

FExNet 2026

Collated SAQs: Environmental Emergencies

ANSWER BOOKLET

Model answers for the 22 environmental emergency SAQs. References cited at the foot of each question. Items marked [core] are required for full marks. Australian envenomation per CSL Antivenom Handbook and ASP-20; altitude per WMS 2024; diving per DAN/SPUMS; carbon monoxide per Weaver criteria; consult Poisons Information Centre 13 11 26.

22 questions • 218 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.

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

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Question 1 | Eastern Brown Snake Envenomation (12 marks)

A 32-year-old man is brought to your regional emergency department by ambulance after being bitten on the right lower leg by a snake while walking through long grass approximately 90 minutes ago. The snake was described as brown. A pressure-immobilisation bandage has been applied from foot to thigh and the leg splinted. On arrival: Glasgow Coma Score 14 (drowsy), heart rate 105 beats per minute, blood pressure 110/65 millimetres of mercury, respiratory rate 22 breaths per minute. Bloods: international normalised ratio >15, activated partial thromboplastin time >200 seconds, fibrinogen <0.2 grams per litre, platelets $80 \times 10^9/L$, D-dimer markedly elevated, creatine kinase 580 U/L, creatinine 110 $\mu\text{mol/L}$.

a) Name 4 features of envenomation present in this patient AND state the principal syndrome. (4 marks)

- **Venom-induced consumptive coagulopathy (VICC)** — INR >15, **unrecordable APTT, undetectable fibrinogen, elevated D-dimer**; the principal syndrome of brown snake envenomation **[core]**
- **Thrombocytopenia** (Plts 80) — microangiopathic haemolytic anaemia / thrombotic microangiopathy (TMA) develops in 5-10% of brown snake envenomations over 24-48 hours **[core]**
- **Mild rhabdomyolysis** (CK 580) and early **acute kidney injury** (Cr 110) — typical of brown snake; AKI may progress over days from TMA-associated renal injury **[core]**
- **Systemic signs**: drowsiness, mild tachycardia. **Neurotoxicity is uncommon** with brown snake (predominant in tiger and taipan); collapse / cardiac arrest possible within 1 hour of bite (pre-synaptic neurotoxin) **[core]**
- **Brown snake group** (Pseudonaja species, Eastern, Western, Dugite): VICC is the cardinal feature; weak neurotoxicity; nephrotoxicity from TMA

b) Outline 5 priorities of management. (5 marks)

- **Do NOT remove the pressure-immobilisation bandage** until antivenom is on hand and IV access secured; resuscitation bay, two large-bore IV cannulas, full monitoring, IDC; involve **retrieval/clinical toxicology service** early (Australian Poisons Information Centre 13 11 26) **[core]**
- **Polyvalent antivenom OR brown snake monovalent antivenom — 1 vial IV diluted in 100-500 mL 0.9% NaCl over 20 minutes.** Pre-treatment with adrenaline NOT routine; have **0.5 mg adrenaline IM ready** for anaphylaxis. **1 vial is sufficient** (further doses do not improve outcome — ASP-20 study) **[core]**
- **Use a Venom Detection Kit (CSL Snake Venom Detection Kit)** on the **bite site swab** (preferred sample) or urine — to confirm snake type and guide monovalent antivenom selection. In Tasmania use tiger antivenom; in most of Australia, polyvalent or brown **[core]**
- **Resuscitation**: IV fluid for hypotension; **blood products** only for active bleeding (otherwise withhold — venom continues to consume factors); tranexamic acid NOT used; FFP after antivenom only if persistent bleeding; tetanus prophylaxis **[core]**
- **Serial monitoring**: coagulation every 2-4 hours until normal (48-72 hours), CK, U&Es, FBC for TMA (haemolysis screen if Hb dropping); **admit to monitored bed for minimum 24 hours after asymptomatic and coag normal**; consider plasmapheresis for severe TMA with AKI **[core]**
- Treat **serum sickness** (delayed 5-14 days, 10-30% of patients) with prednisolone if developing

c) Name 3 indications for antivenom in suspected snake envenomation. (3 marks)

- **Systemic envenomation features**: collapse / loss of consciousness; cardiac arrest; vomiting; sweating; abdominal pain; headache **[core]**
- **Coagulopathy** on screening labs (INR or APTT abnormal, fibrinogen low, D-dimer raised) — even subclinical **[core]**

