REPORT OF GENERAL FELLOWSHIP EXAMINATION

AUGUST/SEPTEMBER 2001

This report is prepared to provide candidates, tutors and their Supervisors of training with information about the way in which the Examiners assessed the performance of candidates in the Examination. Answers provided are not model answers but guides to what was expected. Candidates should discuss the report with their tutors so that they may prepare appropriately for the future examinations.

Twenty-seven candidates presented for this examination. Twenty-two were successful.

ORAL SECTIONS

Objectives Structured Clinical Examination (OSCE) Section

There were fourteen stations with four rest stations (three of these were before and after the interactive stations). All 27 candidates passed this section. A systematic approach to the types of investigations examined was more likely to maximise the candidates score.

Station 1. *Rest*

2. *Chest X-rays* including pneumothorax after endobronchial intubation, lobar collapse, cardiogenic pulmonary oedema. A list of abnormal findings and further investigations was often requested.

3. *ECGs* demonstrating hyperkalaemia, Ventricular Tachycardia, infero-posterior myocardial infarction, P pulmonale and right ventricular hypertrophy.

4. *Blood gas interpretation*. Examples included metabolic alkalosis, diabetic ketoacidosis, and mixed metabolic and respiratory disturbances.

5. *Paediatrics.* Examples included chylothorax, pericardial effusion, endobronchial intubation and misplaced CVC.

6. *Rest*

7. *Procedure station* involving cardiac arrest management (observing BLS knowledge, leadership skills, and practical techniques).

8. *Rest*

9. *Communication with an actor* involved empathic listening, and discussion of management of post-cardiac arrest victim with daughter.

10. *Rest*

11. *Miscellaneous Equipment* including a tracheostomy tube, an ECG electrode, a double lumen tube, and defibrillation pads. Roles, advantages and disadvantages were requested.

12. *Chest X-rays* including endobronchial intubation, lobar collapse, widespread infiltrates, pericardial effusion. A list of abnormal findings and further investigations was often requested.

13. *Other X-rays* including CT of neck with subglottic narrowing, CT head with cerebral oedema and basal ganglia infarcts, CT of chest with aortic dissection.

14. Biochemistry including hepatocellular liver disease, cerebral salt wasting, and hyperglycaemia/hyperosmolar non-ketotic diabetic coma.

Cross Table Viva Section

There were 6 structured Vivas of ten minutes each. There were two minutes provided to read a scenario outside each viva room. 25 out of 27 candidates passed this section. Candidates should be prepared to provide a reasonable strategy for management of conditions that they may not be familiar with. The topics included:

- Management of organophosphate toxicity.
- Management of 14 year old girl with septic shock.
- Management in a post-cardiac surgical patient with renal impairment.
- Diagnosis and management of oxygen delivery dysfunction due to methaemoglobinaemia.
- Differential diagnosis of Critical Illness Polyneuropathy.
- Diagnosis and management of lactic acidosis and hypotension associated with vasodilatation.

The Clinical Section

The Clinical Section was conducted at the Austin and Repatriation Medical Centre.

Only 18 out of twenty-seven candidates passed this section. Candidates should listen carefully to the introduction given by the examiners and direct their examination accordingly. Patients were presented as problem solving exercises. Exposing the patients should be limited to those areas which are necessary for that component of the examination, and in keeping with the modesty requirements of the patients.

Cases encountered included patients with:

COLD CASES

- Hepatosplenomegaly
- HOCM
- Peripheral Vascular Disease
- Rheumatoid arthritis
- Scleroderma
- COPD

HOT CASES

- Myopathy
- Pulmonary embolus
- Foetal death in-utero
- Weaning difficulty
- Airflow obstruction while ventilated
- Cardio-respiratory failure (Down's syndrome)

WRITTEN SECTIONS

Short Answer Questions

It is imperative that candidates answer the specific question asked. A structured, orderly response considering all aspects of management is required.

