

FExNet 2026

Collated SAQs: Renal and Respiratory Emergencies

ANSWER BOOKLET

Model answers for the 22 renal and respiratory SAQs. References cited at the foot of each question. Items marked [core] are required for full marks. Drug doses and protocols confirmed with current eTG Therapeutic Guidelines, KDIGO 2012 AKI Guideline, GINA 2024, COPD-X 2024, BTS/TSANZ NIV guideline, BTS Pleural Disease Guideline 2023, ESC Pulmonary Embolism Guideline 2019, and the European Society of Endocrinology Hyponatraemia Guideline 2014.

22 questions • 229 marks

ACEM-aligned format. Sub-questions labelled a) b) c). Mark allocations indicative; references cited in the Answer Booklet. Question and answer indexes are clickable.

Answer Index

Click any entry to jump to its answer. Marks shown right.

Q1. Acute Kidney Injury and Indications for Dialysis	11	Q12. Paediatric Foreign Body Airway Obstruction	11
Q2. Severe Hyperkalaemia in End-Stage Renal Disease	13	Q13. Acute Cardiogenic Pulmonary Oedema	10
Q3. Acute Glomerulonephritis in a Child	10	Q14. Rhabdomyolysis with Acute Kidney Injury	9
Q4. Life-Threatening Paediatric Asthma	11	Q15. Acute Severe Adult Asthma — Stepwise Therapy	11
Q5. COPD Exacerbation with Non-Invasive Ventilation	12	Q16. Large Pleural Effusion with Mediastinal Shift	9
Q6. Pleural Effusion — Light's Criteria	11	Q17. Haemodialysis Access Complications	10
Q7. Massive Haemoptysis	11	Q18. Contrast-Induced Nephropathy	9
Q8. Pulmonary-Renal Syndrome (GPA / Wegener's)	11	Q19. Nephrotic Syndrome	9
Q9. Pneumonia in Lung Transplant Recipient	11	Q20. Acute Respiratory Distress Syndrome	10
Q10. Primary Spontaneous Pneumothorax	10	Q21. Pulmonary Tuberculosis	10
Q11. Massive Pulmonary Embolism	11	Q22. Acute Severe Hyponatraemia and Volume Status	9

Question 1 | Acute Kidney Injury and Indications for Dialysis (11 marks)

A 77-year-old man presents to your emergency department 7 days after discharge following a total colectomy for obstructing bowel cancer. He describes non-specific symptoms of malaise, lethargy, and nausea. Bloods show sodium 127 mmol/L, potassium 6.1 mmol/L, urea 37.1 mmol/L, creatinine 700 μ mol/L (baseline pre-operatively was 80 μ mol/L), estimated glomerular filtration rate 6 mL/min/1.73 m², bicarbonate 12 mmol/L, chloride 95 mmol/L.

a) List 4 features of severe acute kidney injury in this patient AND state the KDIGO stage. (4 marks)

- **Creatinine 700 μ mol/L** (baseline 80) — rise $>3\times$ baseline or ≥ 354 μ mol/L → **KDIGO Stage 3 acute kidney injury [core]**
- **eGFR <15** (6 mL/min) → advanced renal failure [core]
- **Hyperkalaemia (K 6.1)** with metabolic acidosis (HCO_3^- 12) — uraemic acidosis with raised anion gap [= $127 - (95 + 12) = 20$ mmol/L] [core]
- **Hyponatraemia (Na 127)**; markedly elevated urea (37.1) — uraemia [core]
- Symptoms of uraemic syndrome (malaise, nausea, lethargy) — though pericardial rub, asterixis, encephalopathy may also be present

b) List 4 indications for emergent haemodialysis (AEIOU mnemonic). (4 marks)

- **A — Acidosis** (severe metabolic acidosis with pH <7.1 OR not responding to medical therapy) [core]
- **E — Electrolyte derangement** (refractory hyperkalaemia >6.5 with ECG changes despite medical management; severe hypercalcaemia, hyponatraemia, hypermagnesaemia) [core]
- **I — Ingestion / Intoxication** (dialysable toxin — methanol, ethylene glycol, salicylate, lithium, metformin-associated lactic acidosis, valproate) [core]
- **O — Overload** (refractory fluid overload with pulmonary oedema not responding to diuretics) [core]
- **U — Uraemia** (symptomatic — encephalopathy, pericarditis, bleeding diathesis, nausea/vomiting; urea typically >30 - 35 mmol/L) [core]

c) List 3 likely contributors to AKI in this post-surgical patient. (3 marks)

- **Pre-renal:** hypovolaemia from post-operative fluid losses, vomiting / diarrhoea, third-spacing, sepsis with hypotension [core]
- **Sepsis / infection** — surgical site infection, anastomotic leak with intra-abdominal sepsis, post-operative pneumonia [core]
- **Drug-induced (nephrotoxic)** — non-steroidal anti-inflammatory drugs, intravenous contrast (recent imaging), aminoglycosides, ACEi / ARB [core]
- **Obstructive** — ureteric injury at surgery; retroperitoneal mass causing ureteric obstruction
- **Acute tubular necrosis** from ischaemic or nephrotoxic insult
- **Rhabdomyolysis** (prolonged operative position)

References: KDIGO Acute Kidney Injury Guideline 2012 • eTG (Therapeutic Guidelines, current) • ACEM clinical policies and statements • Tintinalli's Emergency Medicine 9e Ch 95

Question 2 | Severe Hyperkalaemia in End-Stage Renal Disease (13 marks)

A 60-year-old Indigenous man with end-stage renal disease (type 2 diabetic nephropathy) presents to your emergency department with lethargy and general malaise. He has missed his last three haemodialysis sessions. On arrival: Glasgow Coma Score 15, heart rate 80 beats per minute, blood pressure 80/50 millimetres of mercury, respiratory rate 30 breaths per minute, peripheral oxygen saturation 90 percent on room air. A 12-lead electrocardiogram is shown.

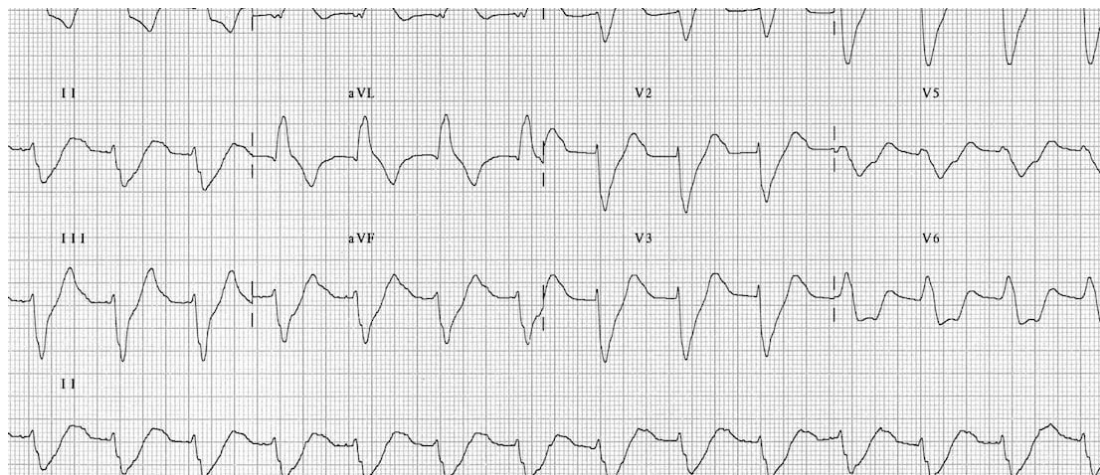


IMAGE — 12-lead ECG

a) Describe 4 abnormalities on the ECG AND state the diagnosis. (4 marks)

- **Markedly broadened QRS complexes** (approaching sine-wave appearance) [core]
- **Tall, peaked T waves** with narrow base [core]
- **Absent or markedly attenuated P waves** (atrial standstill from severe hyperkalaemia) [core]
- **Diagnosis: severe hyperkalaemia** (K typically >7.0; sine-wave / pre-arrest pattern) [core]
- Progressive ECG changes with rising K: tall peaked T (5.5-6.5) → PR prolongation, P-wave flattening (6.5-7.0) → broadening QRS (7.0+) → sine wave / asystole (>8)

b) Complete the table — 4 medications with mechanism, dose, and time to onset for management of acute hyperkalaemia. (6 marks)

- **Calcium gluconate 10 mL of 10% IV over 3 minutes** (repeat in 5-10 min if no ECG improvement) — **mechanism:** stabilises cardiac membrane (does NOT lower K); **onset:** minutes; duration 30-60 min [core]
- **Insulin 10 units actrapid IV + 50 mL 50% dextrose IV** (monitor BSL hourly) — **mechanism:** drives K intracellularly via Na/K ATPase; **onset:** 15-30 minutes; lowers K by 0.5-1.2 mmol/L [core]
- **Salbutamol 10-20 mg nebulised** (or 5 µg/kg IV) — **mechanism:** β₂-agonist drives K intracellularly; **onset:** 30 minutes; additive with insulin [core]
- **Sodium bicarbonate 50-100 mmol IV** (8.4% — 50-100 mL) — **mechanism:** drives K into cells (alkalosis); **onset:** 30 minutes; benefit limited if patient not acidotic [core]
- **Definitive: haemodialysis** — onset immediate, lowers K by 1 mmol/L/h; arrange urgent dialysis for this patient
- **Sodium zirconium cyclosilicate (Lokelma) 10 g PO three times daily** — newer agent, onset 60 min; OR calcium polystyrene sulfonate / Resonium (slower, less effective)

c) List 3 strategies for culturally safe care of this Indigenous patient (per ACEM statement). (3 marks)

- **Engage Aboriginal and Torres Strait Islander Liaison Officer** for advocacy, communication, family support, post-discharge follow-up [core]

