, is still subjective. Recommendations depend greatly on the values and preferences of the committee members.
- Guidelines attempt to include nearly every aspect of critical care potentially related to sepsis, thereby losing focus in the process and becoming a general ICU guideline.
- A narrower guideline dedicated to sepsis-specific management might be more useful.
- Complexity and diversity of sepsis may defy a single guideline for all cases.
- Guidelines may rapidly become out-dated
- E.g. the 2012 guidelines on prone positioning for patients with PaO2/FiO2 ratios < 100 despite such manoeuvres (Grade 2C). This would now potentially be (1B)
- Recommends use of proton pump inhibitors over histamine-2 receptor antagonist for stress ulcer prophylaxis (grade 2C), although the emerging consensus suggests that this approach may not be beneficial and indeed may even be harmful.

- There are recommendations that may be considered controversial.
  E.g. Conservative fluid strategy in patients with sepsis-induced adult respiratory distress syndrome in the absence of evidence of tissue hypo perfusion (grade 1C)
- Early Goal Directed Therapy (EGDT) is strongly recommended, but potentially has a limited evidence base.
- The guidelines emphasize 'bundles' of care for sepsis resuscitation, although the evidence behind some of the bundled recommendations is not strong, for example using central venous pressure readings to guide volume resuscitation.
- Significant risk that bundles will be utilised as quality measures with which intensivists (who may validly disagree with some of the recommendations) treating sepsis will be assessed/benchmarked.

| | |
|---|---|
| **Pass Rate** | 9% |
| **Highest Mark** | 6.5 |

*Examiners' comments: Candidates appeared to have a lack of understanding of the SSC Guidelines and were unable to discuss their strengths and weaknesses. Many candidates focussed on EGDT alone.*

**Question 2**

**Briefly outline the role of each of the following in the diagnosis of pulmonary embolism in the critically ill:**

**a) Echocardiography**

**b) CT pulmonary angiogram (CTPA)**

**c) Serum troponin**

**d) D-dimer levels**

Answer Template

Echo

- Bedside test, rapid.
- Avoids transport, radiation exposure, IV contrast.
- Only 30-40% with PE have suggestive changes. Changes more likely if massive.
- Signs of right heart failure with shock and known PE may be an indication for thrombectomy / thrombolysis.

CTPA

- Spiral CT scan with IV contrast.
- Ability to also detect alternative pulmonary abnormalities.
- Issues of transport, radiation exposure, IV contrast (versus bedside tests (e.g. leg duplex U/S, ECHO) and/or empiric anticoagulation).
- PIOPED II – suggested that CTPA requires concomitant pre-test probability assessment (Wells) to be effective tool in diagnosing or excluding. Positive and negative predictive values differed significantly at different pre-test probabilities.
- Positive predictive value varies with extent of PE and pre-test probability – v good (97%) with main or lobar, falling with smaller; v good with high pre-test probability (96%), falling with lower (NEJM 2006).
- More recent studies with newer generation scanners suggest CTPA better at excluding PE than in PIOPED II - if good quality negative CTPA in an experienced centre, representation with thromboembolism is 1 – 2% at 3 months. In high risk patients, closer to 5%. (J Thromb Haemost 2009).

Troponin

- Not useful for diagnosis of PE.
- Elevated in 30 – 50% with moderate/large PE.
- Presumably from acute RV strain/overload.
- Associated with poorer prognosis.

D-dimer

- Degradation product of cross-linked fibrin.
- Detected in serum (ELISA or agglutination assay).
- Multitude of causes of raised D-dimer other than PE.
- Good sensitivity.
- Good negative predicative value – increased further if use clinical pre-test probability (e.g. Wells).
- Poor specificity and positive predictive value.
- Main role is to exclude PE if low pre-test probability and negative D-dimer.
- No use in the critically ill population as elevated in elderly, post-op, infection, trauma.

| | |
|---|---|
| **Pass Rate** | 34% |
| **Highest Mark** | 7.25 |

*Examiners' comments: Candidates did not answer the question as asked.*

**Question 3**

**3.1**

**a) Outline briefly the difficulties associated with the diagnosis of sepsis during late pregnancy and labour.**

**b) List the leading causes of sepsis in pregnant patients.**

**c) What are the common pathogens encountered in pregnancy-related sepsis?**

**d) List <u>two</u> antibiotics contra-indicated during pregnancy.**

Answer Template

a) Applying SIRS criteria to pregnancy may be problematic as there is:
   1. Leukocytosis
   2. Body temperature is raised during pregnancy and labour
   3. Tachycardia and tachypnoea are seen during normal labour

b)
   1. Pyelonephritis
   2. Chorioamnionits
   3. Septic abortion
   4. Episiotomy infections
   5. Necrotising fasciitis
   6. Septic thrombophlebitis
   7. Aspiration pneumonia

c)
   1. Gram negative more common than Gram positive agents
   2. E.Coli
   3. Group B Streptococcus
   4. Can also be polymicrobial – E.coli, Klebsiella

d)
   1. Tetracyclines
   2. Chloramphenicol
   3. Aminoglycosides
   4. Metronidazole
   5. Sulphonamides
   6. Trimethoprim
   7. Fluoroquinolones
   8. Some macrolides
   9. Nitrofurantoin
   10. Isoniazid

*Note: Some antibiotics in the above list are relatively rather than absolutely contra-indicated. The list is not exclusive and candidates giving other valid choices were given credit.*

**3.2**

**A 74-year-old femle presents with perforated colonic cancer and widespread peritoneal contamination. She has a laparotomy, peritoneal washout, colonic resection and formation of a defunctioning ileostomy. On day 6, she is noted to have abdominal wall cellulitis, abdominal wall oedema and a positive blood culture growing Gram positive bacilli.**

**a) What is the likely diagnosis?**

**b) What is the likely organism isolated in the blood culture?**

Answer Template

a) Necrotising fasciitis.

b) Clostridial species.

**3.3**

**A 56-year-old male presents with pyelonephritis. Ultrasound reveals an obstructed right kidney. Percutaneous nephrostomy is performed.**

**Blood cultures show 2/2 bottles growing Enterobacter cloacae, sensitive to ceftriaxone.**

**What antibiotic will you choose and why?**

Answer Template

Choose an aminoglycoside or meropenem because it is an ESCAPPM organism and will develop resistance to third gen cephalosporins.

| | |
|---|---|
| **Pass Rate** | 97% |
| **Highest Mark** | 9.2 |

**Question 4**

**Outline the principles of, and strategies for management of a persisting broncho-pleural fistula (BPF) in a mechanically ventilated patient.**

**Include in your answer the advantages and disadvantages of each strategy.**

Answer Template

<u>Principles of Management:</u>
1. Drainage
- Adequate drainage of the fistula with an intercostal catheter of adequate size to manage a large air leak.
- May require multiple catheters, and ability to manage large flow rates.
- Minimise suction.

2. Ventilatory management
- Aim is to reduce mean airway pressure to reduce flow through fistula tract.
- Low tidal volume and PEEP.
- Low mandatory breath rate.
- Permissive hypercapnoea.
- Short inspiratory time.
- Attempt to wean to spontaneous breathing mode from mandatory ventilation as soon as practicable and preferably from ventilatory support altogether.

3. General measures
- Standard ICU supportive management
- Broad spectrum antibiotic cover
- Attention to nutritional requirements – patients usually catabolic.

Strategies for Managing Large Leaks:

1. Independent Lung Ventilation
   - Advantages: - May minimise leak in injured lung whilst preserving gas exchange with conventional parameters in normal lung.
   - Disadvantages: -requires some form of double lumen tube – difficult to place and secure.
   - May not be tolerated in hypoxic patients.
   - Requirement for two ventilators –either synchronous or asynchronous – technically demanding and complex.

2. High Frequency Ventilation
   - Advantages are that it may reduce peak air pressures and theoretically reduce air leak.
   - Disadvantages - not widely available. Recent evidence suggesting an increase in mortality for this ventilatory technique in ARDS patients.

3. Surgery
   - Advantages – Definitive management strategy. May be only option to seal leak.
   - Disadvantages – Patient may not be fit enough to tolerate.

4. Endobronchial Occlusion
   - Advantages – Widely available, can be definitive treatment.
   - Disadvantages – may be technically challenging, not feasible with multiple leaks.

5. Application of PEEP to intercostal catheter
   - Advantages – may decrease leak volume and maintain intra-thoracic PEEP.
   - Disadvantages – compromise drainage, risk of tension, not feasible with multiple tubes.

6. ECMO
   - Advantages – may be only option to treat hypoxia.
   - Disadvantages – not widely available, complex, little experience.

| | |
|---|---|
| **Pass Rate** | 26% |
| **Highest Mark** | 6.5 |

*Examiners' comments: Overall, candidates had poor knowledge of this topic.*

**Question 5**

**A child is admitted to hospital following a seizure.**

**a) List the clinical features most consistent with the diagnosis of febrile convulsions.**

**b) List <u>five</u> drugs – one from each class - most commonly used for the treatment of generalised convulsive status epilepticus in children. For each drug you have listed give the appropriate dosage and <u>one</u> important advantage and <u>one</u> important disadvantage.**

Answer Template

a)
   - A convulsion associated with an elevated temperature greater than 38°C.
   - A child younger than six years of age.
   - No evidence of central nervous system infection or inflammation.

- No evidence of acute systemic metabolic abnormality that may produce convulsions.
- No history of previous afebrile seizures.
- Generalised rather than focal.
- Short (< 15 min) rather than prolonged.
- Single rather than multiple.

b)

- Benzodiazepines: a) Diazepam – 0.1 to 0.3 mg/Kg IV over 2 – 5 minutes, maximum 10 mg per dose - or b) Midazolam - 0.1 – 0.3 mg/kg bolus IV, can be given in an infusion 0.1 to 0.5 mg/Kg/hr.
    - Advantage – rapid onset, terminates seizures under most circumstances, can be administered by other routes-IM, P/R, nasally.
    - Disadvantage – excessive sedation, respiratory depression. May need airway control including intubation.

- Phenytoin: 15 – 20 mg/kg IV bolus dose at rate of < 50 mg/min, 5 – 10 mg/kg maintenance daily 12 hours after.
    - Advantage - preventing recurrence of SE for extended periods of time.
    - Disadvantages – Slow onset of action up to 30 minutes, Hypotension, cardiovascular collapse, ataxia, nystagmus, blurred vision, and coma.

- Barbiturates – Phenobarbitone: 10 – 20 mg/Kg initially up to 40 mg/Kg if needed to control seizure activity.
    - Advantage – more effective than phenytoin in controlling seizure activity.
    - Disadvantage – severe respiratory depression, requires monitoring in HDU/ ICU, may require intubation and ventilation.