- **Neurotoxicity** (ptosis, ophthalmoplegia, bulbar palsy, respiratory failure); **myotoxicity** (CK markedly elevated, >1000); **acute kidney injury [core]**
- Positive VDK alone in the absence of systemic features is NOT an indication; VDK is for typing, not for triggering antivenom

References: ASP-20 (Isbister et al. 2017) • Murray's Toxicology — Snake bite • Australian Snakebite Project (ASP) protocol • eTG (Therapeutic Guidelines, current) • Tintinalli's Emergency Medicine 9e Ch 209

Question 2 | Tiger Snake Envenomation with Neurotoxicity (11 marks)

A 45-year-old farmer is brought to your Tasmanian regional emergency department 3 hours after being bitten on the right calf by a tiger snake (*Notechis scutatus*) while clearing brush. A pressure-immobilisation bandage was applied at scene. On arrival: Glasgow Coma Score 13, heart rate 95, blood pressure 105/60, respiratory rate 20, peripheral oxygen saturation 96 percent on room air. He has bilateral ptosis, ophthalmoplegia, dysphagia, and difficulty swallowing his saliva. Forced vital capacity is 1.8 litres (predicted 4.5). Bloods: international normalised ratio 4.5, activated partial thromboplastin time 65 seconds, creatine kinase 12 500 U/L, potassium 5.8 millimoles per litre, creatinine 145, myoglobin in urine.

a) Name 4 features of tiger snake envenomation demonstrated in this patient. (4 marks)

- **Pre-synaptic neurotoxicity** (notexin) — descending paralysis: ptosis, ophthalmoplegia (CN III, IV, VI), bulbar weakness, respiratory muscle weakness (FVC 1.8 — declining); **respiratory failure imminent if FVC <15 mL/kg or <1 L [core]**
- **Severe myotoxicity** (CK 12 500 — tiger snake notable for rhabdomyolysis; myoglobinuria); hyperkalaemia (5.8); renal injury [core]
- **Coagulopathy (VICC)** — INR 4.5, APTT 65; not as severe as brown snake but reliably present [core]
- **Acute kidney injury** from rhabdomyolysis and thrombotic microangiopathy [core]
- Tiger snake is the major Australian neurotoxic snake (also taipan, death adder, sea snakes); brown snake neurotoxicity is uncommon

b) Outline 5 management priorities including antivenom and airway considerations. (5 marks)

- **Tiger snake monovalent antivenom** — 1 vial IV diluted in 100-500 mL 0.9% NaCl over 20 minutes (in Tasmania always tiger; in mainland Australia use polyvalent unless VDK confirms type). **Pre-synaptic toxin damage may be irreversible** once paralysis is established — give early but expect prolonged weakness [core]
- **Airway / intubation planning:** intubate if FVC <15 mL/kg, <1 L, hypoxia, bulbar dysfunction with aspiration risk, or deteriorating respiratory pattern; ICU/retrieval; anticipate weeks of ventilation [core]
- **Rhabdomyolysis management:** aggressive IV 0.9% NaCl 200-500 mL/hour titrated to urine output ≥2 mL/kg/hour; **monitor and treat hyperkalaemia** (K 5.8 with potential to rise); consider urinary alkalinisation; avoid potassium-containing fluids; treat acidosis [core]
- **Coagulopathy monitoring** 2-4 hourly until normal; **no FFP/blood products unless bleeding;** supportive care [core]
- **Retrieval to tertiary centre** (ICU + ventilation capability, neurology, renal dialysis); pre-departure: intubate before transport if bulbar / respiratory compromise; further antivenom (additional vials of monovalent) for ongoing envenomation in transit [core]
- Pre-synaptic neurotoxin: **recovery may take weeks-months** as new presynaptic terminals regenerate (different from post-synaptic — death adder — which responds more rapidly to antivenom)

c) List 2 long-term complications to anticipate. (2 marks)

- **Prolonged ventilator dependence and ICU-acquired weakness** (pre-synaptic damage with delayed recovery weeks-months); critical illness neuromyopathy [core]
- **Serum sickness** (5-14 days post-antivenom) — fever, rash, arthralgia, lymphadenopathy; treat with prednisolone if severe; **acute kidney injury** may require dialysis (5-10% of severe rhabdomyolysis); compartment syndrome of the affected limb post-bandage removal [core]
- Psychological — PTSD; debriefing; rural support