- **Trauma-informed and respectful care** — acknowledge prior negative healthcare experiences; provide consistent clinician contact; allow family presence; respect autonomy **[core]**
- **Cultural awareness and individualised care plan** — engage with patient's preferred dialysis service (satellite vs urban); consider social determinants (housing, transport, finances) limiting dialysis attendance **[core]**
- Coordinate with community health workers and primary care
- Avoid assumptions; ask open questions; document Indigenous status accurately for outcome monitoring

References: eTG (Therapeutic Guidelines, current) • ACEM clinical policies and statements • ACEM Culturally Competent Care Statement • Kidney Health Australia / ANZSN guidelines

Question 3 | Acute Glomerulonephritis in a Child (10 marks)

A 6-year-old boy is brought to your rural emergency department by his parents. He has been generally unwell with a febrile illness 2 weeks ago and now has dark, reddish-brown coloured urine. He has no previous medical history. He appears tired but otherwise well, with healing skin sores on his leg and mild periorbital oedema. Vital signs: heart rate 100, blood pressure 135/85 millimetres of mercury (elevated for age), temperature 37.2 degrees Celsius.

a) List 4 features supporting acute post-streptococcal glomerulonephritis. (4 marks)

- **Macroscopic haematuria (dark cola / reddish-brown urine)** with red cell casts on microscopy (glomerular origin) **[core]**
- **Hypertension** (systolic 135 — elevated for a 6-year-old; >95th centile) from fluid retention and renin-angiotensin activation **[core]**
- **Oedema** (periorbital, dependent) from fluid retention and reduced renal sodium excretion **[core]**
- **Preceding streptococcal infection** 1-3 weeks earlier — pharyngitis (most common in temperate climates) or **skin infection (impetigo / pyoderma)** in this child (typical in tropical / Indigenous Australian communities) **[core]**
- Mild renal impairment, proteinuria (typically <3.5 g/day — nephritic rather than nephrotic), low C3 complement

b) List 3 differential diagnoses for upper tract haematuria in a child. (3 marks)

- **IgA nephropathy** (Berger disease) — recurrent macroscopic haematuria synchronous with respiratory infection **[core]**
- **Henoch-Schönlein purpura (IgA vasculitis)** — palpable purpura, abdominal pain, arthralgia, nephritis **[core]**
- **Alport syndrome** — X-linked or autosomal; sensorineural hearing loss, ocular abnormalities, family history of renal failure **[core]**
- Thin basement membrane nephropathy (benign familial haematuria)
- Membranoproliferative glomerulonephritis
- Lupus nephritis (older children, more common in females)
- Goodpasture syndrome (rare in children)
- Haemolytic uraemic syndrome (E. coli O157 — recent diarrhoea, anaemia, thrombocytopenia)

c) State 3 investigations to confirm the diagnosis. (3 marks)

- **Urinalysis with microscopy** — red cell casts (glomerular origin), dysmorphic red cells, proteinuria; urine protein:creatinine ratio **[core]**
- **Complement levels — low C3** (typical in PSGN), C4 normal; **anti-streptolysin O titre (ASOT) or anti-DNase B** — evidence of recent streptococcal infection **[core]**
- **Renal function (urea, creatinine), potassium, urinalysis**; throat / skin swab if active infection **[core]**
- Renal ultrasound (exclude alternative causes; kidney size normal or enlarged in PSGN)
- Renal biopsy — only if diagnosis uncertain or rapidly progressive disease
- ANCA, anti-GBM, antinuclear antibody if vasculitis suspected

References: eTG (Therapeutic Guidelines, current) • ACEM clinical policies and statements • Tintinalli's Emergency Medicine 9e Ch 95 • RCH CPG

Question 4 | Life-Threatening Paediatric Asthma (11 marks)

A 4-year-old girl is brought to your emergency department by ambulance with an acute exacerbation of asthma. Her parents report she is normally well-controlled on inhaled corticosteroids but has had a viral illness for the past 2 days. On arrival, she is exhausted, lethargic, with cyanosis around her lips. Her vital signs: heart rate 180 beats per minute, respiratory rate 50 breaths per minute, peripheral oxygen saturation 88 percent on 6 litres oxygen via Hudson mask, weight 18 kilograms. Chest auscultation reveals a silent chest.

a) List 6 features supporting life-threatening (rather than severe) asthma. (6 marks)

- **Silent chest** (absent breath sounds — minimal air entry) **[core]**
- **Cyanosis** with peripheral oxygen saturation <90 percent on oxygen **[core]**
- **Exhaustion / poor respiratory effort** with rising arterial CO₂ (paradoxical normalisation of previously low pCO₂) **[core]**
- **Altered mental state** — lethargy, confusion, coma **[core]**
- **Hypotension or arrhythmia** (impending arrest) **[core]**
- **Bradycardia** (peri-arrest sign — from severe hypoxia) **[core]**
- PEFR <33 percent of predicted (where measurable)
- Cyanosis or hypotension are pre-arrest features

b) List 5 treatments for this child including drug, dose, route. (5 marks)

- **Salbutamol** 6-12 puffs via MDI + spacer every 20 minutes (or 5 mg nebulised continuous via flow oxygen); **ipratropium** 8 puffs via MDI + spacer (or 250 µg nebulised) every 20 min × 3 doses **[core]**
- **Methylprednisolone** 1 mg/kg IV (= 18 mg for 18 kg child) every 6 hours; OR oral prednisolone 1-2 mg/kg if tolerated **[core]**
- **Magnesium sulfate** 50 mg/kg IV over 20 minutes (= 900 mg for 18 kg child; max 2 g) — single dose for severe asthma **[core]**
- **IV salbutamol** 15 µg/kg loading over 10 min (= 270 µg for 18 kg) then 1-5 µg/kg/min infusion — for life-threatening asthma not responding to nebulisation **[core]**
- **Adrenaline** 10 µg/kg IM (= 180 µg for 18 kg = 0.18 mL of 1:1000) if peri-arrest OR anaphylaxis suspected **[core]**
- **Aminophylline** IV 10 mg/kg over 60 minutes (= 180 mg) then 1 mg/kg/h — limited evidence; ICU level
- Avoid sedatives; consider intubation with ketamine + rocuronium if peri-arrest

References: Global Initiative for Asthma (GINA) report current • eTG (Therapeutic Guidelines, current) • RCH CPG • APLS Australia/NZ

Question 5 | COPD Exacerbation with Non-Invasive Ventilation (12 marks)

A 75-year-old man with severe chronic obstructive pulmonary disease (forced expiratory volume in 1 second 35 percent of predicted) presents to your emergency department with severe shortness of breath. You have assessed him to have an infective exacerbation of COPD. He is exhausted and you are considering non-invasive ventilation (NIV). Arterial blood gas on FiO_2 0.5 after 1 hour of bi-level NIV (IPAP 14 cm H_2O , EPAP 5 cm H_2O): pH 7.26 (7.35-7.45); pCO_2 86 mmHg (35-45); pO_2 52 mmHg (60-100); bicarbonate 38 mmol/L; base excess +7.1. This result is essentially unchanged from arrival.

a) Interpret the arterial blood gas, including appropriate compensation. (4 marks)

- **Acidaemia** (pH 7.26) with **respiratory acidosis** (pCO_2 86 — markedly elevated) **[core]**
- **Expected HCO_3^- compensation:** acute respiratory acidosis adds 1 per 10 ΔpCO_2 above 40 = $(86-40)/10 \times 1 = 4.6 \rightarrow \text{expected } \text{HCO}_3^- = 24 + 4.6 = 28.6$ **[core]**
- **Chronic respiratory acidosis:** adds 4 per 10 ΔpCO_2 = $4.6 \times 4 = 18.4 \rightarrow \text{expected } \text{HCO}_3^- = 24 + 18.4 = 42$. Actual 38 — close to chronic compensation; suggests **chronic respiratory acidosis** (known severe COPD) **[core]**
- **Hypoxaemia** (pO_2 52 on FiO_2 0.5 — A-a gradient raised but oxygenation acceptable); **NIV not improving CO_2** — treatment failure **[core]**
- Investigate for cause of failure — patient-ventilator dyssynchrony, inadequate IPAP, leak, secretions

b) List 4 contraindications to NIV in COPD. (4 marks)

- **Need for immediate intubation** — respiratory arrest / impending arrest, severely impaired consciousness, inability to protect airway **[core]**
- **Haemodynamic instability or recent cardiac arrest;** significant cardiac arrhythmia **[core]**
- **Inability to clear secretions** (excessive secretions, weak cough, vomiting / risk of aspiration); concurrent severe upper GI bleed **[core]**
- **Recent facial / upper-airway surgery, severe facial trauma, extensive burns affecting face;** uncooperative patient **[core]**
- Severe hypoxia not responding to oxygen / PEEP
- Untreated pneumothorax
- Bullous lung disease (relative)

c) State 4 changes to NIV parameters given the ABG result. (4 marks)

- **Increase IPAP (e.g. 14 $\rightarrow$ 18-20 cm H_2O)** to improve ventilation (alveolar minute ventilation); maximum 25-30 cm H_2O **[core]**
- **Ensure adequate EPAP / PEEP (5-8 cm H_2O)** — splints airways open, reduces auto-PEEP, reduces work of breathing **[core]**
- **Optimise patient-ventilator synchrony** — check mask fit (reduce leak); reassure patient; consider sedation cautiously (small-dose morphine 2.5 mg + low-dose midazolam) if agitation limiting NIV tolerance **[core]**
- **Consider rapid escalation to intubation** if no improvement at 1-2 hours despite optimisation — treatment failure with persistent acidosis is an indication **[core]**
- Re-check ABG at 1-hour intervals to monitor response
- Ensure adequate bronchodilator delivery (via spacer or nebuliser circuit)

References: BTS / TSANZ NIV guidelines • eTG (Therapeutic Guidelines, current) • COPD-X Concise Guide (Lung Foundation Australia) • ACEM clinical policies and statements

Question 6 | Pleural Effusion — Light's Criteria (11 marks)

A 75-year-old man with a known history of lung cancer presents to your emergency department by ambulance with worsening dyspnoea for 2 days. His vital signs: heart rate 120 beats per minute (sinus rhythm), blood pressure 95/55 millimetres of mercury, peripheral oxygen saturation 88 percent on 4 litres oxygen via nasal prongs, temperature 37.5 degrees Celsius, Glasgow Coma Score 13. A portable chest radiograph is shown.