- Thiopentone: 2 – 3 mg/kg bolus IV, repeat as needed.
    - Advantage – most potent of any epileptic agent.
    - Disadvantages – IV anaesthetic agent hence requires intubation and ventilation for administration, hypotension.

- Propofol: 1 – 3 mg /Kg bolus, 1 – 3 mg/Kg/hour.
    - Advantage – quick onset and offset.
    - Disadvantage – very few studies to support its use in status epilepticus, propofol infusion syndrome at high doses, requires intubation and ventilation.

- Sodium Valproate - Loading dose: 20 – 40 mg/kg followed by a continuous I.V. infusion of 1 – 5 mg/kg/hour.
    - Advantages – studies showing effective in 78% cases refractory to diazepam, phenytoin and phenobarb, less sedating than barbiturates.
    - Disadvantages – fatal hepatotoxicity can occur hence contra-indicated in significant hepatic impairment.

- Levetiracetam – Newer anti-epileptic agent – 15 (5 – 30) mg/kg bolus dose, 25 – 50mg/kg maintenance in two divided doses.
    - Advantage – very good safely profile.
    - Disadvantage – Limited published data in paediatric age group.

| | |
|---|---|
| **Pass Rate** | 77% |
| **Highest Mark** | 7.45 |

**Question 6**

**With respect to the multi-trauma patient with morbid obesity:**

**a) Outline how the pattern of traumatic injury differs in the morbidly obese from patients with normal body habitus.**

**b) List the additional factors, occurring as a consequence of the patient's obesity, that need to be considered during the initial assessment.**

**c) List the pros and cons of focussed assessment with sonography in trauma (FAST) in the assessment of the obese multi-trauma patient.**

Answer Template

a)

- Lower injury severity scores overall.
- More severe extremity injuries.
- More thoracic injury.
- Less brain injury – controversial.
- Longer extraction time may make for higher risk for crush injury.

b)

Airway

- Increased risk of partial airway obstruction when lying flat.
- Possibility of difficult intubation and difficult bag mask ventilation (cervical collar, neutral position, pre-existing signs of airway obstruction, possible sleep apnoea syndrome).

Breathing

- Increased difficulty inserting chest drains.
- Possible obesity hypoventilation syndrome.
- Increased risk of atelectasis.

Circulation

- Need for appropriately sized BP cuff.
- IV access more difficult so consider early inter-osseous access.

Other

- Caution with analgesia.
- Clinical signs, e.g. pneumothorax, difficult to detect by palpation and auscultation.
- Log rolling requires additional assistants.

c)

- Bedside investigation avoids transfer to CT scanner.
- Technically challenging with difficulty achieving adequate beam penetration and image quality.
- FAST is less sensitive than in non-obese.
- False positive pericardial collections are more common in the obese.

| | |
|---|---|
| **Pass Rate** | 51% |
| **Highest Mark** | 7.15 |

## Question 7

### 7.1

**A 50-year-old patient was admitted to the ICU for airway observation following a difficult parathyroidectomy. No immediate airway problems were evident. About 24 hours later, the patient was noted to be in fast atrial fibrillation, and complained of difficulty in breathing with generalised aches and pains.**

**a) What is the likely explanation for the patient's symptoms?**

**b) List your specific management for this problem.**

Answer Template

a) Hypocalcaemia and possibly hypomagnesaemia causing muscle cramps, possible laryngospasm.

b)

- Ca gluconate or chloride – bolus or infusion.
- Mg supplements.
- Anti-arrhythmics for AF.

### 7.2

**List <u>three</u> causes for the following combination of findings observed on a serum sample:**

| Parameter | Patient Value | Normal Adult Range |
|---|---|---|
| **Measured osmolality** | **340 mOsm/kg*** | **280 – 290** |
| **Sodium** | **138 mmol/L** | **135 – 145** |
| **Potassium** | **4.0 mmol/L** | **3.5 – 5.0** |
| **Chloride** | **98 mmol/L** | **95 – 105** |
| **Bicarbonate** | **15 mmol/L*** | **22 – 32** |
| **Glucose** | **6.0 mmol/L** | **4.0 – 6.0** |
| **Urea** | **8.0 mmol/L** | **6.0 – 8.0** |

Answer Template

Raised osmolar gap with raised AG

- Methanol
- Ethylene glycol
- Ethanol
- (Lactic acidosis can lead to a raised OG and AG; however, the osmolar gap does not reach the levels seen here.)

**7.3**

**List <u>two</u> causes for the following combination of findings observed on a serum sample:**

| Parameter | Patient Value | Normal Adult Range |
|---|---|---|
| **Measured osmolality** | **310 mOsm/L*** | **280 – 290** |
| **Sodium** | **125 mmol/L*** | **135 – 145** |
| **Potassium** | **4.0 mmol/L** | **3.5 – 5.0** |
| **Chloride** | **98 mmol/L** | **95 – 105** |
| **Bicarbonate** | **21 mmol/L*** | **22 – 32** |
| **Glucose** | **6.0 mmol/L** | **4.0 – 6.0** |
| **Urea** | **8.0 mmol/L** | **3.0 – 8.5** |

Answer Template

Raised osmolar gap with normal AG

- Mannitol
- Glycine
- Ethanol

**7.4**

**The following haemodynamic and metabolic data were obtained from a patient admitted to the ICU with sepsis.**

**Pulmonary artery catheter data:**
**CI 4.2 L/min/$m^2$**
**$DO_2$ 900 ml/min**
**$VO_2$ 190 ml/min**

**Indirect calorimetry data:**
**$VO_2$ 220 ml/min**
**$VCO_2$ 290 ml/min**

a) **Why is the $VO_2$ different between the two methods? (Assume no measurement errors.)**
b) **What changes in patient management will you consider based on the indirect calorimetry data?**

Answer Template

a) Indirect calorimetry also measures lung oxygen consumption.

b) A high RQ suggests excess carbohydrate load. Reduce caloric intake and consider changing to a higher fat intake.

| | |
|---|---|
| **Pass Rate** | 66% |
| **Highest Mark** | 9.5 |

**Question 8**

**a) List the determinants of central venous pressure (CVP).**

**b) Discuss the role of CVP monitoring in the critically ill.**

Answer template

a)
Determinants of CVP:

- Intravascular volume status
- Mean systemic filling pressure
- Right and left ventricular status and compliance
- Pulmonary vascular resistance
- Venous capacitance / tone
- Intra-thoracic pressure
- Intra-abdominal pressure

b)
Introductory statement

- For example: CVP is the pressure recorded from the right atrium or superior vena cava and is representative of the filling pressure of the right side of the heart. CVP monitoring in the critically ill is established practice but the traditional belief that CVP reflects ventricular preload and predicts fluid responsiveness has been challenged.

Most critically ill patients have central venous vascular access with multi-lumen catheters, making CVP monitoring easy to do.

Information derived from the waveform and/or measured value assists with / assists the diagnosis of:

- Confirmation of correct line placement.
- Tricuspid regurgitation or stenosis.
- Complete heart block.
- Constrictive pericarditis.
- Tamponade.
- Right ventricular infarction.
- Differential diagnosis of shock state.
- Determining mechanical atrial capture with AV pacing.
- Determining the presence of P waves in cases of SVT.

Traditionally, CVP measurement has been used to assess fluid responsiveness – including assessment of change in CVP after fluid boluses – and the use of target values as resuscitation end-points as recommended in the Surviving Sepsis Guidelines. However increasing evidence including a recent meta-analysis (Marik in Chest) has shown there is no correlation between CVP and fluid status and targeting a certain CVP value can lead to overload in one patient and to another remaining hypovolaemic. Current thinking suggests that interpretation of CVP should be in association with information relating to other haemodynamic variables.

Complications associated with CVC insertion means that CV monitoring is not risk-free. Correct placement, calibration and measurement (at end-expiration) are needed to obtain an accurate recording. Simultaneous fluid administration through the CVC leads to inaccuracies.

Alternative monitoring modalities include devices such as PiCCO and Vigileo analysing stroke volume variation, pulse contour analysis, global end-diastolic blood volume, etc. and bedside echo.

Summary

- For example: CVP monitoring may contribute information relating to the haemodynamic state of a patient but the value must be interpreted in the context of what else is known about that patient's cardiac function. Use of CVP as a measure of fluid responsiveness is flawed. The increasing use of bedside echo in the ICU is decreasing the utility of CVP monitoring.

| | |
|---|---|
| **Pass Rate** | 23% |
| **Highest Mark** | 6.25 |

*Examiners' comments: Candidates did not think broadly enough and in many cases restricted their answer to assessment of fluid responsiveness or stated only that CVP monitoring had no role.*

**Question 9**

**With respect to the management of a 35-year-old female presenting with toxicity secondary to deliberate self-harm with paracetamol:**

**a) Outline how paracetamol causes liver dysfunction and how N-acetylcysteine (NAC) works as an antidote in this setting.**

**b) List the criteria for liver transplantation in this patient.**

**c) Outline your management of the patient in the event of clinical deterioration, pending transfer to the regional centre for liver transplantation.**

Answer Template

a)

- Paracetamol is predominantly conjugated into glucuronate and sulphate moeities
- Small percentage is metabolized by cytochrome P450 to a toxic metabolite NAPQI, N-acetyl-p-benzoquinone imine (also known as NABQI).
- Amount of NAPQI will vary according to genetic profile.
- NAPQI is conjugated with glutathione to non-toxic moieties.
- In paracetamol toxic ingestion the phase 2 conjugation enzymes are saturated so a higher fraction is converted to the toxic metabolite.
- Conjugation of NAPQI with glutathione continues until it is depleted.
- Toxic NAPQI accumulates and causes direct damage to hepatocytes.
- NAC is a glutathione surrogate that detoxifies the toxic metabolite of paracetamol
- NAC is converted to glutathione increasing the sulphation of paracetamol which prevents formation of the toxic metabolite blunting the localised inflammatory response in the liver.

b)

- Arterial pH < 7.3 or lactate > 3.0 mmol/L after adequate resuscitation
  OR
- If all 3 of the following occur within a 24 hour period
- Creatinine > 300 µmol/L
- PT >100 seconds (INR > 6.5)

- Grade 3 – 4 encephalopathy

c)

- General supportive care with specific liver supportive therapy
- Continue NAC
- Ventilate as required
- Normocarbia
- Support the circulation
- Fluids cautiously to avoid worsening cerebral oedema
- Catecholamines / vasopressors
- Early CRRT for renal failure
- Control of acidaemia
- Control of fluid balance
- Avoid fever
- Commence nutrition involving liver specific feeds with low amino acids
- Lactulose 30 mL mg tds with other aperients
- Thiamine loading large dose 300 mg iv tds
- Regular vitamin K 10 mg iv daily
- Avoid FFP unless requiring coverage for invasive procedures
- Surveillance for infection and early antibiotic therapy if required
- Stress-ulcer and DVT prophylaxis
- Avoid hypoglycaemia
- Control ICP

| | |
|---|---|
| **Pass Rate** | 51% |
| **Highest Mark** | 7.75 |

*Examiners' comments: Candidates who did not pass gave sparse answers without sufficient detail, e.g. answer to part (b) was given as "King's College criteria" without further explanation.*

**Question 10**

**A 67-year-old male has been intubated and ventilated in your ICU for the last 15 days following an upper GI bleed and banding of oesophageal varices. He is obese (BMI 31), has alcoholic liver disease and smokes heavily. He has been assessed as unsuitable for transplantation. His ICU stay has been complicated by aspiration pneumonia, acute kidney injury and ongoing encephalopathy.**

**Discuss the potential benefits and risks of percutaneous dilatational tracheostomy (PDT) in this patient.**

Answer Template

PDT is a common procedure in Australasian ICUs to facilitate airway management and/or weaning from MV. PDT in this man may be helpful in this regard, but presents significant problems related to body habitus and acute and chronic comorbidities.