References: Australian Snakebite Project • Murray's Toxicology Handbook 2.5e • eTG (Therapeutic Guidelines, current) • Tintinalli's Emergency Medicine 9e Ch 209

Question 3 | Snakebite Assessment, Pressure Bandaging and Venom Detection (10 marks)

You are the consultant on duty in a rural emergency department when a paramedic radios that they are transporting a 22-year-old man bitten on the hand by an unknown snake 30 minutes ago. The patient is currently asymptomatic. The paramedic asks for advice on management. The patient is 1 hour from your emergency department.

a) Outline 4 components of the correct pressure-immobilisation bandage technique. (4 marks)

- **Apply a firm crepe or elastic bandage** (10-15 cm wide) **starting from the bite site** moving proximally — pressure 40-70 mmHg (tightness of an ankle sprain bandage; should still be able to slip a finger beneath); **then extend the bandage from fingers/toes to as proximal as possible** [core]
- **Immobilise the limb** with a splint (rigid board or use the second limb for leg) — purpose is to prevent muscle pump from spreading venom via lymphatics [core]
- **Patient must lie still** — minimise all movement; do **NOT** walk; transport in supine position [core]
- **Mark the bite site** over the bandage with a pen/marker for later venom detection swab; **do NOT** cut, suck, apply tourniquet, wash the wound, or apply electric shock — all are harmful folklore [core]
- **Keep bandage on** until in a facility with antivenom AND adequate resuscitation capability

b) Outline 4 priorities for the patient upon ED arrival. (4 marks)

- **Resuscitation area:** full monitoring, two large-bore IV cannulas, full bloodwork (FBC, U&Es, CK, INR, APTT, fibrinogen, D-dimer, fibrinogen, blood film, group and hold). **Do NOT remove PIB until antivenom is on hand** [core]
- **Venom Detection Kit (CSL VDK)** — **bite site swab is the preferred sample** (mark the spot before removing bandage). Urine is alternative (but may take 1-2 hours to be positive). VDK identifies which CSL monovalent antivenom to use [core]
- **Remove the PIB only after IV access, bloods sent, monitoring, antivenom on hand, adrenaline drawn up;** check bloods after 1 hour of bandage removal AND at 6 hours — early bloods may be falsely normal due to local sequestration [core]
- **Indications for antivenom:** systemic envenomation (collapse, vomiting, sweating), coagulopathy, neurotoxicity, myotoxicity, AKI — **NOT positive VDK alone**. Discuss with Poisons Information Centre 13 11 26 [core]
- Tetanus prophylaxis; wound care; admit ≥ 12 hours minimum; serial coags 2-4 hourly

c) List 2 indications for polyvalent antivenom (rather than monovalent). (2 marks)

- **Unknown snake type and either VDK negative or unavailable**, with definite envenomation features — polyvalent covers all dangerous Australian land snakes [core]
- **Critically unwell patient where delay for VDK is unacceptable** (arrest, cardiovascular collapse, imminent respiratory failure); **geographical mismatch** — multiple potential species in region or uncertainty [core]
- Polyvalent contains all 5 monovalent antivenoms (brown, tiger, taipan, death adder, black) — equivalent to giving all 5; uses more antivenom but appropriate when type unknown

References: Australian Snakebite Project • CSL Antivenom Handbook • Murray's Toxicology Handbook 2.5e • eTG (Therapeutic Guidelines, current)

Question 4 | Funnel-Web Spider Envenomation (10 marks)

A 6-year-old boy is brought to your Sydney emergency department by his parents after being bitten on the right hand by a large black spider in their garage 45 minutes ago. The spider has been brought in a jar and identified as a male Sydney funnel-web spider (*Atrax robustus*). On arrival: distressed and crying, Glasgow Coma Score 14, heart rate 145 beats per minute, blood pressure 145/95 millimetres of mercury, respiratory rate 32, temperature 37.0 °C, profuse salivation, lacrimation, sweating, muscle fasciculations of the trunk, and abdominal pain. A pressure-immobilisation bandage has been applied at home.

a) Name 4 features of severe funnel-web spider envenomation present in this patient. (4 marks)