This guide is meant to be an information resource and the views of a practising intensivist. It is not written under exam conditions and does not provide ideal answers.

1. *A eighty (80) year old man needs volume replacement to treat hypotension secondary to biliary sepsis. Compare and contrast one colloid and one crystalloid solution that maybe used in this context.*

In marking this question it was realised that the candidates come from all parts of the world, especially Australia, Hong Kong and New Zealand. The choice of fluids reflected that diversity.

In "comparing and contrasting" it was expected that the candidate would cover content, manufacture, fate in the circulation, effects on organ function and idiosyncratic effects, not merely listing the properties but contrasting the properties within that list.

Eg. Normal Saline versus 4% Human Albumin (CSL).
Normal Saline is a sterile solution of 150mmol each of Na and Cl in I litre water whereas 4% albumin is prepared from human-donor, pooled blood by complex fractionation. The albumin cannot be regarded as sterile, but is heated to 60^{o} C for 10 hours and prepared at low pH. Prion transfer is feasible. It contains 140 mmol/L Na, 128 mmol/L Cl.

Saline would be expected to distribute 25% intravascularly and 75% interstitially whereas albumin, theoretically, is iso-oncotic and expands the vascular compartment by the administered volume. This may not be true in the critically ill with high albumin turnover and capillary leak.

Saline will have effects via expansion of the appropriate compartments and will lead to increased cardiac output proportionately. In large volumes it may lead to oedema formation, hypernatraemia and hyperchloraemic acidosis. On the other hand, colloid,eg albumin, in one meta-analysis has been associated with higher mortality. It also contains pre kalikrein activator (PKA) which, although present in low amounts, may produce hypotension and bradycardia in conjunction with ACEI use.

The half-life of albumin is said to be 20 days. The distribution half-life of saline is short (30mins) and elimination half-life will depend on the hormonal milieu (ADH, ANP, aldosterone levels) due to hypovolaemia and stress.

Cost : Saline- $1-2 per litre
Albumin – free to users in Australia, theoretical cost ~$80 for 500mls.

2. *Briefly outline the role of non-invasive ventilation in the management of a 24 year old woman who presents with acute severe asthma.*

NIV includes CPAP, BiPAP and PAV. Non-invasive ventilation has been used with success in acute severe asthma but there are no RCTs to support its use. In theory it assists the patient by decreasing the inspiratory work, decreasing expiratory work and improving V/Q mismatch. The potential negative effects are numerous and include claustrophobia, agitation, gastric distension, dys-synchrony, increased expiratory work and hyperinflation.

Decreasing the pressure change that needs to be generated to initiate respiration in the presence of auto-peep may decrease inspiratory work. Expiratory work may be decreased by opposing dynamic airway compression and allowing more complete expiration with less gas-trapping and hyperinflation. Experimental work in induced asthma suggests that CPAP mainly acts to unload inspiratory muscles.

Since all these factors cannot be anticipated in an individual, the role of NIV is best found by testing the patient's response to titrated therapy eg starting with 5 cm CPAP and titrating IPAP and EPAP.

There is of course no role in respiratory or cardiac arrest or in the patient who is unable to cooperate or protect the airway.

3. *List the relevant pharmacology of the following drugs when used in ICU to aid the dressing of severe burns: (a) tramadol, (b) celecoxib and (c) ketamine.*

Tramadol is a synthetic non-narcotic analgesic with opioid like effects. It acts centrally to bind with mu receptors and also blocks noradrenaline and serotonin uptake. It is rapidly absorbed orally with high bioavailability. It is cleared by hepatic metabolism and may produce dizziness, somnolence, nausea, constipation, sweating and pruritus similar to opioids, but causes significantly less respiratory depression than morphine.

After an IMI dose, peak effect is achieved in 45 minutes and lasts 4-5 hours. Convulsions and rare anaphylactoid reactions have been described with its use. Overdosage may produce respiratory failure and seizures. Its role in this setting is unclear as yet because of low potency but it may be useful as an adjunct.