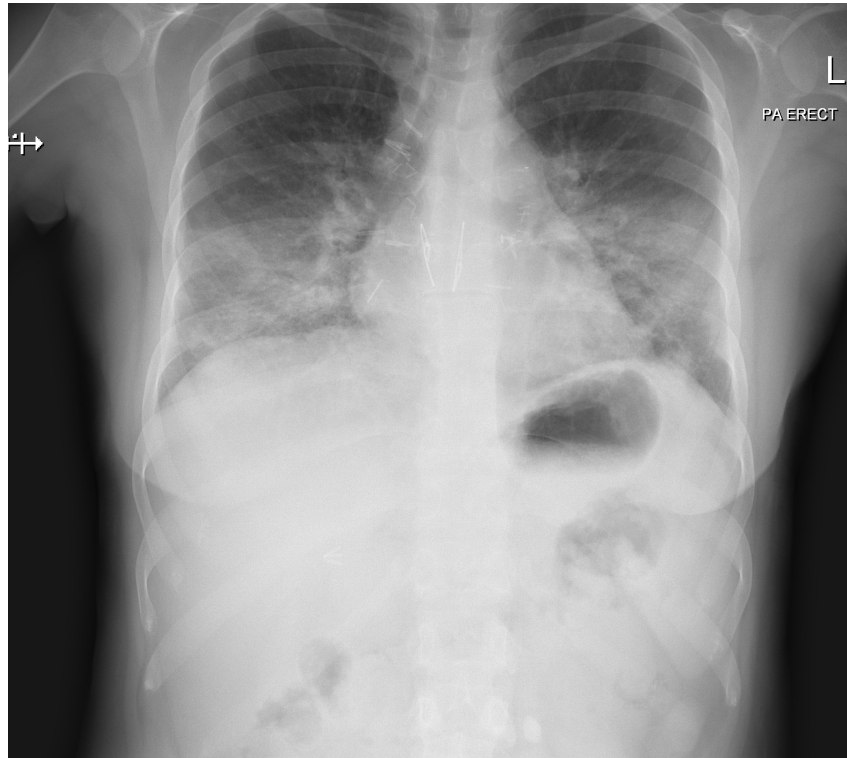


IMAGE — Portable PA chest radiograph

a) Describe 3 positive AND 2 relevant negative findings on the chest radiograph. (5 marks)

- **Positive: large right pleural effusion** with associated meniscus sign / homogeneous opacification of the right hemithorax [core]
- **Positive: mediastinal structures shifted to the contralateral (left) side** — significant volume of effusion (compressing lung) [core]
- **Positive: gastric bubble seen below the left hemidiaphragm** (no left subdiaphragmatic free gas; stomach displaced); cardiac silhouette may be enlarged [core]
- **Negative: no pneumothorax** on either side; no overt consolidation in left lung [core]
- **Negative: no obvious rib fractures, skeletal lesions, or cardiomegaly with cardiac decompensation appearance** [core]

b) List 4 parameters of Light's criteria to distinguish transudate from exudate. (4 marks)

- **Pleural fluid protein : serum protein ratio >0.5** — exudate [core]
- **Pleural fluid LDH : serum LDH ratio >0.6** — exudate [core]
- **Pleural fluid LDH $>2/3$ the upper limit of normal serum LDH** — exudate [core]
- **If ANY criterion is met = exudate** (98 percent sensitivity); if NONE met = transudate (heart failure, hepatic cirrhosis, nephrotic syndrome, hypoalbuminaemia) [core]
- **Other useful parameters:** pleural fluid pH <7.2 (empyema / inflammatory); pleural fluid amylase $>$ serum (pancreatic / oesophageal); glucose <3 (rheumatoid, tuberculous, malignant); cytology, culture

- Common exudates: malignancy, infection, pulmonary embolism, autoimmune (rheumatoid)

c) State 2 immediate management priorities. (2 marks)

- **Therapeutic thoracentesis** (symptomatic relief of dyspnoea) — ultrasound-guided drainage; remove 1-1.5 L initially (avoid re-expansion pulmonary oedema with rapid removal of large effusions); send fluid for cell count, biochemistry (LDH, protein, glucose, pH), microbiology (Gram stain, culture, AFB), cytology **[core]**
- **Oxygen therapy and supportive care**; investigate underlying cause (recurrence with malignancy is common — consider pleurodesis or indwelling pleural catheter for ongoing palliative management); respiratory consultation **[core]**
- Analgesia (intercostal nerve block may help for chest wall pain)
- Discussion of goals of care given underlying malignancy

References: eTG (Therapeutic Guidelines, current) • eTG Therapeutic Guidelines — Respiratory • Tintinalli's Emergency Medicine 9e Ch 66 • ACEM clinical policies and statements

Question 7 | Massive Haemoptysis (11 marks)

A 44-year-old woman presents to your emergency department coughing up large volumes of bright red blood (estimated 400 mL in the last hour). She has a history of bronchiectasis (non-cystic fibrosis). On arrival, she is haemodynamically unstable: heart rate 130 beats per minute, blood pressure 90/55 millimetres of mercury, respiratory rate 28, peripheral oxygen saturation 90 percent on 15 litres oxygen via non-rebreather mask. A chest radiograph shows diffuse bilateral pulmonary infiltrates.



IMAGE — PA chest radiograph showing diffuse pulmonary infiltrates

a) List 4 immediate management priorities. (4 marks)

- **Airway management** — position patient in **lateral decubitus with the bleeding side DOWN** (protect uninvolved lung from aspiration); vigorous suction; consider early intubation with a single-lumen ETT (passed into uninvolved bronchus) OR a double-lumen ETT for lung isolation **[core]**
- **Resuscitation** — two large-bore intravenous access; activate massive transfusion protocol; targeted balanced 1:1:1 transfusion; tranexamic acid 1 g intravenous bolus then 1 g over 8 hours **[core]**
- **Reverse coagulopathy** if applicable — vitamin K, fresh frozen plasma, prothrombin complex concentrate for warfarin; specific agents for direct oral anticoagulants **[core]**
- **Urgent investigations** — computed tomography pulmonary angiogram (identifies bleeding source, pulmonary embolism); FBC, coagulation, U&E, group and crossmatch (4 units); ABG **[core]**
- Senior respiratory / interventional radiology consultation
- Avoid anti-tussives in initial resuscitation (clearing blood from airways important)

b) List 4 definitive management options. (4 marks)

- **Bronchial artery embolisation** (via interventional radiology) — first-line for massive haemoptysis from bronchial circulation (90 percent of pulmonary haemorrhage); success rate 70-95 percent **[core]**
- **Flexible / rigid bronchoscopy** — diagnostic AND therapeutic (localise bleeding, balloon tamponade, topical adrenaline / vasoconstrictor, laser / argon plasma coagulation) **[core]**

- **Surgical resection (lobectomy)** — for localised malignancy, bronchiectasis, or other localised pathology with persistent bleeding; less common as first-line **[core]**
- **Pulmonary artery embolisation** — if pulmonary circulation source (e.g. AV malformation, Rasmussen aneurysm in TB cavity) **[core]**
- Treat underlying cause — antibiotics for infection, antineoplastic for malignancy

c) List 3 differential diagnoses for the CXR appearance (diffuse infiltrates). (3 marks)

- **Diffuse alveolar haemorrhage** (pulmonary vasculitis — GPA / Goodpasture syndrome, antiphospholipid; this case — haemoptysis with bilateral infiltrates) **[core]**
- **Aspiration of blood into uninvolved lung areas** (from focal source) **[core]**
- **Pulmonary oedema** (cardiogenic — heart failure; non-cardiogenic — ARDS, fluid overload, drugs) **[core]**
- Atypical pneumonia (viral, Pneumocystis, Legionella)
- Interstitial lung disease
- Cryptogenic organising pneumonia

References: eTG (Therapeutic Guidelines, current) • ACEM clinical policies and statements • Tintinalli's Emergency Medicine 9e Ch 66

Question 8 | Pulmonary-Renal Syndrome (GPA / Wegener's) (11 marks)

A 43-year-old man with a 6-month history of chronic productive cough, wheeze, sinus pain, and persistent nasal crusting presents to your emergency department with respiratory distress and haemoptysis. He also reports recently noticing dark urine. His vital signs: heart rate 110, blood pressure 145/95 millimetres of mercury, respiratory rate 26, peripheral oxygen saturation 92 percent on 5 litres oxygen, temperature 37.8 degrees Celsius. Bloods: creatinine 280 $\mu\text{mol/L}$ (baseline normal), haemoglobin 95, white cell count 14, C-reactive protein 180. Urinalysis: blood +++, protein ++ with red cell casts.

a) List 4 systemic manifestations of granulomatosis with polyangiitis (GPA, formerly Wegener's). (4 marks)

- **Upper airway involvement** — chronic sinusitis, nasal crusting, saddle-nose deformity (cartilage destruction), epistaxis, subglottic / tracheal stenosis **[core]**
- **Lower airway / pulmonary** — nodules / cavitation, alveolar haemorrhage (this case), pleuritis **[core]**
- **Glomerulonephritis / renal** — pauci-immune crescentic glomerulonephritis (this patient — rising creatinine, active sediment) **[core]**
- **Other organ systems** — neurological (mononeuritis multiplex), ocular (uveitis, scleritis, proptosis), cutaneous (purpura, ulcers), musculoskeletal (arthralgia) **[core]**
- Constitutional — fever, weight loss, fatigue

b) List 4 investigations to confirm the diagnosis. (4 marks)