- **Autonomic storm** — combined sympathetic and parasympathetic hyperactivity from **atraxotoxin (delta-atracotoxin)**: hypertension, tachycardia AND simultaneous salivation, lacrimation, sweating **[core]**
- **Muscle fasciculations** (characteristic — spontaneous skeletal muscle contractions visible under skin), **painful muscle spasms**, abdominal pain **[core]**
- **Severity features warranting antivenom**: altered consciousness, marked autonomic features, pulmonary oedema (catecholaminergic), severe pain and distress, fasciculations **[core]**
- **High-risk demographic**: child (very high mortality without antivenom, particularly <10 years); **male funnel-web is more dangerous** (6× more toxic than female); from Sydney/coastal NSW endemic region **[core]**
- Delayed presentation features (untreated): **pulmonary oedema and cardiac arrest can occur within 1-4 hours** in children

b) Outline 4 immediate management priorities. (4 marks)

- **Funnel-web spider antivenom** (equine derived) — **2 vials IV diluted in 100 mL 0.9% NaCl over 15 minutes** for severe envenomation; 1 vial for mild-moderate. Increase to **4 vials** for life-threatening features (pulmonary oedema, decreased GCS, cardiac arrest) **[core]**
- **Pressure-immobilisation bandage** remains on until antivenom given AND IV access secured; **this is the only spider that requires PIB** (others use ice and analgesia) **[core]**
- **Treat autonomic / catecholaminergic manifestations**: hypertension responds to antivenom; intubate if pulmonary oedema, decreased GCS, secretions overwhelming. Atropine pre-intubation for secretions **[core]**
- **Monitoring**: continuous ECG, IBP, SpO₂; admit to PICU/monitored bed for 12-24 hours minimum; **antivenom reactions** are rare; have adrenaline available; consider Poisons Information Centre **[core]**
- Pain relief: opioids; benzodiazepine for muscle spasms

c) Name 2 differential diagnoses for the presentation. (2 marks)

- **Organophosphate / nerve-agent poisoning** — cholinergic toxidrome (SLUDGE/DUMBELS): salivation, lacrimation, urination, defaecation, fasciculations, bronchorrhoea; rapid **[core]**
- **Marine envenomation** (Irukandji-like — though here clearly spider); **sympathomimetic toxidrome** (cocaine, amphetamine, MDMA); **serotonin syndrome**; **anaphylaxis** **[core]**
- Mouse spider envenomation — clinically indistinguishable from funnel-web; treat with funnel-web antivenom

References: CSL Antivenom Handbook • Isbister et al. Australian Funnel-Web Spider Envenomation • Murray's Toxicology Handbook 2.5e • eTG (Therapeutic Guidelines, current)

Question 5 | Redback Spider Envenomation (9 marks)

A 35-year-old woman presents to your suburban emergency department 3 hours after being bitten on the buttock by a spider while at an outdoor toilet. She describes intense pain in the bite area which has spread to her abdomen and lower back. On arrival: Glasgow Coma Score 15, heart rate 95 beats per minute, blood pressure 145/85 millimetres of mercury, respiratory rate 18, temperature 37.6 °C, profuse sweating. There is regional lymph node tenderness in the right groin, and an erythematous puncture mark at the bite site.

a) Name 3 features of latrodectism (redback spider envenomation). (3 marks)

- **Severe progressive local pain** (out of proportion to the small bite site), **spreading to involve regional and distant sites** (abdomen, chest, back) over hours-days **[core]**
- **Systemic features:** sweating (often localised, may be unilateral from affected limb), hypertension, tachycardia, fever, nausea, vomiting, abdominal rigidity (mimicking acute abdomen) **[core]**
- **Regional lymphadenopathy and tenderness;** muscle spasms; facies latrodectismica (painful grimace, sweating, blepharitis); occasional priapism in males; symptoms may persist for days-weeks **[core]**
- Pathophysiology: α -**latrotoxin** binds neurexin and latrophilin receptors at presynaptic nerve terminals → massive neurotransmitter release

b) Outline 4 management priorities — note recent evidence-based changes in antivenom usage. (4 marks)