Celecoxib is a COX-2 inhibitor and as such has anti-inflammatory, analgesic and anti-pyretic properties. In the absence of COX-1 inhibition, it should have no/little effect on gastrointestinal mucosa or platelet function. Disruption of renal blood flow autoregulation in hypovolaemia and shock is still possible.

NSAIDS have been used in burns to reduce the inflammatory response, but have an uncertain role in dressings due to slow onset (1 hour), low potency, oral preparation and untoward renal effect. Duration of action is 6 – 15 hours. They should not be used in patients with sulfonamide allergy or aspirin/NSAID associated asthma.

Ketamine is a general anaesthetic agent related to the hallucinogen phencyclidine which can be given IV or IM. Despite the tendency to emergence delirium it is a useful agent in this setting because of intense analgesia with maintenance of reflexes and minimal respiratory depression. Duration of action is 2 – 4 hours and it undergoes extensive hepatic metabolism. Dreams and hallucination can be reduced by the concomitant administration of a benzodiazapine.

4. *A 35 year old woman, who is receiving continuous renal replacement therapy for renal failure associated with abdominal sepsis, is noted to have a platelet count of 40 x 10^9/L. How will you manage this problem?*

In this setting thrombocytopenia may be due to decreased platelet production, increased consumption or aggregation. This question should have been approached as a simple practical problem. One needs to obtain a complete history to understand whether this is an acute or a chronic problem, whether the patient is on platelet lowering drugs, did it coincide with heparin use, is there evidence of sepsis, DIC, is there a history of SLE, ITP, malaria etc. Investigations will include heparin antibody, blood film coagulation screen, and DIC screen. If no other cause is found,

marrow aspiration may be indicated. Management will consist of ceasing heparin and other implicated drugs, treating underlying infection, platelet transfusion if bleeding occurs or if surgery is contemplated.

5. *A 45 year old man with severe pancreatitis is receiving Total Parenteral Nutrition. Discuss the role of intravenous lipids in his regimen.*

Enteral nutrition would be preferable. The question assumes that it is not feasible. Intravenous lipid infusion in TPN is important to prevent essential fatty acid deficiency and as an alternative calorie source. In an acute inflammatory disease or sepsis the standard approach would be to provide at least 50% of the non-protein calories of TPN as lipids, but acute pancreatitis may be associated with familial hyperlipidaemia and the hyperlipidaemia of alcoholism. Lipid infusion has been rarely associated with pancreatitis eg paediatric Crohn's Disease. Lipid infusion in critically ill patients may cause deterioration in A-aDO_2, haemagglutination and immune dysfunction via reticuloendothelial blockade.

It is therefore important to check the serum lipids of this patient and to understand the aetiology of the pancreatitis in this case. If there is no contraindication to lipid infusion, then infusion of 20 mls per hour of commercially available soybean emulsion, eg 20% Intralipid will provide 1000 kcal/day to balance the protein and carbohydrate. Clearing of the lipid can be checked by allowing 10mls of blood to settle and observing for a milky serum or by measuring serum lipid 1 hour after infusion is stopped.

6. *What causes the oxygen haemoglobin dissociation curve to move to the right and what are the clinical implications of this change?*

Shift of the O_2 – Hb dissociation curve to the right causes decreased affinity for O_2 and release of O_2 to the tissues. The O_2 dissociation curve is shifted to the right by: –

- increased temperature
- increased CO_2
- increased 2 – 3 DPG
- increased pH
- rare abnormal haemoglobins

This is an important physiological effect responsible for the Bohr effect and allowing greater release of O_2 to the tissues.

At present there is not enough data to support manipulation of the O_2-Hb curve to improve O_2 delivery. If arterial PO_2 is critically low then O_2 binding in the lungs may be impaired by a shift to the right. The end result is that a shift to the right may seriously impair tissue oxygenation.