<u>Benefits:</u>

- May help facilitate ventilatory weaning
- Increased patient comfort
- Improved management of secretions
- May facilitate mobilisation during weaning
- Potentially reduced sedation requirements

- Provide a secure airway in the setting of a fluctuating conscious state

Risks:

- Difficult placement / maintenance:
    - Should mention potentially difficult airway
    - May have difficult neck anatomy as obese/increased risk of malposition or tracheal injury
    - High risk of dislodgement later on if standard trache tube used

Bleeding risk

- Likely coagulopathy secondary to CLD
- Likely thrombocytopenia secondary to portal hypertension / hypersplenism.
- May have systemic venous hypertension (portosystemic shunting, alcoholic cardiomyopathy etc.)

Infection risk

- Increased in setting of chronic liver disease
- Increased in obesity
- Poor wound healing in heavy smoker

General risks

- Loss of airway
- Pneumothorax
- Hypoxaemia (defer if $FiO_2$ > 0.6 and PEEP > 10)
- Cardiac arrest
- Death

Wisdom issues

- Prognosis guarded at best even with tracheostomy; long-term outlook is poor and it will not treat any of this man's underlying issues: therefore requires due consideration / deliberation.
- Number of prior presentations for the same problem are also a factor
- Patient's previously expressed wishes a consideration but ultimately a medical decision
- Risk/benefit ratio may not be favourable: ongoing aggressive treatment of encephalopathy with view to primary extubation may be better.
- If deemed appropriate to proceed, surgical tracheostomy may be a safer alternative

| | |
|---|---|
| **Pass Rate** | 63% |
| **Highest Mark** | 8 |

*Examiners' comments: Some candidates discussed PDT in general rather than issues as they related to this patient.*

**Question 11**

**A 65-year-old male is admitted to your intensive care unit from the haematology ward with hypotension and diarrhoea (1.5L/day). He received an allogeneic stem cell transplant 18 days ago as part of his treatment for multiple myeloma.**

**On arrival to the ICU he is febrile, tachypnoeic, with a tachycardia and hypotension and a distended abdomen, which is diffusely mildly tender.**

**Blood results on ICU admission are as follows:**

| Parameter | Patient Value | Normal Adult Range |
|---|---|---|
| **Sodium** | **137 mmol/L** | **135 – 145** |
| **Potassium** | **4.8 mmol/L** | **3.5 – 5.0** |
| **Chloride** | **99 mmol/L** | **95 – 105** |
| **Bicarbonate** | **16 mmol/L*** | **22 – 32** |
| **Urea** | **21 mmol/L*** | **3.0 – 8.5** |
| **Creatinine** | **146 micromol/L*** | **40 – 90** |
| **Albumin** | **19 G/L*** | **36 – 52** |
| **Bilirubin** | **33 micromol/L*** | **0 – 18** |
| **Alanine Aminotransferase (ALT)** | **49 IU/L*** | **0 – 30** |
| **Aspartate Aminotransferase (AST)** | **140 IU/L*** | **0 – 30** |
| **Alkaline Phosphatase (ALP)** | **120 IU/L*** | **30 – 100** |
| **Gamma Glutamyl Transferase (GGT)** | **225 IU/L*** | **0 – 35** |
| **Haemoglobin** | **84 G/L*** | **115 – 165** |
| **Platelets** | **12 x $10^9$/L*** | **150 – 400** |
| **White Cell Count** | **0.1 x $10^9$/L*** | **4 – 11** |
| **Neutrophils** | **0.0 x $10^9$/L*** | **2.0 – 7.5** |
| | | |
| **$FiO_2$** | **0.4** | |
| **pH** | **7.37** | **7.35 – 7.45** |
| **$PCO_2$** | **28 mmHg*** | **35 – 45** |
| **$PO_2$** | **108 mmHg** | |
| **$HCO_3$** | **16 mmol/L*** | **24 – 31** |
| **Base excess** | **-8 mmol/L*** | **-3 – +3** |
| **Lactate** | **8.1 mmol/L*** | **< 2.2** |
| **Glucose** | **6.2 mmol/L** | **3.0 – 7.8** |
| **Calcium** | **1.24 mmol/L** | **1.2 – 1.3** |

**a) Outline your management priorities.**

**b) List the likely causes of diarrhoea in this patient.**

Answer Template

*NB: Important points in* **bold.**

a)

This is a critically ill, **immunocompromised patient with febrile neutropenia** following a stem cell transplant. There is evidence of **septic shock with evidence of organ dysfunction** (lactic acidosis, renal, hepatic and bone marrow dysfunction)

Management priorities: **resuscitation, determination of relevant history, appropriate investigations and definitive therapy**.

i. **Resuscitation**
- Assessment of work of breathing & NIV, if required.
- Assessment of volume status/responsiveness & cardiac output, IV access and fluid resuscitation, invasive central venous and arterial lines with platelet cover, vasoconstrictor/inotrope therapy aiming for appropriate goals.
- Early antibiotic therapy.

ii. Relevant **history**
- Organ specific symptoms.
- Information about transplant, related chemotherapy, current medications.
- Prior infections/colonisations.
- Consideration of non-infectious causes - e.g. pancreatitis.

**iii. Investigations**

- Detailed **clinical examination**, **source of sepsis.**
- Blood cultures-peripheral and through existing central lines, urine, stool cultures, removal of existing lines if likelihood of infection and tip for culture.
- Investigation for diarrhoea- stool for ova, cysts, parasites, C diff toxin, P/R examination, proctosigmoidoscopy (caution due to thrombocytopenia).
- Erect AXR – rule out perforated viscous and surgical review, if indicated.
- Other **relevant imaging** based on history and examination- chest x-ray, abdominal ultrasound/CT.

**iv. Therapy**

- **Empiric antibiotic therapy** within an hour- either based on existing cultures or colonisation, allergies, recent antibiotic use, local antibiograms. Otherwise established **febrile neutropenia protocol** - Antipseudomonal, anti-staphylococcal and antifungal therapy. Dose adjustment for organ function.
- **Source control** where possible, removal of existing lines, catheters.
- **Management of diarrhoea**- fluid and electrolyte correction, loperamide if cultures negative.
- G-CSF (haematology guidance), platelet transfusion if < 20,000 or active bleeding/pre-procedure.
- Management of symptoms- pain, nausea, mucositis.
- **Establishment of nutrition**- Parenteral nutrition if severe mucositis or diarrhoea, trace element supplementation.

b) Possible causes of diarrhoea:

- **Infectious**
  - Bacterial- Clostridium difficile, salmonella, shigella, E coli including ESBL.
  - Viral - CMV, rotavirus, adenovirus, norovirus.
  - Parasitic – cryptosporidium, microsporidia, giardia.
  - Fungal- candida.

- **Non-Infectious**
  - Acute Graft versus Host Disease.
  - Neutropenic enterocolitis (Typhilitis).
  - Drugs- antibiotic related, opioid withdrawal, promotility agents, tacrolimus (thrombotic microangiopathy), chemotherapy conditioning regime for stem cell transplant.
  - Severe hypoalbuminaemia .

| | |
|---|---|
| **Pass Rate** | 80% |
| **Highest Mark** | 7.5 |

**Question 12**

**a) List the reasons why an underlying diagnosis of rheumatoid arthritis may make intubation difficult in a critically ill patient.**

**b) Briefly outline how rheumatoid arthritis may influence intensive care management of the patient following intubation**

Answer Template

a)

Musculoskeletal

- Limited neck mobility
- Cervical spine instability
- Limited mouth opening (TMJ)
- Cricoarytenoid arthritis
- Chest/spinal deformity

Pulmonary

- Underlying lung disease – e.g. ILD – further reducing her respiratory reserve

Cardiac

- Underlying cardiac disease – cardiac failure, IHD, valvular disease.
- May influence choice of induction agent(s).

Metabolic

- Impaired renal, hepatic function – more likely from medications for RA.
- May influence choice of induction/paralysing agents.

b)

Related to the RA itself

- RA can be a multisystem disease.
- Respiratory – pulmonary fibrosis, pleural effusion, reduced chest wall compliance.
- Cardiac – increased risk of IHD, pericardial disease, valvular insufficiency, cardiac failure.
- Renal – insufficiency directly related to the RA is rare, although does occur (GN, IN, amyloid).
- Haematological – e.g. anaemia (chronic disease), thrombocytopenia (Felty's).
- Amyloidosis – cardiac, renal, hepatic.
- Skin / pressure sores.
- Difficult venous / arterial access – limb deformity.
- Analgesia requirement.
- Secondary amyloidosis affecting liver spleen and kidneys.
- Decisions re-extubation if difficult intubation.
- Post-extubation – difficulties with chest physiotherapy, mobilisation.
- Psychosocial aspects of patient with chronic illness.

Related to the treatment for RA

- Immunosuppression – infectious complications.
- Other cytopaenias – anaemia, thrombocytopenia.
- Need for adequate steroid replacement if long-term use.
- Pulmonary – e.g. ILD from MTX, gold.
- Renal – more likely related to medications that RA itself – e.g. NSAIDS, cyclosporine, penicillamine, gold.
- Hepatic – e.g. MTX, Azathioprine.
- Upper GI bleeding – NSAID, SSZ use.
- Myopathy, skin breakdown, hyperglycaemia – steroids.
- Drug interactions.

| | |
|---|---|
| **Pass Rate** | 49% |
| **Highest Mark** | 7.5 |

*Examiners' comments: Candidates did not think broadly enough, e.g. in part (a) confined their answer to issues relating to C-spine disease.*

**Question 13**

*NB: Images removed from this question.*

**13.1**

**a) What does the following pressure-volume loop indicate?**

**b) What is the likely underlying diagnosis?**

Answer Template

a) Shift of the pressure volume loop to the left suggestive of increased lung compliance.

b) Emphysema (COPD).