- **Anti-neutrophil cytoplasmic antibody (ANCA)** — c-ANCA with PR3 specificity (proteinase 3) is highly sensitive and specific for GPA (90 percent); p-ANCA with MPO suggests microscopic polyangiitis or Churg-Strauss **[core]**
- **Renal biopsy** — pauci-immune crescentic glomerulonephritis (diagnostic) **[core]**
- **Lung / nasal biopsy** — necrotising granulomatous inflammation **[core]**
- **Computed tomography of chest and sinuses** — pulmonary nodules / cavities / haemorrhage; sinus destruction **[core]**
- Anti-glomerular basement membrane antibody (exclude Goodpasture)
- Inflammatory markers, full blood count, complement (normal in GPA — differentiates from lupus nephritis)

c) State 3 immediate management priorities. (3 marks)

- **High-dose corticosteroids** — methylprednisolone 1 g IV daily for 3 days, then oral prednisolone 1 mg/kg/day; rapid induction of remission **[core]**
- **Cyclophosphamide IV** (15 mg/kg pulse every 2-4 weeks) OR **rituximab** (375 mg/m² weekly for 4 weeks) — first-line immunosuppressive therapy; specialist (rheumatology / nephrology) input **[core]**
- **Plasma exchange** for severe pulmonary haemorrhage with renal failure (recent evidence less convincing — PEXIVAS trial); discuss with nephrologist **[core]**
- Supportive care — oxygen, transfusion if anaemic, intubation if respiratory failure
- Pneumocystis prophylaxis (trimethoprim-sulfamethoxazole) for patients on cyclophosphamide / prolonged steroid
- Multidisciplinary care — rheumatology, nephrology, ENT, respiratory, ICU

References: eTG (Therapeutic Guidelines, current) • ACEM clinical policies and statements • Tintinalli's Emergency Medicine 9e Ch 66 / Ch 95 • EULAR Vasculitis Guidelines

Question 9 | Pneumonia in Lung Transplant Recipient (11 marks)

A 28-year-old female patient presents to your regional emergency department with fever and cough. She is 6 months post-bilateral lung transplant for cystic fibrosis and is on tacrolimus, mycophenolate, and prednisolone. Vital signs: heart rate 105, blood pressure 120/75 millimetres of mercury, respiratory rate 24, peripheral oxygen saturation 91 percent on room air, temperature 38.0 degrees Celsius. Her chest radiograph is shown.

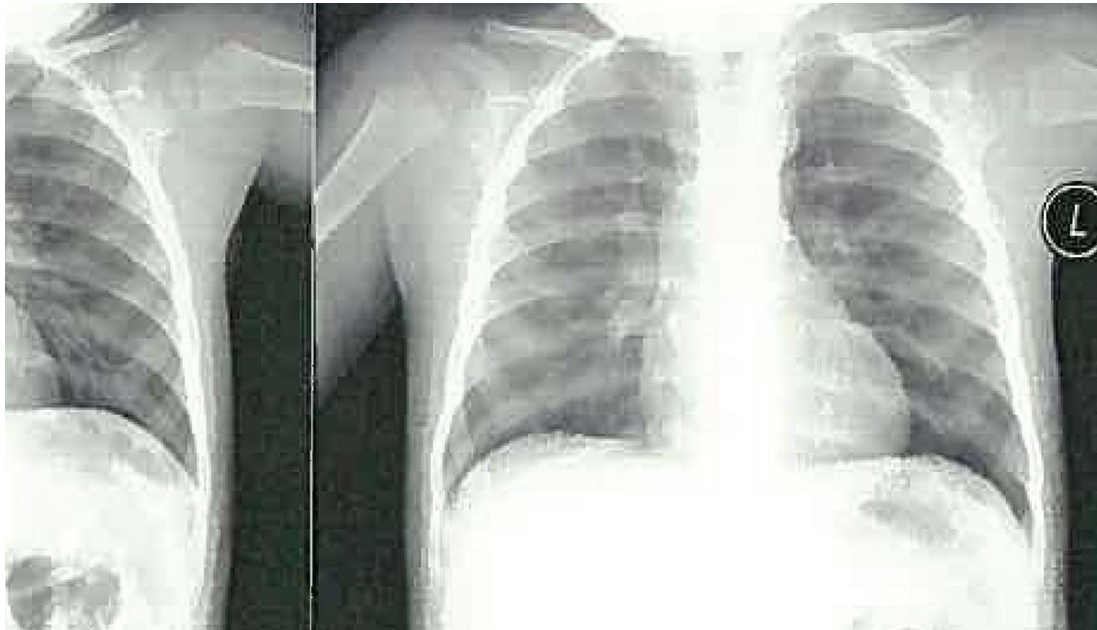


IMAGE — PA chest radiograph

a) Describe 3 abnormalities on the CXR. (3 marks)

- **Right upper / mid-zone airspace consolidation / opacification [core]**
- **Possible cavitation or destructive changes** in affected area; bilateral infrahilar haziness [core]
- **Trachea midline; no obvious pleural effusion; absence of pneumothorax;** cardiac silhouette preserved [core]
- Pulmonary nodular pattern

b) List 5 differential diagnoses to consider. (5 marks)

- **Bacterial pneumonia** — *Pseudomonas aeruginosa* (common in CF and transplant), *Stenotrophomonas*, *Burkholderia* [core]
- ***Pneumocystis jirovecii* pneumonia (PCP)** — typical in 6-12 months post-transplant; reduced PCP prophylaxis penetration [core]
- **Cytomegalovirus (CMV) pneumonitis** — 1-6 months post-transplant; characteristic time frame [core]
- **Invasive fungal infection** — *Aspergillus*, *Cryptococcus*, *Mucormycosis* (consider in neutropaenic or chronically immunosuppressed) [core]
- **Acute rejection (cellular or antibody-mediated)** — biopsy-diagnosed; consider with declining lung function [core]
- Atypical bacteria (*Legionella*, *Nocardia*, *Mycobacterium tuberculosis* or non-tuberculous mycobacteria)
- Drug-induced pneumonitis (sirolimus / everolimus); chronic rejection (bronchiolitis obliterans)

c) State 3 immediate management priorities. (3 marks)

- **Empirical broad-spectrum antibiotics** — piperacillin-tazobactam 4.5 g IV every 8 hours + vancomycin 25 mg/kg IV loading + levofloxacin 750 mg IV daily (or per local antibiogram); covers gram-positive, Pseudomonas, atypicals **[core]**
- **Antimicrobial cover for opportunistic infections** — consider trimethoprim-sulfamethoxazole high-dose IV (20 mg/kg/day) for PCP, ganciclovir 5 mg/kg IV every 12 hours for CMV; voriconazole / liposomal amphotericin if fungal suspected **[core]**
- **Urgent transplant team / respiratory consultation**; transfer to tertiary lung transplant centre where possible; bronchoalveolar lavage for pathogen identification (microbiology, viral PCR, fungal) **[core]**
- Continue immunosuppression but adjust if severe sepsis
- Investigate broadly: blood cultures, respiratory viral PCR, sputum culture and AFB, Aspergillus antigen, CMV PCR, viral load

References: eTG Therapeutic Guidelines — Antibiotic • eTG (Therapeutic Guidelines, current) • ACEM clinical policies and statements • Tintinalli's Emergency Medicine 9e Ch 66

Question 10 | Primary Spontaneous Pneumothorax (10 marks)

A 22-year-old tall thin male presents to your emergency department with sudden onset of right-sided pleuritic chest pain and mild dyspnoea for the past 6 hours. He has no significant past medical history and does not smoke. On examination, his vital signs are: heart rate 95 beats per minute, blood pressure 130/80 millimetres of mercury, respiratory rate 20 breaths per minute, peripheral oxygen saturation 96 percent on room air. Right chest examination reveals reduced breath sounds and hyper-resonance. Chest radiograph shows a 30 percent (4 cm rim) right-sided pneumothorax with no tension features.

a) List 4 features distinguishing primary from secondary spontaneous pneumothorax. (4 marks)

- **Primary:** typically young (15-35 years), tall thin male, smokers; **Secondary:** older, underlying lung disease (COPD, cystic fibrosis, pneumonia, interstitial lung disease, Marfan / Ehlers-Danlos) **[core]**
- **Primary:** minimal symptoms / well tolerated; **Secondary:** more symptomatic / haemodynamically compromised even with smaller pneumothorax **[core]**
- **Primary:** lower recurrence (30 percent first event, 50 percent after second); **Secondary:** higher recurrence (50-70 percent); lower threshold for definitive treatment **[core]**
- **Primary:** caused by rupture of apical bullae / blebs; **Secondary:** caused by underlying lung disease — usually indicates more severe pathology **[core]**
- Management approach often differs — secondary requires earlier intervention even with small pneumothorax

b) State 4 management options with criteria. (4 marks)

- **Observation** — small primary pneumothorax (<2-3 cm rim on lateral, asymptomatic patient); high-flow oxygen accelerates resolution; review at 6-24 hours; outpatient follow-up with chest radiograph **[core]**
- **Needle aspiration** — small intercostal cannula / 14-gauge needle in 2nd intercostal space, mid-clavicular line; aspirate up to 2.5 L; success rate 30-80 percent; first-line for primary spontaneous (BTS 2010 update) **[core]**
- **Intercostal catheter** (8-14 Fr small-bore catheter, OR 20-28 Fr larger-bore) — indicated for: failed aspiration, secondary spontaneous pneumothorax, tension, large pneumothorax (>50 percent), traumatic **[core]**
- **Pleurodesis / surgical intervention** — for recurrent (2nd episode), persistent air leak (>5 days), bilateral pneumothorax, high-risk occupation (pilots, divers) **[core]**
- Heimlich valve (one-way valve attached to ICC for ambulatory management)

c) State 2 important discharge instructions. (2 marks)