7. *What drug withdrawal states are relevant to ICU practice? Outline the principles of their management.*

Drug withdrawal states in ICU patients may be more common than is generally appreciated. They include –

- Alcohol
- Tobacco (nicotine)
- Narcotic (heroin, morphine)
- Benzodiazepines
- Caffeine

- Other street drugs (cocaine etc)

Principles of their management include –

- prevention (avoid prolonged high dose narcotics, benzodiazepines
- detection/diagnosis (be alert for signs eg agitation, tachycardia, fever)
- sedation (may be necessary to control systemic effects)
- replacement/substitution (eg nicotine patch)
- support (airway and respiration, fluid replacement)
- simple measures such as but firm communication, reality orientation, visible clock and presence of a relative contribute to reassurance of the patient.

8. *Critically evaluate the use of hypertonic saline and mannitol in the management of severe closed head injury.*

Hypertonic Saline has theoretical advantages in the initial resuscitation of head injured patients because smaller volumes of fluid are required and blood pressure restoration is more effective. Brain oedema may be decreased to lower ICP and CPP may be increased. Post resuscitation use is less clear. In this setting, reduction in intracranial hypertension is due to improved systemic and cerebral haemodynamics and modulation of vasospasm. Adverse effects include renal impairment, rebound ICP rise and osmotic myelinolysis. Trials are continuing and a well defined role is not apparent as yet.

Mannitol has a long history of use in the management of head injuries. It lowers ICP initially by increasing CBF and producing a compensatory vasoconstriction. An osmotic effect and diuresis produce delayed fall in ICP. Efficacy would be dependent initially on the presence of adequate brain with intact autoregulation. Prolonged use may lead to leak into damaged brain with concomitant increase in ICP and swelling. The accepted role is in the urgent lowering of ICP before definitive therapy (eg. evacuate haematoma or perform decompression craniectomy). Chronic use is not supported by evidence.

9. *Following severe trauma a 35 year old woman is being enterally fed via a nasogastric tube. The dietitian calculates that only 25% of her daily nutritional requirements are being achieved. Outline your approach to this problem.*

Again, a sensible practical approach was expected. There may be a place for early jejunal feeding or, if laparotomy is performed, insertion of percutaneous enterostomy.

Otherwise a more conservative approach involves thorough assessment of history, recent events, combined with physical examination and perhaps some simple investigations to address the problem.
Are the dietitians calculations appropriate?
Why are the feeds not meeting targets? Large aspirates, inappropriate orders, starving for procedures. If it is because the feeds are not being absorbed, is this due to GIT pathology, systemic illness or narcotic infusion?
Physical examination should be performed looking for distension, rebound tenderness and presence of bowel sounds.
AXR for position of NG tube, ileus.
Treatment will be aimed at reversible causes. If there is no sign of abdominal pathology, the NG tube is in good position, orders are being followed then prokinetics should be tried and if unsuccessful recourse to naso-enteral tube is next step.

10. *Describe the effects of the Intra-abdominal Compartment Syndrome. Outline your method for measuring intra-abdominal pressure and explain the pitfalls of this method.*

Discussion on the effects of the ICS should include:

- renal effects – capillary compression, decreased GFR/UO, ATN,
- bowel – decreased SMA/coeliac flow, decreased pHi, bowel ischaemia
- hepatic – decreased portal blood flow, lactate clearance
- cardiac –decreased venous return/cardiac output, elevated PAOP/CVP/afterload
- respiratory –increased PIP, shunt, Paw,
- cerebral – increased ICP, decreased CPP

Description of a simple, sterile and practical technique for measurement of intra-vesical pressure was expected.

Pitfalls include:

- using the wrong zero point
- allowing a leak in the system to produce a falsely low reading
- chronic cystitis, radiation cystitis producing a small contracted bladder with low compliance which gives a falsely high reading
- pelvic haematoma producing a tight pelvic compartment with falsely elevated IAP.