- **First-line: oral analgesia** (paracetamol, NSAIDs, opioids) and **ice** applied to the bite site for 10-minute periods; **NO pressure-immobilisation bandage** (only indicated for funnel-web and some neurotoxic snakes, not for latrodectism) **[core]**
- **Redback antivenom — limited evidence:** the RAVE-II randomised trial (Isbister 2014) showed antivenom **no better than placebo** for pain relief. **Current recommendation:** reserve for severe persistent pain unresponsive to analgesia, OR for life-threatening features (rare); 2 vials IM or IV diluted **[core]**
- **Search for and rule out other causes:** spider may not have been seen; consider scorpion bite, envenomation by other (mouse spider, marine), other toxidromes; investigate abdominal/back pain if atypical **[core]**
- **Disposition:** discharge with oral analgesia and ED review at 24 hours if pain controlled; admit if severe pain uncontrolled or systemic features; **tetanus prophylaxis; do NOT routinely use antivenom** given limited efficacy and serum sickness risk **[core]**
- Symptoms can recur for weeks; reassurance and follow-up

c) List 2 other Australian spider envenomations and 1 distinguishing feature for each. (2 marks)

- **White-tailed spider (Lampona)** — previously blamed for necrotic skin lesions but **this is now disproven** (systematic review Isbister 2003); produces local pain only; **'necrotising arachnidism' is a MISDIAGNOSIS** — necrotic skin lesions usually have other cause (infection, pyoderma gangrenosum, cutaneous lymphoma) **[core]**
- **Mouse spider (Missulena)** — clinically indistinguishable from funnel-web (atraxotoxin-like venom); **treat with funnel-web antivenom; black-house spider** — local pain only **[core]**
- Huntsman spider — large, alarming but minor envenomation; wolf spider — local pain only

References: RAVE-II (Isbister et al. 2014) • Murray's Toxicology Handbook 2.5e • eTG (Therapeutic Guidelines, current) • Tintinalli's Emergency Medicine 9e Ch 210

Question 6 | Box Jellyfish (*Chironex fleckeri*) Envenomation (11 marks)

You are called to the beach as the on-duty emergency physician of a North Queensland regional hospital in February. A 24-year-old man has been pulled from the water with extensive whip-like linear welts wrapped around his torso, legs and right arm following contact with a large box jellyfish (*Chironex fleckeri*) approximately 5 minutes ago. On arrival of paramedics: Glasgow Coma Score 8, heart rate 50 beats per minute, blood pressure 60/40 millimetres of mercury, respiratory rate 8 and irregular, agonal breathing. Tentacles remain attached to skin.

a) Outline 4 immediate pre-hospital / on-scene priorities. (4 marks)

- **Basic life support / cardiopulmonary resuscitation** per ARC algorithm if arrested — likely venom-induced cardiac arrest from Chironex toxin (porin-channel formation, calcium-mediated myocardial dysfunction) **[core]**
- **Douse adherent tentacles liberally with vinegar (4-6% acetic acid) for at least 30 seconds** — inactivates undischarged nematocysts (vinegar at all tropical Australian lifeguard stations); do NOT use fresh water, alcohol, urine, or methylated spirits (all trigger nematocyst discharge) **[core]**
- **Carefully remove tentacles** after vinegar; **pressure-immobilisation bandage NOT recommended for Chironex** (was previously taught but now contra-indicated by ARC — concentrates venom and worsens local effects) **[core]**
- **Box jellyfish antivenom — 1 vial (20 000 units) IV undiluted** as soon as available; first responders may carry; transport rapidly to ED **[core]**
- Cardiac arrest: **magnesium sulphate 50 mg/kg IV bolus** as adjunct (anti-arrhythmic, potential venom antagonism); continue CPR until antivenom + Mg administered

b) Outline 5 ED priorities once the patient arrives. (5 marks)

- **Box jellyfish antivenom — up to 3 vials IV** for arrest / severe envenomation, diluted in 0.9% NaCl 1:10. Doses titrated; **further vials** may be needed for ongoing instability **[core]**
- **Advanced cardiopulmonary resuscitation** per ARC ALS algorithm; **magnesium sulphate 50 mg/kg IV** as adjunct; prolonged CPR is warranted as venom-induced arrhythmias are potentially reversible **[core]**
- **Airway management:** intubate if GCS <9, respiratory failure, or ongoing arrest; large-bore IV access × 2; RSI with ketamine to support BP **[core]**
- **Treat ongoing pain:** opioids (often severe pain); local wound care; tetanus prophylaxis; **monitor for compartment syndrome and secondary skin necrosis**; scar prevention with silicone dressings **[core]**
- **Admit to ICU/HDU** for 24-48 hours; monitor for delayed cardiotoxicity, arrhythmias; serial ECG and troponin; psychological support; debriefing (major Australian envenomation event) **[core]**
- Notify retrieval / tertiary ICU for transfer if outside major centre

c) Name 2 differentiating features between box jellyfish and Irukandji envenomation. (2 marks)