- **Avoid air travel** for 2 weeks (or until full resolution and respiratory physician approval); **avoid scuba diving for life** after primary pneumothorax (unless definitive surgical repair) **[core]**
- **Smoking cessation** (reduces recurrence by 80 percent); avoid valsalva manoeuvres **[core]**
- Return to emergency department if increasing dyspnoea, chest pain, or systemic symptoms
- Follow-up CXR at 1-2 weeks; respiratory outpatient appointment

References: BTS Pleural Disease Guideline 2010 • eTG (Therapeutic Guidelines, current) • ACEM clinical policies and statements • Tintinalli's Emergency Medicine 9e Ch 66

Question 11 | Massive Pulmonary Embolism (11 marks)

A 59-year-old wheel-chair-bound paraplegic (spinal cord injury 10 years ago) presents to your emergency department with chest pain and shortness of breath. He has a previous history of a clipped Circle of Willis aneurysm 6 years ago. He denies headache. CT pulmonary angiogram confirms a massive pulmonary embolism with saddle clot. His vital signs: Glasgow Coma Score 15, heart rate 114 beats per minute, blood pressure 87/39 millimetres of mercury, respiratory rate 24, peripheral oxygen saturation 97 percent on 15 litres oxygen via non-rebreather mask.

a) List 5 sequential management steps in the first 30 minutes. (5 marks)

- **Resuscitation** — large-bore IV access; bloods (FBC, U&E, troponin, BNP, coagulation, group and save); cautious crystalloid bolus 250-500 mL (excessive volume worsens RV function); noradrenaline IV infusion (5-15 µg/min) for sustained shock **[core]**
- **Systemic thrombolysis** — **alteplase 100 mg IV over 2 hours** (or 0.6 mg/kg over 15 min in cardiac arrest); CONTRAINDICATIONS in this patient: recent intracranial surgery (6 years post; relative); discuss with neurosurgery to weigh risks **[core]**
- **Bedside echocardiography** — assess RV size, septal D-shape, TAPSE, McConnell sign; guides thrombolysis decision; documents RV strain **[core]**
- **Catheter-directed thrombolysis / embolectomy** via interventional radiology — for haemodynamically unstable PE with contraindication to systemic thrombolysis; or surgical embolectomy **[core]**
- **ICU admission** with continuous monitoring; mechanical ventilation carefully (low PEEP, low tidal volume; positive pressure further reduces RV preload) **[core]**
- Continue therapeutic anticoagulation post-thrombolysis — UFH infusion initially
- Consider ECMO if catastrophic instability

b) List 3 absolute contraindications to systemic thrombolysis. (3 marks)

- **Active major bleeding**; intracranial neoplasm, AV malformation, or aneurysm **[core]**
- **Prior haemorrhagic stroke** (at any time); ischaemic stroke within 3 months **[core]**
- **Recent significant head / spinal trauma or surgery (within 3 weeks)**; recent cranial / spinal surgery **[core]**
- Active aortic dissection
- Recent significant gastrointestinal bleed (within 1 month)
- Suspected infective endocarditis

c) Describe 3 ethical and medico-legal issues in this case. (3 marks)

- **Informed consent** in life-threatening situation — patient is conscious (GCS 15); explain risks of thrombolysis (including intracranial haemorrhage given previous aneurysm) vs no treatment; document discussion **[core]**
- **Risk-benefit analysis with relative contraindication** (previous intracranial surgery — consider neurosurgery input before thrombolysis; weigh death from PE vs intracranial bleed **[core]**)
- **Code status / advance care planning** — discuss escalation of care (ICU, intubation, ECMO) in context of spinal cord injury and quality of life considerations; involve family **[core]**
- Patient autonomy and right to refuse treatment
- Documentation and consultation with team (respiratory, cardiology, neurosurgery, intensive care)

References: eTG (Therapeutic Guidelines, current) • ACEM clinical policies and statements • Tintinalli's Emergency Medicine 9e Ch 56 • ESC PE Guidelines 2019

Question 12 | Paediatric Foreign Body Airway Obstruction (11 marks)

A 12-month-old boy (weight 10 kg) has been unwell with cough for 1 week. Today he was eating spaghetti when he seemed to gag and have difficulty breathing over 1 minute. His mother reports he is now clingy with a 'strange cough'. Vital signs: heart rate 120, blood pressure 90/50 millimetres of mercury, peripheral oxygen saturation 90 percent on room air, respiratory rate 24, temperature 37.5 degrees Celsius. On examination, he is alert in mother's arms with multiple petechiae around his eyes, intermittent cough, mild intercostal recession and tracheal tug, but no stridor.

a) Explain 3 examination findings. (3 marks)

- **Periorbital petechiae** — from increased venous pressure during coughing / Valsalva (intense forceful expiratory effort); suggests recent severe coughing episode **[core]**
- **Intermittent cough with 'strange' character** — partial airway obstruction with foreign body shifting; may be transient depending on object position **[core]**
- **Mild intercostal recession and tracheal tug** with hypoxia (SpO₂ 90) — increased work of breathing from partial airway obstruction **[core]**
- Reduced air entry on auscultation of affected side (more typical with bronchial FB)
- Lack of stridor — suggests obstruction is in the trachea or bronchus (not glottis / subglottic)

b) List 3 expected CXR findings (inspiratory and expiratory views). (3 marks)

- **Unilateral hyperinflation** on expiratory film — air trapping distal to FB (ball-valve mechanism) **[core]**
- **Mediastinal shift** away from obstructed side on expiration (towards unaffected side); shift towards obstructed side if complete collapse **[core]**
- **Unilateral atelectasis / consolidation** on inspiratory film (post-obstructive); pneumonia may complicate prolonged FB **[core]**
- Radio-opaque foreign body (uncommon — most are radiolucent organic matter)
- Decubitus film: dependent lung normally expands less; with FB, the affected lung remains hyperinflated despite dependent position

c) State 5 immediate management steps for infant with complete airway obstruction and inability to ventilate. (5 marks)

- **Basic life support — 5 back blows + 5 chest thrusts** in infant <1 year (head-down position, supporting head); repeat alternating until object expelled OR child loses consciousness **[core]**
- **Visualise oropharynx with laryngoscope** (if BLS fails) — remove visible FB with Magill forceps; do NOT perform blind finger sweep (may push object deeper) **[core]**
- **Attempt intubation** — push the FB into one bronchus if cannot be removed; this allows ventilation of the contralateral lung; size ETT = age/4 + 4 = 4.0 mm uncuffed **[core]**
- **Urgent paediatric ENT and anaesthetic consultation** for rigid bronchoscopy under general anaesthesia — definitive treatment **[core]**
- **Cricothyrotomy / surgical airway** if all else fails (rarely needed); needle cricothyroidotomy with transtracheal ventilation; alternative is needle tracheostomy **[core]**
- Concurrent resuscitation per APLS — compression / ventilation if not breathing; adrenaline 10 µg/kg IV / IO if needed
- Avoid Heimlich manoeuvre in infants <1 year (causes intra-abdominal injury)

References: APLS Australia/NZ • ANZCOR Guidelines (current) • eTG (Therapeutic Guidelines, current) • Tintinalli's Emergency Medicine 9e Ch 109

Question 13 | Acute Cardiogenic Pulmonary Oedema (10 marks)

A 75-year-old man with a history of ischaemic cardiomyopathy and previous myocardial infarction presents to your emergency department by ambulance with acute severe shortness of breath that woke him from sleep 2 hours ago. He has not been compliant with his medications (furosemide, enalapril, carvedilol, frusemide) and ate a large salty meal 24 hours ago. On arrival, he is upright, anxious, and unable to speak in full sentences. Vital signs: heart rate 130, blood pressure 195/115 millimetres of mercury, respiratory rate 36, peripheral oxygen saturation 84 percent on 15 litres oxygen via non-rebreather mask, temperature 36.5 degrees Celsius. Bilateral fine crepitations to mid-zones; raised JVP.

a) State 4 immediate management priorities (drug, dose, end-point). (4 marks)

- **Sit patient upright; commence non-invasive ventilation (CPAP 10-12 cm H₂O or BiPAP IPAP 14-16 / EPAP 8 cm H₂O)** — reduces preload (decreased venous return) and afterload, improves alveolar recruitment; aim SpO₂ >94 percent **[core]**
- **Glyceryl trinitrate (GTN) IV infusion 10-200 µg/min** titrated to blood pressure (or 400 µg sublingual spray repeated; 5-10 mg topical patch) — reduces preload AND afterload; aim systolic BP 140-150 (lower in cardiogenic shock contraindication) **[core]**
- **Furosemide 40-80 mg IV bolus** (or twice usual daily oral dose); venodilatory effect within 5 minutes; diuretic effect within 30-60 minutes; AVOID in normovolaemic / hypovolaemic patients (Trauma) **[core]**
- **Identify and treat underlying cause** — investigate for acute coronary syndrome (ECG, troponin), arrhythmia (rate control), hypertensive emergency (this case), anaemia, sepsis, valvular event **[core]**
- AVOID morphine routinely (worsens outcomes; no evidence of benefit)
- Manage hyperkalaemia / metabolic disturbance if present
- ICU / HDU admission with continuous monitoring

b) List 3 indications for intubation in acute pulmonary oedema. (3 marks)

- **Failure of NIV** after 1-2 hours (no improvement in respiratory rate, SpO₂, work of breathing, or acid-base status) **[core]**
- **Cardiac or respiratory arrest / peri-arrest**; severe haemodynamic instability (cardiogenic shock with MAP <65) **[core]**
- **Decreased Glasgow Coma Score / obtundation**, inability to protect airway, vomiting **[core]**
- Inability to tolerate NIV (claustrophobia, uncooperative, contraindication)

c) List 3 contraindications / cautions to NIV in this setting. (3 marks)