11. *What is meant by the expression "patient – ventilator dys-synchrony"? What are the principles of managing this problem?*

Patient-ventilator dys-synchrony refers to the situation in which the patient fails to achieve comfortable respiration in synchrony with the ventilator in terms of timing of inspiration, adequate inspiratory flow for demand, timing of the switch to expiration and duration of inspiration.

Managing this problem may be addressed by –

- treating patient respiratory problems eg sputum, irritable airways
- checking ETT for kinking, secretion block, impinging on carina or between cords
- choosing the appropriate ventilator
- choosing the appropriate mode
- selecting sensitivity not too low or high
- choosing the appropriate ventilator rate
- setting appropriate flow rate
- sedating the patient to reduce agitation
- taking over ventilation if fatigue is apparent

12. *List the chest physiotherapy manoeuvres that you prescribe in ICU and provide the rationale for each.*

Chest physiotherapy encompasses many manoeuvres, which are used to aid sputum clearance, recruit areas of collapse and prevent the effects of suppressed cough, disrupted mucociliary clearance and reduced FRC. The evidence for much of these procedures is scant.

A list of manoeuvres may include:

- Endotracheal suctioning
- Nasopharyngeal suctioning
- Bagging

- Percussion
- Assisted coughing
- Recruitment manoeuvres

A simple rationale for each was expected.

13. *A 70 year old man with an implanted cardioverter/defibrillator is admitted to ICU following elective surgery. How does the device affect your management? What problems may be associated with the device?*

The cardioverter/defibrillator is usually inserted for ventricular arrhythmias resistant to antiarrhythmics or where antiarrhythmics are contraindicated. The patients usually have severe LV dysfunction and this has its own implications. Batteries usually last for 5-7 years and AV pacing facility is included.

In routine elective surgery its presence should not effect the patient's management greatly but it may have been switched off because of the interference from diathermy. Cardiac surgery may have displaced a lead or fractured a lead, there is a risk of lead or box infection if bacteraemia occurs and threshold may be changed by medications. It is important to check with the responsible technician and cardiologist for programming and idiosyncrasies of the unit and maintain ECG monitoring with external defibrillator available.

Problems that arise from the device include –

- Battery depletion
- Lead fracture or displacement
- Infection
- Multiple shocks due to algorithm error, sensing failure, oversensing of physiological signals and lead failure
- EMF interference from shaver, TV remote, MRI are also possible.

14. *List the information that can be obtained from ascitic fluid analysis. What are your indications for an ascitic fluid tap?*

Ascitic fluid analysis provides –

Fluid for General appearance
Albumin / protein content
Red cell count
White cell count
Culture and sensitivity
Cytology
Biochemistry - amylase

Indications for performing a tap include: any patient with ascites and PUO, critical illness or suspected malignancy.

15. *List the essential characteristics of a ventilator for use in the helicopter transport of a critically ill patient.*

The essential characteristics of a transport ventilator for this role are :

- easily portable (weighing <5 kg)

- able to deliver air mix or 100% oxygen
- able to be triggered by the patient when time cycled
- consume only those gases equal to minute volume and therefore require minimum gas supply
- compact size
- able to ventilate a variety of patient sizes/ages
- have airway pressure and apnoea alarms built in
- able to use variable PEEP

Ideal range of features may include:

- Capability for a variety of modes eg SIMV, PSV
- Variable FiO_2

Long Answer Questions

The questions release information piecemeal and incompletely as in the clinical situation.

Specific issues in the specific setting were expected to be addressed rather than broad generalities. The examiners apportioned marks according to difficulty and required time within each question.

An organised/systematic approach is expected.

Question 1

A forty-two (42) year old man has been well, apart from a history of alcohol induced liver dysfunction and portal hypertension. He has abstained from alcohol for the past 8 months after being told that it would kill him. After a large haematemesis he presents drowsy, clinically shocked, with a blood pressure of 80 systolic, heart rate of 124 beats/minute, cold and clammy peripheries. He is also clinically jaundiced.

Many of the techniques in an individual unit will be chosen/imposed by the gastroenterologists.