**13.2**

**The following pressure-volume loop was obtained from a mechanically ventilated patient.**

**a) What does it indicate?**

**b) What changes would you make to the ventilator settings to correct the abnormality?**

Answer Template

a) "Beaking" pattern of lung over-distension, where airway pressure continues to rise without much increase in tidal volume.

b) Reduce the applied tidal volume.

**13.3**

**Outline <u>four</u> causes for the capnograph trace (shown below) obtained from a critically ill patient.**

Answer Template

1. Ventilator disconnection
2. Esophageal intubation
3. Cardiac/respiratory arrest
4. Apnoea test in a brain dead patient
5. Capnograph obstruction

**13.4**

**A 58-year-old female ventilated in intensive care for a week following a motor vehicle accident was noted to drop her oxygen saturation suddenly, requiring an increase in $FiO_2$ from 0.4 to 0.6.**

**The nursing staff has performed an arterial blood gas.**

| Parameter | Patient Value | Normal Adult Range |
|---|---|---|
| $FiO_2$ | 0.6 | |
| pH | 7.48* | 7.36 – 7.44 |
| $PCO_2$ | 41 mmHg (5.4 KPa) | 35 – 45 (4.6 – 6.0) |
| $PO_2$ | 86 mmHg (11.3 kPa) | |

**Ventilator data**

**Tidal Volume** **700 mL**
**Respiratory rate** **14 breaths/min**
**Peak pressures** **28 cm $H_2O$**
**Plateau pressures** **18 cm $H_2O$**
**PEEP** **7.5 cm $H_2O$**

**$SpO_2$** **94%**
**$EtCO_2$** **28 mmHg**

**What is the most likely diagnosis? Give the reasons for your diagnosis.**

Answer Template

The most likely diagnosis is a pulmonary embolus.

The reasons are as follows:

- Sudden onset of hypoxemia raises a number of possibilities – mucus plugging, pneumothorax, LVF, aspiration etc. However, the ventilation data indicate preserved compliance, normal peak pressures (argue against a pneumothorax or plugging or LVF) and there is increased dead space, (raised A-et $CO_2$ gradient)

| | |
|---|---|
| **Pass Rate** | 66% |
| **Highest Mark** | 9.75 |

**Question 14**

**With regards to Clostridium difficile (C. difficile) infection in critically ill patients:**

**a) What are the risk factors for development of this condition?**

**b) What complications can occur as a result of this infection?**

**c) How is the diagnosis of C. difficile and its complications established?**

**d) Briefly outline the options for prevention and treatment.**

Answer Template

a) Risk factors:
- Exposure to antibiotics
  - Clindamycin
  - Cephalosproins
  - Fluoroquinolones
  - Extended spectrum penicillins
- Extremes of age
- Immunosuppression
- Proton pump inhibitors and H2 antagonists
- Nursing home or group care home

b) Complications:
- Related to the diarrhoea
  - Hypovolaemia
  - Electrolyte disturbance; hypokalaemia, hypomagnesaemia
- Related to the intestinal infection
  - Sepsis and septic shock
  - Perforation
  - Toxic megacolon
  - Bleeding

c) Diagnosis:
Clinical and investigation:
- Clinical findings
  - Diarrhoea, but may have severe disease without diarrhoea
  - Abdominal pain, colic in nature
  - Fever
  - Shock
- Microbiology
  - Stool; C. difficile toxin (false negatives problematic)
  - PCR for C. difficile (false positives problematic)
  - ELISA for C difficile glutamate dehydrogenase
- Sigmoidoscopy, colonoscopy
  - Pseudomembranes
- CT scan
  - Abdominal and pelvis
  - Oral and ivi contrast
  - Helps to diagnose complications such as toxic megacolon, perforation and exclude differential diagnosis

d)
Prevention and treatment:

Prevention
- Antibiotics stewardship, limitation of broad spectrum antibiotics
- Isolation of C diff positive cases with notices advising contact precautions
- Limit spread with hand washing with soap and water, alcohol hand rub is ineffective

Treatment
- Supportive care and resuscitation
- Specific
  - Medical
    - Antibiotics;

        - Oral vancomycin (250 – 500 mg enteral q6h)
        - Metronidazole oral or ivi
        - Tigecycline
    - Surgical
        - For perforation or toxic megacolon
        - Subtotal colectomy
    - Monoclonal antibodies and vaccine under development
    - Faecal transplant
        - More for recurrent infection than for acute severe illness

| | |
|---|---|
| **Pass Rate** | 57% |
| **Highest Mark** | 8.0 |

*Examiners' comments: Overall, candidates' knowledge of this topic was limited.*

**Question 15**

**You are asked to review the guidelines for transfusion of packed red blood cells in critically ill patients in your hospital.**

**Outline the steps that you will take to achieve this.**

Answer Template

1. Form a multidisciplinary team including medical, nursing and haematology/blood bank staff to help you prepare the guideline.

2. Review current guidelines of your unit if available. Review the date of publication of those guidelines and times of updates.

3. Audit the indications and volume of transfusions in your ICU.

4. Review the current literature for packed cell transfusion. In particular review any statements or guidelines form national blood bank authority or professional bodies. In the absence of strong evidence, expert opinion is available in these statements.

5. Determine the relevance of the current literature to you case mix – e.g. transfusion threshold for stable post cardiac surgical patients are important.

6. Prepare a draft guideline and circulate widely including to ED/ theatres / haematology.

7. Review comments and issues raised after circulating draft guidelines.

8. Prepare final guideline and circulate and publish for use in your ICU.

9. Plan to monitor compliance with these guidelines.

10. Date for future review.

| | |
|---|---|
| **Pass Rate** | 57% |
| **Highest Mark** | 9.25 |

**Question 16**

a) **Give the differential diagnosis for hypercapnic respiratory failure.**

b) **Outline features from the clinical examination that assists in making a diagnosis/diagnoses**.

Answer Template

Differential Diagnosis:

1. CNS:
    1. Drugs (prescription, illicit, deliberate ingestion/OD)
    2. Brain stem lesion
    3. Any intra cranial lesion with mass effect (haemorrhagic stroke or traumatic brain injury),
    4. Central Sleep Apnoea
2. Spinal Cord:
    1. Cervical spinal cord injury/tumour
3. Peripheral Neuro-muscular:
    1. Polio, MND, Guillan Barre, Myopathies, Myasthaenia Gravis
4. Chest wall:
    1. Kyphoscoliosis, ankylosing spondylitis
    2. Obesity-hypoventilation syndrome
5. Respiratory:
    1. Asthma/COPD
    2. Obstructive sleep apnoea
    3. Re-breathing / increased dead space
6. Cardiovascular:
    1. Acute severe left heart failure

Clinical examination

1. Neurological:
    a. Cranial nerves
    b. UMN and LMN signs.
2. Chest wall and rib cage mechanics:
    a. Evaluation of thoracic cage component
    b. Effect of obesity on ventilation
3. Respiratory:
    a. Signs of acute on chronic bronchospasm, chronic lung disease
4. Cardiovascular:
    a. Signs of Cor Pulmonale
    b. Signs of Left heart failure (dilated cardiomyopathy/valvular heart disease)

| | |
|---|---|
| **Pass Rate** | 71% |
| **Highest Mark** | 8.5 |

**Question 17**

a) **List the features which distinguish diabetic ketoacidosis (DKA) from the hyperosmolar hyperglycaemic state (HHS).**

b) **Describe your specific treatment for a 62-year-old female presenting with a decreased conscious state secondary to HHS.**

Answer Template

a)

1. History
    i. Known type 1 DM; discontinuation of insulin therapy
    ii. Presentation: DKA evolves rapidly (24 hours); HHS typically days-weeks with polydipsia, polyuria and weight loss.

2. Clinical features
    i. Neurological symptoms more common in HHS.
    ii. Abdominal pain and hyperventilation more common in DKA.

3. Laboratory features
    i. Degree of hyperglycaemia (HHS typical higher, exceeding 56 mmol/l; DKA usually < 44 mmol/L)
    ii. Degree of acidosis: severe in DKA, mild in HHS
    iii. Anion gap acidosis present in DKA; absent (or mild in case of concomitant lactic acidosis) in HHS
    iv. Ketones: HHS small ketonuria, absent to low ketonaemia [there is sufficient basal insulin secretion to prevent ketogenesis]; both high in DKA
    v. Hyperosmolality more severe in HHS, typically > 320 mosm/L

4. NOTE: Significant overlap can occur in 30% of patients – represent part of a spectrum

b)

1. Fluid replacement
    i. Expect fluid replacement of up to 10 litres, but GO SLOW (replace over 48 hours)
    ii. Start with isotonic crystalloids (boluses if in shock, infusion rate up to 1L/hour). Need justification for choice of fluid, while recognising there is substantial controversy in this area.
    iii. Continue isotonic if serum $Na^+$ low; change to 0.45% NaCl if serum $Na^+$ is normal or elevated.
    iv. Change to 5% dextrose with 0.45% NaCl when serum glucose reaches 15 mmol/L or below
    v. Individual tailoring based on heart rate, blood pressure, peripheral perfusion, urine output

2. Insulin infusion 0.05 U/kg/hr. initially following adequate fluid resuscitation aiming for steady but slow reduction in blood sugar levels (e.g. 5 mmol/hr)

3. Electrolyte replacement
    i. Expect potassium deficit even if level appears normal
    ii. Give 20 - 30 mmol $K^+$ in each Litre of fluid or use separate infusion; aim for serum $K^+$ 4 – 5 mmol/L
    iii. Phosphate depletion only requires treatment if levels are very low (e.g. < 0.3 mmol/L) or symptomatic (Ref: BMJ best practice)

4. Treat possible precipitating cause (infection? need for broad spectrum antibiotics? Think about underlying precipitant in this case – there is a long list of possible causes (e.g. pancreatitis). What about drugs [both β blockers and HMGCo-A reductase inhibitors have been associated with HHS. Other common precipitating drugs e.g. antipsychotics, steroids…] Does she even have diabetes? [Check HbA1C].