- **Vomiting / aspiration risk**; facial / upper airway trauma; inability to clear secretions **[core]**
- **Cardiac or respiratory arrest / peri-arrest** — proceed to intubation **[core]**
- **Pneumothorax (untreated)**; severe upper GI bleed **[core]**
- Hypotension / cardiogenic shock (relative — NIV may worsen if SBP <90)
- Recent oesophageal surgery

References: eTG (Therapeutic Guidelines, current) • ACEM clinical policies and statements • Tintinalli's Emergency Medicine 9e Ch 53 • BTS / TSANZ NIV guidelines

Question 14 | Rhabdomyolysis with Acute Kidney Injury (9 marks)

A 55-year-old male is brought to your emergency department after being found at home on the floor by his family. He had been there for approximately 18 hours after a fall. He has a history of polypharmacy including a statin (rosuvastatin 40 mg). On arrival he is alert but confused. Bedside investigations: heart rate 115, blood pressure 105/65 millimetres of mercury, urinalysis blood +++ (no red cells on microscopy — myoglobin), creatinine 320 $\mu\text{mol/L}$ (baseline 90), potassium 6.5, creatine kinase 88,000 U/L.

a) List 3 management priorities for rhabdomyolysis-associated AKI. (3 marks)

- **Aggressive intravenous fluid resuscitation** — initial bolus 1-2 L 0.9 percent saline, then 1-2 mL/kg/h continuous infusion; target urine output 2-3 mL/kg/h to clear myoglobin **[core]**
- **Treat hyperkalaemia** — calcium gluconate 10 mL 10% IV (membrane stabilisation); insulin / dextrose (temporise); salbutamol nebulised; haemodialysis if persistent OR established AKI **[core]**
- **Urinary alkalinisation** — sodium bicarbonate infusion to maintain urine pH >6.5 (reduces myoglobin precipitation); limited evidence but commonly used **[core]**
- Cease offending drugs (statin)
- Investigate cause — compartment syndrome (check limbs), drug interaction (statin + fibrate, clarithromycin), trauma, neuroleptic malignant syndrome, exertional heat stroke
- Monitor for compartment syndrome, disseminated intravascular coagulation, fluid overload

b) List 4 causes of rhabdomyolysis. (4 marks)

- **Crush injury / prolonged immobility** (this patient — 18 hours on floor); trauma; severe exertion **[core]**
- **Drug-induced**: statins (especially with concurrent fibrate or clarithromycin); cocaine, amphetamines; serotonin syndrome / neuroleptic malignant syndrome **[core]**
- **Heat stroke / hyperthermia**; malignant hyperthermia **[core]**
- **Severe electrolyte disturbance** — hypokalaemia, hypophosphataemia, hypocalcaemia **[core]**
- Inherited muscle disorders (McArdle disease, muscular dystrophies)
- Severe infection (influenza, Legionella, sepsis)
- Status epilepticus, dystonic reactions
- Snake / spider envenomation

c) List 2 indications for renal replacement therapy. (2 marks)

- **Refractory hyperkalaemia** ($K > 6.5$ with ECG changes despite medical management); severe metabolic acidosis **[core]**
- **Anuric AKI**, refractory fluid overload, severe uraemia with symptoms (typical AKI indications apply); persistent oliguria despite fluid resuscitation **[core]**
- Persistent severe rhabdomyolysis with CK >30,000 may benefit from extracorporeal myoglobin clearance (controversial)

References: eTG (Therapeutic Guidelines, current) • ACEM clinical policies and statements • Tintinalli's Emergency Medicine 9e Ch 269 • Kidney Health Australia / ANZSN guidelines

Question 15 | Acute Severe Adult Asthma — Stepwise Therapy (11 marks)

A 20-year-old known asthmatic has presented to your tertiary emergency department with an acute exacerbation of asthma. She was initially seen by your registrar and treated with supplemental oxygen, salbutamol (5 mg × 5) and ipratropium (500 mcg × 3) nebulisation and IV hydrocortisone 200 mg. She has failed to improve after 60 minutes of treatment. Her vital signs: heart rate 130, blood pressure 125/80 millimetres of mercury, respiratory rate 40, peripheral oxygen saturation 90 percent on 15 litres oxygen via non-rebreather mask. She is tiring.

a) List 4 further pharmacological treatment options (with drug, dose). (4 marks)

- **Magnesium sulfate 2 g IV over 20 minutes** (single dose) — bronchodilation; evidence supports use in severe asthma not responding to first-line **[core]**
- **Intravenous salbutamol** — loading 250 µg over 10 minutes then 5-20 µg/min infusion; close monitoring (tachycardia, hypokalaemia, lactic acidosis) **[core]**
- **Aminophylline 5 mg/kg IV over 60 minutes** (loading) then 0.5 mg/kg/h infusion; narrow therapeutic window; level monitoring required; limited evidence but option for ICU-level care **[core]**
- **Adrenaline 0.3-0.5 mg IM (1:1000)** — for refractory asthma approaching arrest, OR if any concern for anaphylaxis (consider always in severe asthma — atypical anaphylaxis) **[core]**
- Heliox 70:30 (helium / oxygen mix) — reduces airway resistance; limited availability
- Inhaled volatile anaesthetic (isoflurane) — ICU level

b) List 4 steps to optimise before proceeding with rapid sequence intubation. (4 marks)

- **Pre-oxygenation with BiPAP / NIV** (15-20 cm H₂O) — preserves FRC, opens collapsed alveoli, allows delivery of inhaled bronchodilator; set short expiratory time **[core]**
- **Volume optimisation** — fluid bolus 500 mL crystalloid (often intravascularly depleted from increased respiratory work); vasopressor (noradrenaline) drawn up **[core]**
- **Choose induction agent carefully** — **ketamine 1-2 mg/kg IV** (bronchodilator, haemodynamic-sparing) is preferred; avoid propofol (vasodilation) **[core]**
- **Plan ventilator strategy** — low tidal volume (6 mL/kg ideal body weight), low rate (8-10 breaths/min), prolonged expiratory time (I:E ratio 1:4-1:5), permissive hypercapnia **[core]**
- Optimise positioning (sitting up if tolerated; immediate flat for intubation)
- Senior airway operator with surgical airway back-up; clearly defined Plan B

c) State 3 immediate management measures if BP drops to 80/40 immediately post-intubation. (3 marks)

- **Disconnect from ventilator** — allow passive exhalation (relieves auto-PEEP / dynamic hyperinflation, common cause of post-intubation hypotension in asthma); if BP improves, modify ventilator settings **[core]**
- **Exclude tension pneumothorax** — common complication of barotrauma; auscultate, percuss, bedside ultrasound (lung point); needle / finger thoracostomy if suspected **[core]**
- **Fluid bolus AND vasopressor** — 500-1000 mL crystalloid bolus; noradrenaline 0.05-0.5 µg/kg/min; check ETT position and depth **[core]**
- Adrenaline 50-100 µg IV bolus if peri-arrest

References: Global Initiative for Asthma (GINA) report current • eTG (Therapeutic Guidelines, current) • ACEM clinical policies and statements • ANZCOR Guidelines (current)

Question 16 | Large Pleural Effusion with Mediastinal Shift (9 marks)

A 60-year-old female with a history of metastatic ovarian cancer presents to your emergency department with acutely worsening dyspnoea over the past 24 hours. Her vital signs: heart rate 125, blood pressure 100/65 millimetres of mercury, respiratory rate 32, peripheral oxygen saturation 87 percent on 8 litres oxygen via Hudson mask, temperature 37.5 degrees Celsius. The chest radiograph is shown.

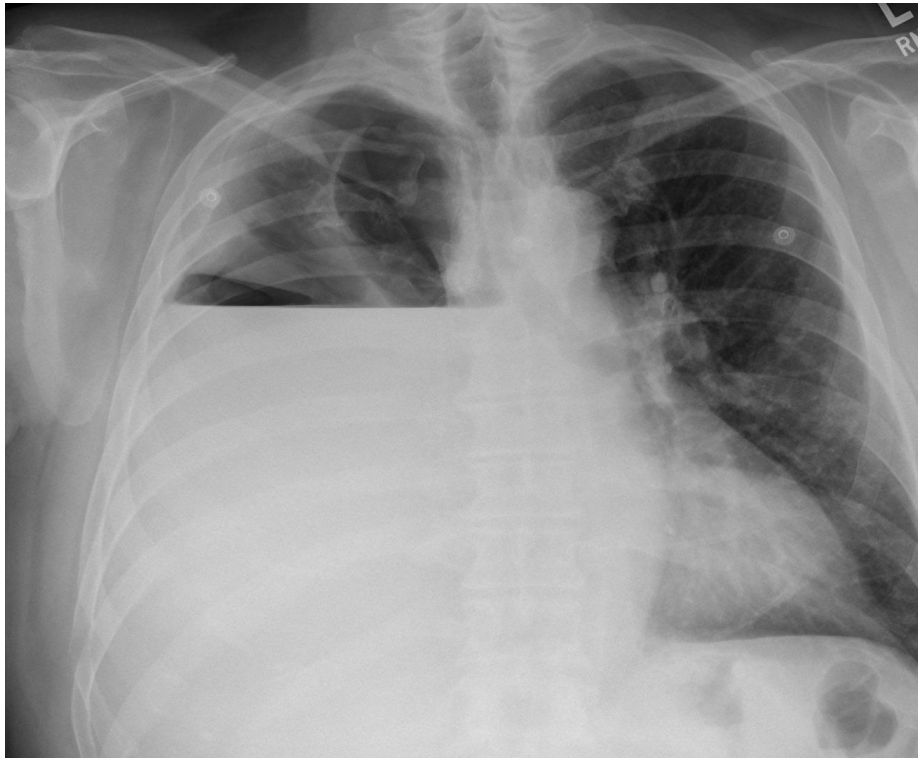


IMAGE — PA chest radiograph

a) Describe 3 key findings on this radiograph. (3 marks)