(a) Outline the principles of, and rationale for, the initial management of this patient.

Principles of management include resuscitation (of someone who may well have lost >25% of blood volume), establishing a diagnosis, and definitive treatment while avoiding therapies that might worsen his underlying condition.

Resuscitation includes assessment of airway protection and breathing adequacy, which combined with neurological impairment indicates need for emergency intubation. Circulatory support requires adequate intravenous access, but may not need to be too aggressive (as excessive resuscitation may worsen portal hypertension), and could be guided by factors including usual blood pressure (? accept MAP of 60 mmHg), urine output, and other signs of circulatory compromise. Temporary use of a Sengstaken Blakemore tube (or equivalent eg Minnesota) may be considered if blood loss is uncontrollable. Invasive monitoring may be useful, but is not necessary in the early phase of resuscitation.

Establishing a diagnosis for the cause of bleeding includes immediate examination (signs suggesting non-GI haemorrhage, chronic liver disease), history (from family/observers) of immediate event and possible precipitants (drugs, retching etc). Differential diagnosis of causes for jaundice should be considered (including hepatitic and toxins). More detailed history and examination will need to be completed later.

Immediate commencement of therapy (eg. intravenous vasoconstrictor such as somatostatin or vasopressin) should be considered while organising urgent endoscopy (which will usually result in banding or sclerotherapy for varices, and injection for some other pathologies). Initial investigations should include cross match, coagulation tests, full blood count, urea & electrolytes, liver function tests, blood glucose and paracetamol level. An ascitic tap should be undertaken early for microscopy and culture (as infection may well be present). Some rationale should have been given for the investigations listed.

Candidates should be aware of therapies that may be specifically required (correction of coagulopathy [FFP &/or platelets], prophylactic antibiotics, laxatives eg. lactulose; beta-blockers once stable, proton pump inhibitors) or contraindicated (sedatives worsening hepatic encephalopathy).

(b) Variceal bleeding is diagnosed and it initially responds to therapy. 48 hours post admission he remains on invasive respiratory support, with weak withdrawal response to pain despite minimal sedation, a persistent coagulopathy, and is inotrope dependent. Serum bilirubin concentration is elevated (100 micromol/L [N 3-20]). He develops a further acute variceal bleed associated with hypotension. Outline your management of this episode.

Standard resuscitation goals and technique should be reiterated. Re-bleeding from varices requires repeat endoscopy for diagnosis and treatment. Additional treatments should be considered including vasoconstrictor infusions (eg. somatostatin or vasopressin with GTN), Trans-jugular Intra-hepatic Porto-systemic Shunt (TIPS), and surgical shunts (eg. spleno-renal). Balloon tamponade is being used less frequently because of a high incidence of complications (aspiration, oesophageal rupture, death).

Ongoing investigation and treatment of coagulopathy, and investigation of causes of jaundice should be undertaken. Treatment should include strategies to minimise hepatic encephalopathy.

(c) At 6 days there has been no further haematemeses. However he has a Glasgow Coma Score (GCS) of 5, despite no sedation. His serum bilirubin concentration is now 350 micromol/L. Prothrombin time and serum creatinine concentration are twice normal. A CT of the head shows no focal abnormality. What supportive therapies and strategies would you have in place at this stage and why?

Specific strategies to minimise hepatic encephalopathy should have been described if not already done so (including the use of lactulose). Precipitants must be minimised (treatment of infections, avoidance of sedatives, correction of electrolyte abnormalities/hypoxia, avoid alkalosis, limit dietary protein, consider unproven dietary supplements including BCAA etc.). Cautious volume expansion should be considered. Other reversible causes for renal dysfunction and coma should be sought and excluded. Management of ICP may be necessary (and the CT does not exclude cerebral oedema). General supportive care should be considered (eg. physiotherapy, avoidance of line-related problems, family support etc.). Specific treatment may be required for ascites and its effects (drainage, colloid replacement etc).