5. Thromboprophylaxis mandatory – consider risks and benefits of heparin infusion.

6. Monitor
    i. Haemodynamic situation
    ii. Mental state
    iii. Urine output
    iv. Levels of glucose and electrolytes every 1 – 4 hours
    v. Levels of ketones in DKA

7. Consider CT brain scan (possibility of ischaemic stroke).

| | |
|---|---|
| **Pass Rate** | 51% |
| **Highest Mark** | 7.75 |

**Question 18**

*NB: Images removed from this question.*

**18.1**

**A 65-year-old male presents to the Emergency Department (ED) with persisting chest pain for one week, following an acute severe episode that lasted for two hours. His 12-lead ECG, (ECG 1), taken on presentation to ED, is shown below.**

**a) Describe the ECG changes.**

**b) What is the most likely diagnosis?**

**The patient develops worsening chest pain and becomes more tachypnoeic and hypotensive.**

**c) Give <u>two</u> likely causes for this deterioration.**

Answer Template

a)

- Atrial fibrillation with a controlled ventricular response
- Right Bundle Branch Block
- Q-waves V1- V5 and which are wide
- Left axis deviation
- ST elevation anterior and inferior
- ST depression in aVL

b)

- Recent transmural anterior MI with resulting ventricular aneurysm

c)

- Aneurysm rupture
- Septal rupture causing a VSD
- Cardiac tamponade
- Papillary muscle rupture
- Re-infarction
- (Pulmonary embolus)

**18.2**

**A 45-year-old male has been admitted to the hospital for investigation of syncope. He has a MET call for another syncopal episode. His 12 lead ECG is shown below (ECG 2).**

**a) Describe the ECG changes.**

**b) What is the most likely diagnosis?**

**c) What is the underlying pathophysiology?**

**d) List <u>four</u> clinical situations that can worsen this condition.**

Answer Template

a)

- Coved ST segment elevation V1 – V2 > 2 mm.
- Subsequent negative T wave in the same leads.

b)

- Brugada syndrome (Type 1).

c)

- A mutation in the cardiac sodium channel gene.

d)

- Fever.
- Myocardial ischaemia.
- Medications
    - E.g. Flecainide, Amitriptyline, Lithium, Bupivacaine, Propofol, Alcohol.
- Hypokalaemia.
- Hypothermia.
- Cardioversion.

**18.3**

**A 75-year-old female admitted to the ICU with community-acquired pneumonia suddenly develops a tachycardia. Her 12 lead ECG is shown below (ECG 3).**

**a) What is the diagnosis? Justify your answer.**

**b) Name <u>two</u> co-existing diseases in critically ill patients where this condition is commonly seen.**

Answer Template

a)

- Multifocal atrial tachycardia
- Irregularly irregular rhythm rate > 100 bpm
- Multiple P wave morphologies

b)

- COPD
- Congestive cardiac failure

| | |
|---|---|
| **Pass Rate** | 40% |
| **Highest Mark** | 8.0 |

**Question 19**

**With respect to the management of a multi-trauma patient requiring mechanical ventilation:**

**Describe the injuries that require specific positioning or immobilisation of the patient and the strategies used in this context.**

**Include in your answer how these strategies impact upon the care of the patient.**

Answer Template

Patients with "unstable" injuries may be at risk of secondary injury if passive or active movements are not limited.

Brain- Traumatic Brain Injury:

- Head up (venous drainage)
- May be at odds with spinal precautions
- Priority given to greatest identified injury
- Can nurse flat in bed, with entire bed angled head up
- Avoid venous obstruction if TBI (collar and jugular CVC)

C-Spine injury

- Collar (which type not esp evidence based- Philadelphia/Aspen/hard collar)
- Particular attention to head hold in movement including airway manipulation
- Lie flat (but can tilt bed if head elevation dictated by underlying TBI)
- Log roll acceptable but recommended to use 4 people
- Can side lie with wedge to minimise pressure injury
- Should aim to remove collar as early as possible, and many trauma hospitals institute a Radiological clearance protocol using CT or MRI.
- If injury is identified then collar should not be removed until definitive treatment is defined (fixation/hard collar/conservative mx)
- Prolonged collar placement may lead to pressure injuries
- C-spine collar may make airway access more difficult

Thoraco-lumbar spine injury

- Lie flat (no bending) or side lie with a wedge.
- Log roll (4 person).
- Radiologic clearance protocols used commonly.

Pelvic fractures

- Haemodynamic instability may be related to pelvic injury
- Mechanically unstable pelvic fractures may be worsened by rolling/side lie/ sitting
- Pelvic binders may be required if haemodynamically unstable
- Additional fixation once injury identified- or removed if not.

Long bone fractures

- No universal position restrictions
- In event of clinical suspicion long bones should be immobilised to prevent embolic and haemorrhagic complications and pain

Other points

Competing injuries- precautions should relate to the most serious identified injury - e.g. a cleared spine may mean a patient can be sat up, but not in the setting of a co-existing mechanically unstable pelvis.

Likewise:

- Management of ICP in TBI takes precedence over use of cervical collars.
- Chest injuries/hypoxia takes precedence over spinal precautions
- Intubation and securing the airway takes precedence over cervical collars/head holds

Urgency exists in identifying injuries at the earliest possible time (secondary and tertiary survey) in order to remove or increase position restrictions for the individual patient.

Emphasis should be on own practice, no single "right way" but sensible risk/benefit based approach including clinical and radiologic findings to guide practice.

| | |
|---|---|
| **Pass Rate** | 37% |
| **Highest Mark** | 6.5 |

*Examiners' comments: Candidates who did not pass this question did not think broadly and gave a limited answer and did not adequately address the issue of competing injuries and risk v benefit.*

**Question 20**

**A 57-year-old female has required intubation and mechanical ventilation for hypoxaemic respiratory failure with symptoms of cough and dyspnoea that have been gradually progressive over 4 weeks. There is a diffuse bilateral infiltrate on CXR.**

**She has a history of rheumatoid arthritis and is receiving treatment with methotrexate and prednisolone and has no previous history of respiratory disease.**

**a) List the likely differential diagnosis.**

**b) Briefly outline the specific management issues relating to diagnosis and treatment of this patient, excluding acute resuscitation.**

Answer Template

a) Differential Diagnosis:
    1. Bacterial/atypical Pneumonia
    2. Opportunistic Infections:
        a. Viral: Influenza/CMV/other Herpes Viruses
        b. Fungal: Aspergillus/Cryptococcus
        c. Other Organisms: PCP/PJP
    3. Related to Rheumatoid Arthritis:
        a. Methotrexate-induced pneumonitis
        b. Rheumatoid Lung Disease

4. Acute cardiac failure e.g. secondary to valvular heart disease, ischaemic cardiomyopathy

b) Management issues:
    1. Diagnostic investigations:
        a. HRCT/CTPA
        b. Bronchoscopy +/- lung biopsy (level of respiratory support may determine whether these investigations are possible)
        c. Echo
    2. Cease methotrexate
    3. Steroids
        a. Consider increasing the dose of steroid to cover “stress response”
        b. Consider treatment dose associated with PCP/PJP treatment
        c. Consider high-dose pulse of steroids
    4. Empirical anti-infective treatment (complex decision, treatment may be associated with toxicity)
        a. Broad spectrum antibiotic e.g. 3rd generation cephalosporin/aminoglycoside
        b. Atypical cover
        c. Oseltamivir
        d. High dose Co-trimoxazole: monitor for Myelotoxicity
        e. Gangcyclovir: monitor for Retinitis, Myelotoxicity
    5. Specific treatment for cardiac disease

| | |
|---|---|
| **Pass Rate** | 40% |
| **Highest Mark** | 8.25 |

**Question 21**

*NB: Images removed from this question.*

**21.1**

**Name the dermatomes indicated by the letters A to H and L to R in the figure below.**

Answer Template

A = C4, B = C5, C = T3, D = T2, E = C6, F = T1, G = C7, H = C8,
L = C4, M = T2, N = C5, O = T1, P = C6, Q = C8, R = C7

**21.2**

**For each of the following <u>three</u> clinical photographs, name the side of the lesion and the cranial nerve/s involved.**

Answer Template

(a) Left Glossopharyngeal (IX) cranial nerve.

(b) Right Hypoglossal (XII) cranial nerve.

(c) Left Facial (VII) and Left Abducens (VI) nerves.

**21.3**

**This patient has been instructed to look to her left (image A) and then to her right (image B).**

**(a) Name the phenomenon observed.**

**(b) List <u>two</u> possible locations for the lesion associated with this observation.**

**(c) If this patient were also hemiplegic, which side would be paralysed?**

Answer Template

(a) Horizontal gaze palsy (right)

(b) Any two:
- Frontal eye field
- Posterior hemispheric lesion
- Pre-pontine Reticular Formation (PPRF)
- Abducens (VI) nerve nucleus

(c) Right sided paralysis.

| | |
|---|---|
| **Pass Rate** | 37% |
| **Highest Mark** | 6.4 |

**Question 22**

**A 62-year-old male is admitted to the ICU post-operatively having undergone a transthoracic oesophagectomy for squamous cell carcinoma of the oesophagus. The patient was extubated at the end of the operation but requires re-intubation two days post-surgery due to respiratory failure.**

**a) List the likely underlying causes of respiratory failure specific to this clinical situation.**

**b) List the pros and cons of non-invasive ventilation in this clinical situation.**

**c) Briefly outline the principles of management of an anastomotic leak in this patient.**

Answer Template

a)
- Pre-existing COAD.
- Diminished airway protection /Altered mental status.
- Chronic aspiration due to impaired preoperative oesophageal function.
- Postoperative aspiration due to recurrent laryngeal nerve compromise and/or inability to swallow.
- Surgical complication including anastomotic breakdown or conduit ischaemia.
- Postoperative pain.
- Pleural effusion.
- Chylothorax.
- Myocardial ischaemia.
- Cardiac failure.
- Weakness due to pre-existing malnutrition.

b)

Pros

- May reduce need for invasive ventilation
- Decreased need for sedation as opposed to invasive ventilation
- Many of the these patient have COAD – reduces work of breathing
- May decrease risk of VAP

Cons

- Oesophageal anastomosis might be compromised and oesophageal leak is a devastating complication
- Many of these patients are at high risk of aspiration

c)

- Assurance of adequate perfusion – maintain good MAP, maintain euvolemia, (avoid vasopressors if possible).
- Adequate source control- all leaks must be adequately drained by re-operation or percutaneous drainage.
- Cessation of contamination – Nil by mouth and well positioned NG tube with free drainage.
- Appropriate nutritional support e.g. enteral feed via jejunostomy
- Endoscopy to assess graft viability if concerned.
- Consider oesophageal stent
- Broad-spectrum antibiotics such as Tazocin and consider anti-fungals – Fluconazole after culture of blood and other secretions.
- In general, cervical leaks can be managed with drainage of neck wound at the bedside, while thoracic leaks are likely to need open re-exploration and drainage

| | |
|---|---|
| **Pass Rate** | 34% |
| **Highest Mark** | 8.0 |

**Question 23**

**A 39-year-old female is admitted to a tertiary centre and intubated and ventilated for severe Legionella pneumonia. Two days after admission to ICU she remains profoundly hypoxaemic ($PaO_2/FiO_2$ = 55), despite optimising ventilatory support and appropriate antimicrobial therapy.**

**a) Outline the factors that would influence your decision whether or not to institute extra-corporeal membrane oxygenation (ECMO) in this patient.**

**b) Outline the relative merits of veno-venous (V-V) and veno-arterial (V-A) ECMO for this patient.**

Answer Template

a)

ECMO is indicated for potentially reversible life-threatening cardiac and/or respiratory failure unresponsive to conventional support, buying time for recovery from the underlying condition and specific treatment to take effect.