- **Near-complete opacification of the right hemithorax** with homogeneous density consistent with large pleural effusion **[core]**
- **Mediastinal shift to the left** (contralateral) — implies massive effusion with intact lung architecture (if shifted TOWARDS the opacified side, suspect collapse, lobectomy, or fibrothorax) **[core]**
- **Left lung clear**; no pneumothorax or other gross abnormality on left; trachea displaced to the left **[core]**
- Possible squared-off costophrenic angle (small effusion); reverse meniscus if very large

b) List 3 management priorities for this symptomatic large effusion. (3 marks)

- **Therapeutic ultrasound-guided drainage** — remove 1-1.5 L slowly (avoid re-expansion pulmonary oedema with large volumes); send fluid for cell count, biochemistry, cytology, culture **[core]**
- **Investigate the cause** — Light's criteria to determine exudate (likely malignancy in this patient); cytology for malignant cells; consider CT abdomen / pelvis / chest for staging **[core]**
- **Definitive ongoing management** — recurrent malignant effusion may require indwelling pleural catheter (IPC), chemical pleurodesis (talc / doxycycline), or surgical pleurectomy depending on prognosis; respiratory or palliative team involvement **[core]**
- Discussion of goals of care given underlying metastatic disease
- Analgesia (consider local anaesthetic for procedure)

c) List 3 complications of pleural fluid drainage. (3 marks)

- **Re-expansion pulmonary oedema** (removing >1.5 L rapidly or fully collapsed lung re-expanding); presents with cough, dyspnoea, tachypnoea, hypoxia **[core]**
- **Pneumothorax** (from puncture of underlying lung) — use ultrasound guidance to minimise **[core]**
- **Bleeding** — intercostal artery injury (above superior border of rib); check coagulation pre-procedure **[core]**
- Empyema / infection (introduce organisms)
- Hypotension from large fluid shift
- Subcutaneous emphysema, local pain

References: *BTS Pleural Disease Guideline* • *eTG (Therapeutic Guidelines, current)* • *ACEM clinical policies and statements* • *Tintinalli's Emergency Medicine 9e Ch 66*

Question 17 | Haemodialysis Access Complications (10 marks)

A 65-year-old man on haemodialysis (left brachiocephalic arteriovenous fistula) presents to your emergency department with sudden onset of swelling and pain in his left arm. He reports fever for the past 24 hours. His vital signs: heart rate 115, blood pressure 105/70 millimetres of mercury, respiratory rate 22, peripheral oxygen saturation 96 percent on room air, temperature 38.5 degrees Celsius. The left arm is swollen, erythematous, and tender from elbow to mid-upper-arm. The fistula thrill is diminished compared with previous dialysis session.

a) List 4 important AV fistula complications to consider. (4 marks)

- **Infection / fistula-related infection** (this patient — septicæmia from contaminated dialysis access; bacteraemia rate 1-2 per 1000 patient-days) **[core]**
- **Thrombosis / fistula occlusion** — diminished thrill, no bruit on auscultation; needs urgent intervention **[core]**
- **Pseudoaneurysm** (false aneurysm from needle cannulation) — pulsatile swelling; risk of rupture **[core]**
- **Steal syndrome** — ischaemia of the hand distal to fistula (cold, painful, weak grip); may require fistula ligation or distal revascularisation **[core]**
- Heart failure (high-output) from large flow
- Venous hypertension (swelling proximal to fistula with no thrill)

b) State 4 management priorities. (4 marks)

- **Blood cultures and broad-spectrum IV antibiotics** — **vancomycin 25 mg/kg IV loading** (then 15-20 mg/kg every 12 hours; covers MRSA, common at access sites) + **ceftriaxone 1 g IV daily** (gram-negative cover); duration 2-4 weeks for bacteraemia **[core]**
- **Source control** — vascular surgery / interventional radiology consultation; pseudoaneurysm drainage if abscess; consider fistula removal in severe / persistent infection **[core]**
- **Renal team consultation** for dialysis access (temporary venous catheter if AV fistula not usable); arrange next dialysis session through alternative access **[core]**
- **Investigate for complications** — Doppler ultrasound of fistula (flow, thrombosis, pseudoaneurysm); echocardiography (endocarditis screen if bacteraemic) **[core]**
- Analgesia (avoid NSAIDs in renal failure)
- Investigate underlying renal function — U&E; consider need for emergent dialysis

c) List 2 most common organisms in dialysis-access infections. (2 marks)

- **Staphylococcus aureus** (including MRSA) — most common (45 percent); skin colonisation **[core]**
- **Coagulase-negative staphylococci** (staph epidermidis); enterococcus and gram-negative organisms (E. coli, Pseudomonas) less common **[core]**
- Polymicrobial infection in 10-20 percent

References: eTG Therapeutic Guidelines — Antibiotic • eTG (Therapeutic Guidelines, current) • Kidney Health Australia / ANZSN guidelines • ACEM clinical policies and statements

Question 18 | Contrast-Induced Nephropathy (9 marks)

A 70-year-old male with diabetes mellitus and chronic kidney disease (baseline creatinine 180 $\mu\text{mol/L}$, eGFR 38 mL/min) is referred from the emergency department for computed tomography pulmonary angiogram (CTPA) with intravenous iodinated contrast to investigate suspected pulmonary embolism. The radiology registrar contacts you for clarification regarding contrast risk.

a) Define contrast-induced nephropathy AND state 3 risk factors. (3 marks)

- **Contrast-induced nephropathy (CIN) / contrast-induced AKI** = AKI occurring within 48-72 hours of intravenous iodinated contrast administration, defined as a rise in serum creatinine $\geq 26.5 \mu\text{mol/L}$ (0.3 mg/dL) OR ≥ 50 percent above baseline **[core]**
- **Risk factors:** pre-existing renal impairment (eGFR <60); diabetes mellitus with nephropathy **[core]**
- **Age >75, dehydration, hypotension**, heart failure, concurrent nephrotoxic drugs (NSAIDs, ACE-i, aminoglycosides), large contrast volume / repeated exposure within 48-72 hours **[core]**

b) State 4 strategies to prevent CIN. (4 marks)

- **Adequate hydration with intravenous crystalloid** (1 mL/kg/h of 0.9 percent saline OR isotonic sodium bicarbonate) for 6 hours pre and post contrast — most important preventive measure **[core]**
- **Withhold nephrotoxic drugs** (NSAIDs, ACE-i / ARB, diuretics, aminoglycosides, metformin) peri-procedure where possible **[core]**
- **Use lowest effective contrast volume**; iso- or low-osmolar non-ionic contrast preferred over high-osmolar contrast **[core]**
- **Avoid repeat contrast within 48-72 hours**; consider alternative imaging (USS, non-contrast MRI, V/Q scan) where diagnostically adequate **[core]**
- N-acetylcysteine (oral / IV) — evidence mixed; recommended in some guidelines but not consistently effective

c) State the RANZCR recommendation for metformin AND iodinated contrast. (2 marks)

- **If eGFR ≥ 30 :** continue metformin; recheck creatinine if AKI suspected **[core]**
- **If eGFR <30 OR if AKI present:** withhold metformin at the time of contrast and for 48 hours; restart only after renal function is confirmed stable **[core]**
- Risk: metformin accumulation with AKI $\rightarrow$ lactic acidosis (rare but life-threatening)

References: RANZCR Iodinated Contrast Media Guidelines • KDIGO 2012 AKI • eTG (Therapeutic Guidelines, current)

Question 19 | Nephrotic Syndrome (9 marks)

A 35-year-old male presents to your emergency department with 2 weeks of progressive bilateral lower limb swelling and frothy urine. He also describes mild shortness of breath on exertion. His vital signs are: heart rate 90, blood pressure 145/85 millimetres of mercury, respiratory rate 18, peripheral oxygen saturation 96 percent on room air, temperature 37.0 degrees Celsius. Examination shows marked peripheral oedema (pitting to mid-shin) and periorbital puffiness. Urinalysis: protein +++, no blood. Bloods: albumin 18 g/L, cholesterol 9, urine protein:creatinine ratio 8 g/g.

a) Define nephrotic syndrome (3 components). (3 marks)

- **Heavy proteinuria** — urine protein >3.5 g/day OR urine protein:creatinine ratio >300 mg/mmol (or >3 g/g) **[core]**
- **Hypoalbuminaemia** — serum albumin <30 g/L **[core]**
- **Generalised oedema** (peripheral, periorbital, anasarca); **hyperlipidaemia / dyslipidaemia** often present (liver compensatory response) **[core]**
- Differentiates from nephritic syndrome (red cell casts, mild proteinuria, hypertension, oliguria)

b) List 3 causes of nephrotic syndrome. (3 marks)

- **Minimal change disease** (most common in children; 20 percent in adults) **[core]**
- **Membranous nephropathy** — common in adults; primary (anti-PLA2R antibodies) or secondary (malignancy, hepatitis B, drugs) **[core]**
- **Focal segmental glomerulosclerosis** (post-infection, HIV, obesity); diabetic nephropathy **[core]**
- Lupus nephritis (class V membranous nephritis); amyloidosis
- Membranoproliferative GN; HIV-associated nephropathy

c) List 3 acute complications of nephrotic syndrome to consider in the ED. (3 marks)