(d) His wife tells you that he had been recently unjustly fired from work and for the week prior to his admission had started to drink heavily again. He had complained of headache for which he would frequently take paracetamol and had been eating poorly. She asks you what are his chances of survival. How do you respond?

Prognosis of hepatic encephalopathy and associated organ dysfunction depends on whether the process is acute or chronic, and whether there are any reversible factors. The very high bilirubin level (350 mcgmol/L), and the fact that this man has rebled from his varices make his prognosis

worse, but not unsalvageable. Shunting procedures may decrease his likelihood of further bleeding but are likely to worsen the encephalopathy.

(e) His wife then asks why he has not been considered for liver transplantation. How do you respond?

This issue should have been anticipated and thought through, probably including discussion with the transplant service. Potential liver transplant recipients outnumber potential donors. Factors involved in the selection of patients include likelihood of survival and compliance with therapy as well as some more controversial issues such as abstinence from alcohol, social support and mental health. It would not be an appropriate forum to discuss the more controversial issues (eg. active drinking being a contraindication), but focus could be put instead on the other organ dysfunctions that may limit success of the transplant. Specific indications and contraindications would be specific to the local transplant service (needs discussion), and they could also be involved with the counselling process.

Question 2

A seventy-six (76) year old man is admitted to the ICU following a laparotomy for faecal peritonitis. He has developed Multiple System Organ Failure over two days, requiring ventilatory and inotropic support. He is oliguric, increasingly acidotic, uraemic and has a rising serum creatinine.

(a) List the likely mechanisms for this patient's renal failure.

Likely mechanisms include pre-renal, renal and post-renal causes.
Pre-renal renal failure includes hypovolaemia (inadequate resuscitation), hypotension (inadequate perfusion pressure compared to his normal BP, ? hypertensive), and impaired cardiac output (myocardial depression, myocardial ischaemia/infarction, arrhythmias).
Renal mechanisms include toxins (circulating, nephrotoxic drugs [eg. aminoglycosides]) and microcirculatory failure (sepsis and inflammatory response) with medullary ischaemia, tubular obstruction and vasoconstriction (acute tubular necrosis).
Post-renal mechanisms include increased intra-abdominal pressure, ureteric obstruction and catheter problems (unrecognised, resulting in obstruction).

(b) What would be your indication for renal dialysis in this man?

In this man, indications for renal replacement therapy/dialysis would include:
Uncontrolled electrolyte disturbances (eg. hyperkalaemia, hypernatraemia); uncontrolled metabolic acidosis (pH criteria depend on ventilatory response); uraemia (traditionally > 35 mmol/L, or ? creatinine > 0.6 mmol/L); complications of uraemia (eg. encephalopathy, pericarditis); fluid overload unresponsive to diuretics. Some units would consider early intervention (unproven) with specific techniques to minimise the inflammatory response to sepsis.

(c) List the available dialytic therapies and their associated advantages/disadvantages. Which mode would you choose in this man and how does it achieve solute clearance?

Available techniques (not limited to the candidates unit) include intermittent haemodialysis, peritoneal dialysis, and the variants contained within continuous renal replacement therapy (CRRT).
Intermittent Haemo-Dialysis (IHD; solute clearance = diffusion): quick control, less ICU staff involvement (? cost implications), minimise exposure to anticoagulation BUT haemodynamic instability, potentially dramatic fluid and electrolyte shifts, exposure to extracorporeal circuit and

filter membrane, vascular access problems, poor control between dialyses, timing dependent on dialysis staff.

Peritoneal dialysis (PD; solute clearance = convection): continuous control of fluids, avoids vascular access problems, gentle technique, cheap, does not require electricity/machinery/renal unit, timing only dependent on ICU staff BUT requires intact peritoneum, fluid dwelling may impair respiratory function, peritoneal access problems (especially infection), potential inability to control severe uraemia and electrolyte disturbances, hyperglycaemia.