This patient meets criteria for ECMO with a potentially reversible condition (Legionella pneumonia) and P/F < 60 and age < 65 years.

Alternative treatment strategies

- Ensure all other strategies have been tried – (e.g. - recruitment manoeuvres, prone positioning, NO/inhaled prostacyclin, diuresis, etc.)
- Exclude easily treated reversible problem e.g. pneumothorax, mucous plugging
- Ensure optimisation of haemodynamics, consider measurement of adequacy of $DO_2$

Exclude contra-indications / relative contra-indications – severe pre-existing organ dysfunction, presence of other severe co-morbidities e.g. advanced malignancy, co-existing irreversible lung/cardiac pathology, and presence of bleeding disorder.

Available resources – appropriate level of expertise with trained staff to insert catheters, set up, monitor and troubleshoot ECMO circuit, and adequate equipment.

*(Reference to meeting unit/regional criteria for institution of ECMO, or similar, are an acceptable answer.)*

b)
Choice of V-V or V-A ECMO will depend on co-existing cardiogenic shock. V-A ECMO provides complete cardio-respiratory support, whereas V-V ECMO only provides respiratory support. If profound septic shock with myocardial depression and EF<25%, V-A ECMO indicated. If adequate cardiac function then V-V ECMO indicated otherwise significant native blood pulmonary blood flow and cardiac output results in relatively hypoxic perfusion of upper body compared with lower half.

V-V ECMO also avoids risks of serious arterial injury, has less severe consequences in case or air or clot embolization, and as a low-pressure system may prolong circuit life.
Animal studies suggest preservation of pulmonary blood flow with V-V ECMO may improve recovery from lung sepsis compared with V-A ECMO.

| | |
|---|---|
| **Pass Rate** | 43% |
| **Highest Mark** | 7.0 |

**Question 24**

**a) Briefly explain the concept of the quantitative approach (Stewart's approach) to acid-base analysis.**

**b) How does the quantitative approach classify acid-base disturbances?**

Answer Template

a)
The quantitative approach to acid-base chemistry provides a mathematical explanation of the relevant variables that control $H^+$ in body fluids and their interactions. The approach treats body fluids as a sys- tem that contains multiple interacting constituents.

The Henderson-Hasselbach approach to evaluating acid-base status considers the interactions of only a few variables in the system, such as pH, $PCO_2$, and bicarbonate, whereas Stewart considers the interactions among more variables and allows one to identify the variables that control $H^+$.

Quantitative approach uses physical laws of aqueous solutions to write equations that describe the interactions among the variables in the system. These laws are the maintenance of electrical neutrality, the satisfaction of the dissociation equilibria for weak electrolytes (partially dissociated when dissolved in water), and the conservation of mass.

An important basic concept of Stewart's principles is the classification of variables in a system as independent or dependent. Independent variables can be altered from outside the system without affecting each other. Dependent variables are thought of as internal to the system. Their values depend on the values of the independent variables and reflect the behaviour of the equilibrium reactions in the system.

Three independent parameters are known to control acidity in arterial or venous plasma. These parameters are the strong ion difference (SID), which summarises the strong or fully dissociated electrolytes, the total weak acid concentration ($A_{tot}$), which summarises the non-volatile weak or partially dissociated electrolytes, and the partial pressure of carbon dioxide ($PCO_2$). It is these 3 independent variables that control $[H^+]$.

Basic equation such as below should feature:
$[SID] = [Na^+] + [K^+] + [Ca^{2+}] + [Mg^{2+}] - [CL^-]$ - [Other Strong Anions/lactate].
$[A_{TOT}] = [Pi_{TOT}] + [Pr_{TOT}]$ + albumin.

b)
*Classification of Primary Acid–Base Disturbances*

| | | |
|---|---|---|
| Respiratory | ↑ $PCO_2$ | ↓ $PCO_2$ |
| Non-Respiratory | | |
| *a. Abnormal SID* | | |
| i .Water excess/deficit | ↓ SID, ↓ $[Na^+]$ | ↑ SID, ↑ $[Na^+]$ |
| ii. Imbalance of strong anions | | |
| Chloride excess/ deficit | ↓ SID, ↑ $[Cl^-]$ | ↑ SID, ↓ $[Cl^-]$ |
| Unidentified anion excess | ↓ SID, ↑ $[XA^-]$ | |
| *b. Non-volatile weak acids* | | |
| i. Serum albumin | ↑ [Alb] | ↓ [Alb] |
| ii. Inorganic phosphate | ↑ [Pi] | ↓ [Pi] |

Indicate essential points to achieve pass:
Clear description of the quantitative approach. This question is not intended to be answered at PhD biochemistry level but rather at a level that demonstrates a good consultant understanding of the issues e.g. if asked by a visiting team about quantitative acid-base.

| | |
|---|---|
| **Pass Rate** | 5.7% |
| **Highest Mark** | 7.5 |

*Examiners' comments: Candidates were not expected to have an advanced knowledge of biochemistry but an overall understanding of the principles involved e.g. to allow an explanation of the issues to colleagues.*

**Question 25**

*NB: Images removed from this question.*

**Examine the single slice non-contrast CT image, depicted below, of a 58-year-old male who was brought to the Emergency Department with a headache. He was not on any medication.**

**a) Name the structures labelled A- E.**

**b) Describe lesion F as you would on the phone to a neurosurgical colleague.**

**c) Give <u>three</u> pathological causes for F.**

**A day after the CT scan the patient's Glasgow Coma Scale drops from 13 to 10.**

**d) Give <u>three</u> possible intracranial causes for this.**

**e) List <u>five</u> validated features affecting prognosis for patients with F.**

Answer Template

a)

A Left frontal cortex
B Caudate nucleus
C Top of quadrigeminal cistern (not 3rd or 4th ventricle)
D Septum pellucidum
E Posterior horn of left lateral ventricle

b)

*'Acceptable' answer:*

There is a hyperdensity in keeping with an intracerebral haematoma in the right frontoparietal region with midline shift and surrounding oedema.

c)

- Hypertensive haemorrhage.
- AV malformation.
- Haemorrhagic transformation of ischaemic stroke.
- Bleed into tumour.
- (No evidence of subarachnoid haemorrhage).

d)

- Expanding haematoma / Worsening oedema / mass effect.
- Seizure (including non-convulsive).
- Hypdrocephalus due to obstruction of ventricles.

e)

The features included in the intracerebral haemorrhage score are:

- Age: < 80 or > 80
- GCS: on transfer from the ED to definitive to care.
- Location of bleed: supra vs infra tentorial.
- Volume of Bleed: < 30 mL or > 30 mL.
- Intraventricular extension of haemorrhage.

| | |
|---|---|
| **Pass Rate** | 77% |
| **Highest Mark** | 8.1 |

**Question 26**

**With reference to clinical studies:**

**a) Define the term "external validity".**

**b) Define the term "bias".**

**c) Briefly explain selection bias and measures to reduce it.**

Answer Template

a) External validity is the extent to which the results of a study can be generalised to other situations, e.g. different case-mix

b) Bias in statistics is defined as systematic distortion of the observed result away from the "truth", caused by inadequacies in the design, conduct, or analysis of a trial.

c) Selection bias is caused by a systematic error in creating intervention groups, such that they differ with respect to prognosis. The study groups differ in measured or unmeasured baseline characteristics because of the way participants were selected or assigned. Selection bias also means that the study population does not reflect a representative sample of the target population. Selection bias undermines the external validity of the study and the conclusions drawn by the study should not be extended to other patients.

Measures to reduce selection bias include:

- Randomisation: Randomisation assigns patients to treatment arms by chance, avoiding any systematic imbalance in characteristics between patients receiving experimental versus the control intervention.
- Allocation concealment: The allocation sequence is the order in which participants are to be allocated to treatment. Allocation concealment involves not disclosing to patients and those involved in recruiting trial participants, the allocation sequence before random allocation occurs.

| | |
|---|---|
| **Pass Rate** | 77% |
| **Highest Mark** | 8.25 |

**Question 27**

**A 59-year-old male is admitted to the ICU following a severe traumatic brain injury sedated, intubated and ventilated.**

**a) List the arguments for and against intracranial pressure (ICP) monitoring in this patient.**

**b) Explain the term "secondary brain injury" and list the steps to avoid this.**

Answer Template

a)
For:

- This patient has about a 50 – 60% chance of developing raised ICP.
- It is critical that CPP is maintained and to know the CPP need to know the ICP.
- ICP is a strong predictor of outcome after severe TBI.
- Several studies have shown substantial lowering of mortality after ICP monitoring and control was introduced.
- Numerous studies have also shown that patients who respond to ICP-lowering therapies have a lower mortality compared to those who don't, allowing some prognostication.
- Internationally accepted BTF Guidelines advise ICP monitoring in patients with severe TBI (GCS < 9) and an abnormal CT scan.
- Doesn't lead to greater intensity of treatment or ICU LOS compared to no ICP
- If EVD allows CSF drainage and analysis.
- Early diagnosis of secondary surgically correctable lesion e.g.: delayed subdural haematoma.