- **Venous thromboembolism** (particularly renal vein thrombosis, deep vein thrombosis, pulmonary embolism) — increased risk from loss of antithrombin III in urine; consider anticoagulation **[core]**
- **Infection** — particularly spontaneous bacterial peritonitis (loss of immunoglobulins in urine; *Streptococcus pneumoniae*); cellulitis **[core]**
- **Severe hypovolaemia / shock** (intravascular depletion despite oedema — 'underfill'); acute kidney injury **[core]**
- Refractory oedema with respiratory compromise (pulmonary oedema)
- Hyperlipidaemia / cardiovascular events
- Adrenal insufficiency (loss of cortisol-binding globulin)

References: eTG (Therapeutic Guidelines, current) • ACEM clinical policies and statements • Tintinalli's Emergency Medicine 9e Ch 95 • Kidney Health Australia / ANZSN guidelines

Question 20 | Acute Respiratory Distress Syndrome (10 marks)

A 65-year-old man with previously well health is admitted with severe community-acquired pneumonia. He has been intubated for respiratory failure. After 24 hours, his ventilatory parameters reveal: tidal volume 600 mL on volume control; FiO_2 0.8 with PEEP 5; peak inspiratory pressure 38 cm H_2O ; plateau pressure 32 cm H_2O . Arterial blood gas: pH 7.32, pCO_2 48, pO_2 65 ($\text{PaO}_2/\text{FiO}_2$ ratio 81). Bilateral diffuse alveolar infiltrates on portable chest radiograph.

a) Define ARDS using the Berlin definition (4 components) AND state the severity. (4 marks)

- **Acute onset** — within 1 week of a clinical insult or new or worsening respiratory symptoms **[core]**
- **Bilateral lung infiltrates on chest imaging** (radiograph or computed tomography) not fully explained by effusions, lobar / lung collapse, or nodules **[core]**
- **Respiratory failure not fully explained by cardiac failure or fluid overload** (requires objective assessment — echocardiogram — to exclude cardiogenic component) **[core]**
- **Oxygenation: $\text{PaO}_2/\text{FiO}_2$ ratio with PEEP ≥ 5 cm H_2O** — Mild: 200-300; Moderate: 100-200; **Severe: ≤ 100** (this patient — 81 = SEVERE ARDS) **[core]**

b) State 4 ventilator strategy adjustments per ARDSnet protocol. (4 marks)

- **Low tidal volume (6 mL/kg ideal body weight)** — this patient's current TV 600 mL likely too high for predicted ideal body weight; reduce to lung-protective settings **[core]**
- **Plateau pressure ≤ 30 cm H_2O** (this patient's plateau 32 — borderline; reduce TV further if needed) **[core]**
- **Higher PEEP titrated to oxygenation** — ARDSnet PEEP / FiO_2 table (e.g. PEEP 14-18 cm H_2O with FiO_2 0.7-0.8); aim to reduce FiO_2 as much as possible while maintaining oxygenation **[core]**
- **Permissive hypercapnia** — allow rising pCO_2 up to 60-80 (pH >7.20) to facilitate lung-protective ventilation **[core]**
- Prone positioning for 16+ hours/day (PROSEVA trial — reduces mortality in severe ARDS)
- Neuromuscular blockade for first 48 hours (ACURASYS trial — controversial)
- Consider veno-venous ECMO for refractory hypoxaemia (EOLIA trial selection)

c) List 2 measures to reduce ventilator-induced lung injury. (2 marks)

- **Avoid high tidal volumes** (volutrauma) — limit to 6 mL/kg ideal body weight **[core]**
- **Avoid high plateau pressures** (barotrauma) — <30 cm H_2O ; **avoid cyclical atelectasis** (atelectrauma) — appropriate PEEP **[core]**
- Adequate sedation (avoid asynchrony / double-triggering causing biotrauma)
- Minimise FiO_2 (oxygen toxicity)
- Restrictive fluid strategy (FACTT trial)

References: Berlin Definition (JAMA 2012) • ARDSnet low tidal volume trial (NEJM 2000) • eTG (Therapeutic Guidelines, current) • ACEM clinical policies and statements

Question 21 | Pulmonary Tuberculosis (10 marks)

A 50-year-old man originally from a tuberculosis-endemic country (Philippines; in Australia for 3 years) presents to your emergency department with 3 months of progressive productive cough, haemoptysis, fevers, night sweats, and 10-kilogram weight loss. He has no other significant past medical history. Vital signs: heart rate 95, blood pressure 125/80 millimetres of mercury, respiratory rate 22, peripheral oxygen saturation 95 percent on room air, temperature 37.4 degrees Celsius. Chest examination: reduced breath sounds and crepitations in right upper zone.

a) State 4 infection control / public health actions. (4 marks)

- **Negative-pressure isolation room** (or single room with door closed and appropriate ventilation if no negative-pressure available) **[core]**
- **Healthcare worker PPE** — N95 / P2 respirator (fit-tested), eye protection, gown, gloves; minimise aerosol-generating procedures **[core]**
- **Surgical mask for the patient** when transferred or moved through common areas **[core]**
- **Mandatory notification to public health authority** — TB is a notifiable disease in all Australian states; contact tracing arranged **[core]**
- Stop performing high-risk aerosol-generating procedures (sputum induction, bronchoscopy) unless essential
- Inform infectious diseases and respiratory teams promptly

b) List 3 first-line investigations. (3 marks)

- **Three sputum samples for AFB smear, Mycobacterium TB nucleic acid amplification (Xpert MTB/RIF), and culture on consecutive days**; early morning samples preferred **[core]**
- **Chest radiograph** — upper-lobe cavitation typical; miliary pattern; lymphadenopathy; old fibrotic changes **[core]**
- **Computed tomography of chest** (if CXR equivocal); HIV testing (co-infection common); tuberculin skin test or interferon-gamma release assay (IGRA — QuantiFERON Gold) **[core]**
- Bloods — FBC, U&E, LFTs (baseline pre-treatment), HIV, hepatitis serology
- Bronchoalveolar lavage if sputum-negative and high clinical suspicion

c) State the standard 4-drug regimen for active TB. (3 marks)

- **Intensive phase (8 weeks): Rifampicin + Isoniazid + Pyrazinamide + Ethambutol (RIPE)** — daily, weight-based dosing **[core]**
- **Continuation phase (16 weeks): Rifampicin + Isoniazid (RI) daily**; total 6 months for drug-sensitive pulmonary TB **[core]**
- **Pyridoxine 25 mg orally daily** (prevents isoniazid-related peripheral neuropathy) **[core]**
- Directly observed therapy (DOT) often implemented
- Monitor for hepatotoxicity (LFTs); ocular review for ethambutol; specialist input (infectious diseases / respiratory)
- Multidrug-resistant TB (MDR-TB) regimens and extensively drug-resistant TB (XDR-TB) are complex and longer (18-24 months)

References: eTG Therapeutic Guidelines — Antibiotic • eTG (Therapeutic Guidelines, current) • Australian National TB Guidelines • ACEM clinical policies and statements

Question 22 | Acute Severe Hyponatraemia and Volume Status (9 marks)

A 65-year-old female presents to your emergency department with confusion and a tonic-clonic seizure that has resolved. She has a 6-month history of progressive dyspnoea and was diagnosed with small cell lung cancer 2 weeks ago. Bloods: sodium 110 mmol/L, potassium 3.8, urea 4, creatinine 75, osmolality 235 mOsm/kg. Urine osmolality 600 mOsm/kg, urine sodium 60. Vital signs: heart rate 90, blood pressure 130/80 millimetres of mercury, peripheral oxygen saturation 95 percent on room air, temperature 36.8 degrees Celsius.

a) Classify the hyponatraemia AND identify the likely cause. (4 marks)

- **Hypotonic hyponatraemia** (measured plasma osmolality 235 — low; truly hypotonic, not pseudohyponatraemia) **[core]**
- **Euvolaemic** — no clinical features of dehydration (haemodynamically stable; normal JVP, no oedema) **[core]**
- **Inappropriately concentrated urine** (urine osmolality 600 >100 expected with dilute urine in hyponatraemia) AND urine sodium >40 (preserved renal sodium excretion) **[core]**
- **SIADH (Syndrome of Inappropriate ADH)** — likely secondary to small cell lung cancer (paraneoplastic); matches biochemical pattern **[core]**
- Exclude other causes: hypothyroidism, adrenal insufficiency (random cortisol), drugs (SSRIs, carbamazepine, thiazides)

b) State 3 immediate management priorities (with drug, dose). (3 marks)

- **Hypertonic saline 3 percent 100-150 mL IV bolus over 10 minutes**; repeat to raise sodium by 4-6 mmol/L (aim to abort seizures and reduce cerebral oedema) **[core]**
- **Target rate of sodium correction** — ≤ 8 mmol/L in any 24-hour period (lower in chronic hyponatraemia / high-risk patients) — risk of osmotic demyelination syndrome **[core]**
- **Monitor** — hourly serum sodium initially; check potassium, magnesium, glucose; ICU / HDU admission; treat underlying cause (oncology consultation, fluid restriction 800-1000 mL/day long-term for SIADH) **[core]**
- Treat seizures with benzodiazepine if ongoing (midazolam 5-10 mg IM/IV)
- Tolvaptan (vasopressin V2 receptor antagonist) 15 mg orally daily — definitive treatment for chronic SIADH; specialist input

c) List 2 risk factors for osmotic demyelination syndrome. (2 marks)

- **Chronic hyponatraemia** (≥ 48 hours; brain has adapted) AND **rapid correction** (> 8 mmol/L/24 hours) **[core]**
- **Severe initial hyponatraemia** ($\text{Na} < 105$); concurrent hypokalaemia, hypomagnesaemia, hypophosphataemia; alcohol use disorder; malnutrition; liver disease **[core]**
- Burns; AIDS; advanced age

References: European Society of Endocrinology Hyponatraemia Guideline 2014 • eTG (Therapeutic Guidelines, current) • ACEM clinical policies and statements • Tintinalli's Emergency Medicine 9e Ch 117