Continuous Renal Replacement Therapy (CRRT; solute clearance = mixture of convection and diffusion): continuous control of fluids and electrolytes (and ? other substances), easily titratable (changing fluid replacement and arterial flow rate or gradient for ultrafiltrate), greater haemodynamic stability (compared with IHD), timing only dependent on ICU staff BUT complex, vascular access problems, usually requires anticoagulation, exposure to extracorporeal circuit and filter membrane.

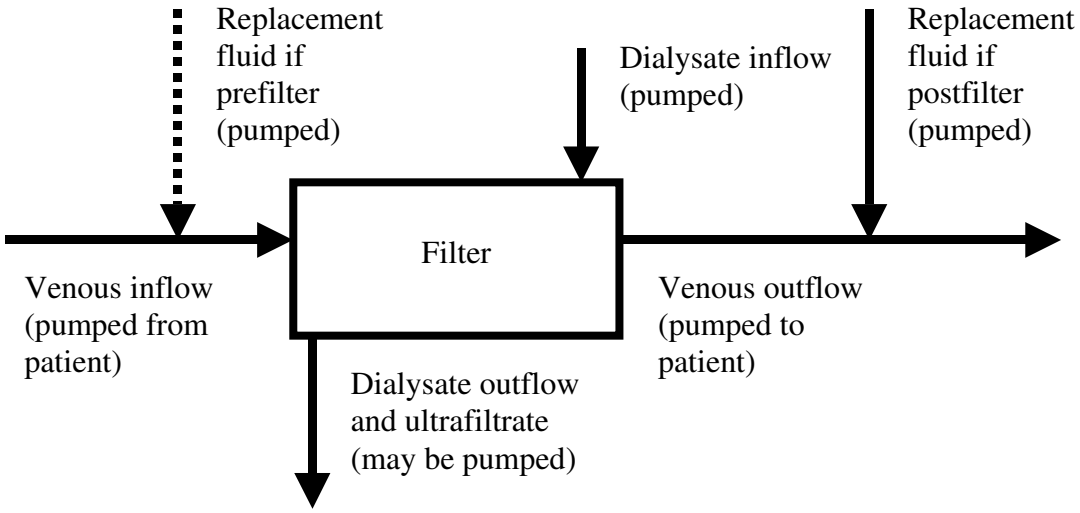
Specific subtypes of CRRT should be discussed, including:

Continuous Arterio-Venous Haemofiltration (CAVH; solute clearance = convection): simple, can do without pump, electrolyte balance determined by replacement fluid BUT requires arterial access, arterial flow rates and ultrafiltrate flow limit clearance.

Continuous Veno-Venous Haemofiltration (CVVH; solute clearance = convection): avoids arterial access problems, blood flow rate controlled by pump, good clearance of middle molecules, electrolyte balance determined by replacement fluid BUT requires pump and large bore venous access

Continuous Veno-Venous Haemo-Dia-Filtration (CVVHDF; solute clearance = convection and diffusion): increased solute clearance (dependent on dialysate flow), flow rates controlled by pump, electrolyte balance determined by replacement fluid and dialsysate BUT less efficient clearance of middle molecules, still requires pump and large bore venous access.

(d) Illustrate and label a dialysis circuit that depicts veno-venous haemodiafiltration (CVVHDF).



(e) Outline the means by which you would maximise urea clearance and filter life when using CVVHDF.

Urea clearance depends on ultrafiltrate flow rate (clearance by convection proportional to flow rate) and dialysate (countercurrent) flow rate (clearance proportional to flow rate). Increasing clearance would therefore be obtained by increasing either flow rates. Other factors include the use of filters with larger membrane surface areas, the use of predilution (ie. prefilter position for replacement fluid) if ultrafiltration rate is significant, and changing filter if it is failing. Independent factors that may prevent filter fibre loss (ie. prolong filter life) include adequate anticoagulation, priming with albumin, filter coating with anticoagulants, the use of predilution (decreasing oncotic pressure and haematocrit), and avoidance of large negative transmembrane pressures.

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