Against:
- Risks associated with brain injury associated coagulopathy.
- Other risks – infection, false readings and risks of avoidable interventions (osmotherapy, falsely elevating CPP, deep sedation).
- BEST TRIPPS study showing no difference in outcome.
- May require transfer to OT for insertion.

b)
- Secondary injury occurs at any time after the primary injury, and thus should theoretically be preventable and is caused primarily by:
    - Hypoxia
        - Ensure a $PaO_2$ > 80 and/or $SpO_2$ > 92%
    - Hyper/hypocarbia
        - $PaCO_2$ 35 - 40mmHg
    - Hypotension
        - SBP > 90 mmHg and/MAP > 70 mmHg / CPP > 50 mmHg
    - Metabolic disturbance (Na, glucose, osmo)
        - Na+ of 140 – 150 mmol/L, glucose 6 – 10, Serum osmo 320 mOsm/L
    - Fever
        - Normothermia
    - Seizures
        - Phenytoin x 72hrs
    - Raised ICP
        - ICP lowering therapy (head up $30^o$, neck neutral alignment, sedation and paralysis, osmotherapy, drain CSF, surgical decompression)
    - Secondary surgical lesion (delayed subdural/parenchymal haemorhage)
        - Repeat CT, surgical therapy

| | |
|---|---|
| **Pass Rate** | 97% |
| **Highest Mark** | 8.5 |

**Question 28**

**The following questions relate to the ventilatory management of a critically ill adult patient with asthma.**

**(Assume the patient has adequate sedation and analgesia, and that optimum treatment for bronchospasm has commenced.)**

**a) Outline your optimal initial ventilator settings for volume control ventilation. Explain your rationale.**

**b) Outline the utility of the following three ventilatory measures in monitoring for dynamic hyperinflation (DHI). Explain your reasoning. (Assume patient on volume controlled mode).**

**i. Peak airway Pressure (Ppk)**

**ii. Intrinsic or Auto PEEP (PEEPi)**

**iii. Plateau Pressure (Ppl) include in your answer how Ppl is measured**

Answer Template

a)
**Key concept** is to avoid **dynamic hyperinflation (DHI**) - most effectively done **by reducing minute volume (Ve), <10l/min** to provide "**controlled hypoventilation**". Tolerate hypercapnia and ensure oxygenation. Settings must be individualised as dictated by measures of DHI.

- Suggested start up settings: Mode; Volume-controlled; High inspiratory flow rate 60 – 80 L/min (also reduces inspiratory time), long expiratory time ( Exp time 4 – 5s or I:E > 1:3) achieved by low respiratory rate 8 – 12 breaths/min (may need lower), & Small Vt 6 – 8 (10) mL/kg, extrinsic PEEP usually set at 0 (use of PEEP controversial however), $FIO_2$ for $SpO_2$ > 90% (oxygenation not usually major issue in pure asthma) , set Ppeak limit to 40 – 45 $cmH_2O$, maybe higher.

b)

i. Peak Pressure: **Not** useful for assessing DHI. Ppk represents the sum of pressures required to overcome the elastic recoil pressure of the inflated respiratory system and to overcome resistance in the airway. Changes in airway resistance and inspiratory flow may alter Ppk without affecting DHI. In particular, an increase in flow used to shorten inspiratory time in an effort to promote sufficient expiratory time may increase Ppk even though DHI decreases.

ii. PEEPi: May **underestimate** end expiratory alveolar pressure – marked DHI may occur despite low levels of PEEPi, especially at low respiratory rates. This may be due to widespread airway closure that prevents accurate assessment of alveolar pressure at end expiration.

iii. Plateau Pressure: **The best assessment of DHI**. Alveolar pressure will increase as lung volume goes up so Pplat reflects gas trapping. Measure at end inspiration with a 2s pause – pressure falls from peak (static plus resistive) to Pplat (static). Must be no leaks in system and patient generally sedated paralysed to get reliable measure. Aim < 25 – 30 $cmH_2O$.

| | |
|---|---|
| **Pass Rate** | 80% |
| **Highest Mark** | 8.0 |

**Question 29**

**A 55-year-old patient with severe sepsis develops Heparin Induced Thrombotic Thrombocytopaenia Syndrome (HITTS) while on continuous veno-venous haemodiafiltration (CVVHDF).**

**Outline the strategies available for prolonging the life of the CVVHDF circuit in this patient, mentioning the advantages and disadvantages of each strategy.**

Answer Template

Ensure good wide bore access, high flow rates, consider predilution.

No Anticoagulant +/- Saline Flushes (50 – 100 mL every hour)

Advantage:

- Minimizes bleeding risk.

Disadvantage:

- Shortened filter life / increased time off dialysis.
- Alternative systemic anti-coagulant required for treatment of underlying HITTS.

Regional citrate

Advantage:

- Provides good regional anticoagulation.
- Pre-mix solutions and protocols for use have simplified process.

Disadvantage:

- Requires diligent monitoring of serum sodium, ionized calcium, and bicarbonate.
- Requires infusion of calcium outside the circuit (access issues).
- Large sodium load occurs when trisodium citrate used.
- May cause alkalosis.
- Special diasylate required: hyponatraemic, without buffer, Ca free.
- Not appropriate in liver failure.
- Alternative systemic anti-coagulant required for treatment of underlying HITTS.

Prostacycline and Analogues

Advantages

- Reduced bleeding risk.

Disadvantages

- Shorter filter life.
- Hypotension.
- Alternative systemic anti-coagulant required for treatment of underlying HITTS.

Direct thrombin Inhibitors: Bivalirudin / Hirudin / Lepirudin / Argatroban

Advantages:

- Linear relationship between levels and APTT (< 100s) for Hirudin.

Disadvantages

- Renal clearance, accumulation in renal failure (Bivalirudin, Hirudin, Lepirudin) Hepatic metabolism, accumulation in liver disease (Argatroban) No antagonist.
- Argatroban falsely raises INR / PT.
- Expense.

Other agents

Danaparoid

- Limited availability
- Risk of cross-reactivity with heparin-induced antibodies
- Hard to monitor

| | |
|---|---|
| **Pass Rate** | 43% |
| **Highest Mark** | 7.5 |

**Question 30**

**30.1**

**You are asked to review an 80-year-old female in the Emergency Department who has presented with a depressed conscious state. She has ischaemic heart disease and paroxysmal atrial fibrillation. Her medication includes aspirin, metoprolol, and amiodarone.**

**On examination she has a temperature of 34.5$^{o}$C, she is drowsy with a GCS of 10, a pulse of 50 beats/min and a blood pressure 90/40 mmHg. CT brain scan shows age related atrophy. The blood results are as follows:**

| Parameter | Patient Value | Normal Adult Range |
|---|---|---|
| **Sodium** | **120 mmol/L*** | **137 – 145** |
| **Potassium** | **4.0 mmol/L** | **3.5 – 5.0** |
| **Urea** | **6.0 mmol/L** | **2.5 – 7.5** |
| **Creatinine** | **90 micromol/L** | **50 – 100** |
| **Measured Osmolality** | **255 mmol/kg*** | **280 – 300** |
| **Glucose** | **3.0 mmol/L*** | **3.5 – 6.0** |
| **CK** | **1000 U/L*** | **20 – 200** |
| **Cholesterol** | **7.2 mmol/L** | **3.0 – 5.5** |

**a) Give the likely diagnosis and the underlying cause to account for all these blood results.**
**b) List <u>four</u> measures essential for the specific management of this patient.**

Answer Template

a)
Hypothyroidism secondary to amiodarone toxicity.

b)

- Commence thyroxine, probably low dose (50 – 100ug/day and slowly increase) or consider T3 orally or intravenously (give cautiously).
- Commence on glucocorticoids (Hydrocortisone 50 mg 6 hourly).
- Correct the hypoglycaemia with intravenous glucose.
- Correct the hyponatraemia very slowly with hypertonic saline to sodium.
- 130 mmol/L (no more than 2 mmol/L per hour).

**30.2**

**A 35-year-old female with a history of poorly controlled hypertension presents with paraesthesia and weakness. Her blood results are shown below:**

| Parameter | Patient Value | Normal Adult Range |
|---|---|---|
| **Sodium** | **145 mmol/L** | **135 – 145** |
| **Potassium** | **1.8 mmol/L*** | **3.5 – 5.0** |
| **Chloride** | **85 mmol/L*** | **95 – 105** |
| **Bicarbonate** | **40 mmol/L*** | **24 – 32** |
| **Urea** | **3.4 mmol/L** | **3.0 – 8.5** |
| **Creatinine** | **80 micromol/L** | **70 – 110** |

| Parameter | Patient Value | Normal Adult Range |
|---|---|---|
| **pH** | **7.56*** | **7.35 – 7.45** |
| **$pO_2$** | **85 mmHg (11.3 kPa)** | |
| **$pCO_2$** | **46 mmHg* (6.1 kPa)*** | **35 – 45 mmHg (4.6 – 5.9 kPa)** |
| **Bicarbonate** | **40 mmol/L*** | **24 – 32** |
| **$FiO_2$** | **0.21** | |

**a) Interpret these results.**

**b) List <u>two</u> likely diagnoses.**

**c) Give <u>two</u> drugs used to treat this condition.**

Answer Template

a)
Metabolic alkalosis with partial respiratory compensation and severe hypokalaemia.

b)
- Primary Hyperaldosteronism most likely secondary to an aldosterone producing adenoma (Conn's syndrome – 50 – 60%) or adrenal hyperplasia (40 – 50%).
- Licorice ingestion.
- Liddle's syndrome.
- Excessive diuretic use.

c)
- Aldosterone antagonist (spirinolactone or eplerenone).
- Amiloride.

**30.3**

**The following set of arterial blood gases were obtained from a patient admitted to the ICU after a suicide attempt.**

| Parameter | Patient Value | Normal Adult Range |
|---|---|---|
| **pH** | **6.84*** | **7.36 – 7.44** |
| **$PCO_2$** | **94 mmHg* (12.3 kPa)** | **36 – 44 (4.6 – 5.9)** |
| **$PO_2$** | **140 mm Hg (18.4 kPa)** | |
| **P50** | **24 mm Hg** | |
| **Standard base excess** | **-16.0 mmol/L*** | **-2.0 – +2.0** |
| **$FiO_2$** | **0.4** | |

**a) In addition to the hypercapnia and the acidosis, what anomaly do you notice in the blood gas report?**

**b) List <u>two</u> other investigations you would perform to elucidate the cause of the anomaly.**

Answer Template

a)
A left shifted curve despite a high PCO2 and a low pH.

b)
- CoHb
- Measure temperature
- Measure 2,3 DPG

| | |
|---|---|
| **Pass Rate** | 80% |
| **Highest Mark** | 9.0 |

## SECOND PART ORAL EXAMINATION

### CLINICALS "HOT CASES"

### Royal Brisbane and Women's Hospital

- 41-year-old male, with sepsis and extensive erythroderma associated with psoriasis and a history of IVDU, day 4 ICU admitted following Medical Emergency Team call for tachycardia and tachypnoea, Clinical findings included widespread erythroderma, generalised pain triggered by soft touch, acute kidney injury on CRRT, bilateral upper lobe consolidation and generalised wheeze on chest auscultation and hepato-splenomegaly.
    - Candidates were directed to examine him and provide possible causes for the renal failure.

- 75-year-old female 5 days following right hemi-hepatectomy for a mass lesion that initially had an uneventful recovery but was readmitted for a decrease in conscious level. Clinical findings included jaundice, lower body swelling and encephalopathy with lateralising signs L>R.
    - Candidates were directed to examine her and discuss the possible causes of her decreased conscious state.

- 33-year-old female with a history of significant alcohol use, day 3 post coiling of PICA aneurysm and who had been re-intubated for confusion. CT scan the previous day had shown a left cerebellar infarct. Clinical findings included ongoing blood-stained CSF drainage, hypertonic saline infusion in progress, no obvious neurological defect, intact airway reflexes and a clear chest.
    - Candidates were directed to examine her with a view to determining her suitability for extubation and to make a management plan.

- 69-year-old female day 19 ICU post SAH secondary to left peri-callosal aneurysm treated with craniotomy, clipping and insertion of EVD and with slow neurological recovery and failed extubation for fluctuating conscious state and retained secretions. Clinical findings included drowsiness but able to obey commands and no focal neurological signs and high urine output.
    - Candidates were directed to examine her and provide a differential diagnosis for her fluctuating neurological state.

- 53-year-old female, day 7 ICU, with pneumococcal pneumonia and bacteraemia, admitted following a Medical Emergency Team call for respiratory distress. Her ICU stay had been complicated by acute kidney injury and biventricular failure. She had not required invasive ventilatory support. Clinical findings included fever, widespread septic vasculitic rash, left sided bronchial breath sounds and signs of right heart failure.
    - Candidates were directed to examine her to determine her cardio-respiratory status and the cause of her respiratory failure.

- 41-year-old male, day 3 ICU, attempted self-hanging, asystolic at the scene and resuscitated with return of spontaneous circulation after 3 doses of adrenaline. Clinical findings were GCS 3 with absent brain stem reflex responses.
    - Candidates were directed to assess him for brain death.

- 36-year-old male, day 26 ICU, was in a motor vehicle accident with chest and orthopaedic injuries. Clinical findings included obesity; fever with fluctuant mass on

right thigh, decreased breath sounds bibasally, hepatomegaly and a sacral pressure sore.
    - Candidates were directed to examine him and determine why he was still ventilator-dependent at day 26.

- 79-year-old female, day 22 ICU with strangulated hiatus hernia was treated by gastrectomy and primary anastomosis. Clinical findings included global weakness, right-sided ICC sites, bronchial breath sounds at right base, decreased air entry with crackles at left base, abdominal wound and jejunostomy tube.
    - Candidates were directed to examine her with a view to establishing why she was difficult to wean.

**Princess Alexandra Hospital**

- 42-year-old male, day 6 ICU, following admission with shock, with type A thoracic aortic dissection, right CVA and severe aortic regurgitation, and now post Bentall's procedure. Clinical signs included on sedation and muscle relaxants, sternotomy scar, right groin wound, prosthetic aortic valve, bronchial breath sounds at left base and decreased air entry right base.
    - Candidates were directed to examine his cardiovascular system with a view to finding the cause for his initial collapse.

- 67-year-old male, day 2 ICU post elective low anterior resection.Clinical findings included obesity, haemodynamic instability with high dose inotropic support, atrial fibrillation, aortic stenosis and low urine output, bibasal collapse and a fresh midline incision with a viable stoma.
    - Candidates were directed to examine him and determine the cause for his haemodynamic instability and failure to wean.

- 72-year-old male, day 14 ICU, post Ivor-Lewis oesophagectomy, complicated by anastamotic leak, multiple pneumothoraces, and atrial fibrillation. Clinical findings included bleeding from fresh tracheostomy with intermittent air leak, subcutaneous emphysema, left bronchopleural fistula, bile draining from right-sided chest drains and jejunostomy feeding tube.
    - Candidates were directed to establish the nature of the post-operative complications.

- 42-year-old male, day 6 ICU, admitted following surgery for anastamotic leak and faecal peritonitis post anterior resection for metastatic colorectal carcinoma. Clinical signs included decreased breath sounds bilaterally, multiple abdominal drains and an ileostomy.
    - Candidates were asked to examine him and identify the major clinical issues.

- 42-year-old male, day 2 ICU, admitted following unsuccessful clot retrieval for right MCA infarct, complicated by perforation of MCA. Clinical signs included puncture wound right groin and dense left hemiparesis but obeying commands right side.
    - Candidates were directed to assess him and provide a plan for the day.

- 39-year-old female, day 5 ICU, intubated for MRI following presentation with a stroke. MRI showed multiple lesions and large left MCA territory stroke, inflammatory in origin. Clinical findings included right hemiparesis, eyes deviated to left, not obeying commands and left-sided neglect.
    - Candidates were directed to examine her with focus on the neurological deficits and a cause for the stroke.

**Prince Charles Hospital**

- 87-year-old female, day 3 ICU, with scleroderma, pulmonary fibrosis and pulmonary hypertension, presenting with haemoptysis and respiratory failure. Clinical findings included signs of scleroderma with CREST, blood-stained respiratory secretions, bronchial breathing at left base with diffuse crackles, aortic regurgitation and hepatomegaly.
    - Candidates were directed to identify the key clinical findings and to provide a management plan.

- 59-year-old female, day 6 ICU, admitted with Klebsiella sepsis with cavitating pulmonary lesions and liver abscess, two weeks after returning from Malaysia. She was intubated for worsening hypoxaemia, tachypnoea and respiratory alkalosis. Clinical signs included a widespread rash, fever, right lower lobe changes, poor lung compliance and septic shock on high-dose vasopressors.
    - Candidates were directed to examine her and identify possible causes for her fever.

- 51-year-old male, day 7 post resuscitation from out-of-hospital VF arrest. Clinical signs included ongoing sedation requirements, high $FiO_2$ requirements, central flail segment and decreased air entry at bases.
    - Candidates were directed to assess his suitability for extubation.

- 70-year-old female, day 3 ICU following re-admission for shock three days post AVR and who underwent re-sternotomy two days earlier for cardiac tamponade. She had a background of end-stage kidney disease treated with peritoneal dialysis. Clinical signs included decreased air entry at bases, prosthetic aortic valve and pericardial rub, vascath and peritoneal dialysis catheter in situ.
    - Candidates were directed to assess her suitability for extubation.

**VIVAS**

**Viva 1**

A 74-year-old obese female with type 2 diabetes is transferred to your ICU from a district hospital with a diagnosis of ascending cholangitis. Ultrasound has confirmed an impacted gall-stone in the common bile duct.

Her vital signs are:
Temperature is 34.5$^{o}$C.
Cold clammy peripheries
Capillary refill time 4 secs
Heart rate 130 beats/min, sinus rhythm
Blood Pressure 90/50 mmHg
$SpO_2$ 100% on 4 $LO_2$/min via nasal prongs

Her examination findings are:
GCS 13 being confused and opening eyes to commands.
Normal heart sounds with no murmurs or added sounds.
Bibasal inspiratory crepitations, with no wheeze or bronchial breathing.
Abdomen soft with right hypochondrial tenderness, but no rebound tenderness or guarding.
No residual urine in the bladder after catheterisation.

Outline your initial management of this patient.

**Viva 2**

A 50-year-old male patient returns to ICU following a laparotomy, splenectomy and partial hepatectomy for intra-abdominal bleeding following a high speed motor vehicle accident with isolated abdominal trauma. He has had a massive transfusion in theatre.

Outline your initial assessment upon his arrival in ICU from the operating room.

**Viva 3**

A 28-year-old Australian aid worker, returns from the Philippines' flood disaster and is subsequently admitted to your ICU via the Emergency Department. Twelve days following her return she developed fevers, headaches and severe myalgias. This continued for a week, and then improved. Despite feeling weak she remained well for 3 days before deteriorating again and presenting to ED.

On clinical examination the following is evident:

She appears unwell, respiratory rate 24 breaths/min, bibasal crackles on auscultation, Heart Rate 102 beats/min
Blood Pressure 92/45 mmHg, cool peripheries, conjunctival suffusion, and mild meningism.
She is confused but with no focal neurology.
She has no rash and moderate hepato-splenomegaly.

Provide a differential diagnosis.

**Viva 4**

A 54-year-old previously healthy male was admitted to ICU after 45% total body surface area burns.

He was pulled out of his garden shed, unconscious, by the fire brigade and was intubated at the scene of the incident by ambulance personnel.

He was admitted to ICU within one hour of injury.

Please describe methods of assessment of cutaneous burns injuries with regards to the depth of injury and body surface area estimates.

**Viva 5**

*NB: Image removed from this question.*

A 42-year-old male presented with a stroke. He was admitted to a general ward with a right-sided hemiplegia, neglect and speech deficits. He was not thrombolysed.

A day post admission, you are called by your registrar from a MET call because the patient has just become drowsy, although wakes to follow commands.

His CT scan at the time of the MET call is as below.

Describe the findings on this image and outline the implications.

## Viva 6 (Procedure Viva)

As the duty Intensivist you have been called to review a patient on the orthopaedic ward in a small private hospital.

The patient is a 56-year-old male who had a total knee replacement 6 days ago. He has a past history of obesity and hypertension. Yesterday he complained of an episode of shortness of breath and was seen by his surgeon.

This morning he has collapsed unconscious whilst being assisted into the shower, the nurses have now placed him back into bed and called for urgent review because of ongoing hypoxia, hypotension and tachycardia.

## Viva 7 (Radiology Viva)

*NB: Images removed from this question.*

*Consisted of 4 CXR images and 3 CT scans for interpretation.*

## Viva 8 (Communication Viva)

You are the duty Intensivist arriving for the first day of your ward service week. One of your patients is a previously independent 60 year old female, Mrs. Jane Smith, who was admitted 5 days ago with community-acquired pneumonia. She has improved, but remains ventilated with progressive renal dysfunction. It was decided last evening to commence renal replacement therapy.

Overnight a registrar inserted a right internal jugular vascath under ultrasound guidance. Local swelling developed, and transducing the line revealed intra-arterial placement. The patient was subsequently transferred to theatre where the vascath was removed and the carotid artery laceration repaired.

This morning the patient was noted to have new left sided weakness. Urgent CT brain reveals early changes consistent with a very large right-sided ischaemic stroke.

The bedside nurse tells you that the family is upset, mainly because the only communication they have received was a phone call from the vascular surgery registrar last night. This call was to obtain consent for an operation “to fix the problem caused by ICU putting the line in the wrong place”. Also, they are worried that she is not moving one side today, and want to know the results of the CT scan.

You are about to meet Mrs. Smith’s next of kin.