- **Box jellyfish (Chironex):** immediate severe pain with characteristic **multiple whip-like linear welts**; cardiac arrest can be very rapid; tropical waters; large tentacles visible **[core]**
- **Irukandji syndrome (Carukia barnesi, Malo kingi, etc):** mild initial sting from a tiny (~1 cm) jellyfish usually unseen; **delayed (20-30 min) onset systemic 'Irukandji syndrome':** severe muscle cramps, abdominal/back/chest pain, severe hypertension, catecholaminergic cardiomyopathy with pulmonary oedema; no antivenom **[core]**
- Both occur in tropical Australian waters Oct-May; stinger nets and lifeguard education

References: ANZCOR Guidelines (current) • Australian Resuscitation Council Guidelines • Pereira et al. 2020 — Chironex envenomation review • Murray's Toxicology Handbook 2.5e • eTG (Therapeutic Guidelines, current) • Tintinalli's Emergency Medicine 9e Ch 210

Question 7 | Irukandji Syndrome (10 marks)

A 38-year-old man presents to your Cairns emergency department in February 30 minutes after a 'mild sting' while swimming. He now describes severe lower back pain, abdominal pain, muscle cramps, profuse sweating and a sense of impending doom. On arrival: Glasgow Coma Score 15 but very distressed, heart rate 140 beats per minute, blood pressure 220/130 millimetres of mercury, respiratory rate 28, temperature 37.4 °C. The initial sting site is a small (1 cm) erythematous patch on the right shoulder with no obvious tentacles. Bedside echocardiography shows a moderately reduced left ventricular ejection fraction with global hypokinesis.

a) Name 3 features that confirm Irukandji syndrome. (3 marks)

- **Delayed onset (20-30 minutes)** of systemic features after a mild local sting from a small/unseen jellyfish — characteristic time course **[core]**
- **Catecholaminergic syndrome:** severe hypertension, tachycardia, severe generalised muscle cramps/back pain, abdominal pain, sweating, 'sense of impending doom' **[core]**
- **Catecholaminergic cardiomyopathy** (takotsubo-like) — left ventricular dysfunction with apical or global hypokinesis; pulmonary oedema; troponin elevation; T-wave inversion on ECG; in 5-15% of cases **[core]**
- Reported deaths from intracranial haemorrhage (hypertensive) or cardiogenic shock; tropical Australia Oct-May

b) Outline 5 management priorities. (5 marks)

- **Vinegar application to the sting site** to inactivate any remaining nematocysts; remove tentacle remnants; **do NOT use pressure-immobilisation bandage** (worsens venom effect) **[core]**
- **IV opioid analgesia** (fentanyl/morphine/PCA) — pain is characteristically severe and opioid-responsive; **large doses often required** (fentanyl 1-2 microgram/kg boluses, titrate) **[core]**
- **Magnesium sulphate 10 mmol IV over 15 minutes**, then infusion 2-4 mmol/hour (target Mg 1.25-1.5 mmol/L) — for hypertension AND pain. Limited evidence but conventional Australian practice **[core]**
- **Treat hypertensive emergency:** phentolamine 1-5 mg IV boluses OR GTN infusion 5-200 microgram/min for severe; **avoid pure β -blockers** (unopposed α -stimulation similar to pheochromocytoma); **no antivenom available** **[core]**
- **Treat cardiomyopathy:** serial ECG and troponin, formal echocardiography; supportive care; CPAP / diuretic for pulmonary oedema; admit monitored bed (typically 24-48 hours); recovery is the rule **[core]**
- Public-health: stinger nets, beach warnings, lycra stinger suits

c) List 2 differentials for the syndrome. (2 marks)

- **Pheochromocytoma crisis** — severe hypertension, sweating, palpitations, sense of doom, catecholaminergic cardiomyopathy; **sympathomimetic toxidrome** (cocaine, amphetamines, MDMA) **[core]**
- **Acute coronary syndrome** (particularly if cardiomyopathy predominates); **thoracic aortic dissection**; **serotonin syndrome**; **scorpion envenomation** (overseas); **funnel-web spider envenomation** **[core]**
- Acute pancreatitis (severe back/abdominal pain); intracranial haemorrhage

References: Pereira et al. Irukandji syndrome — Med J Aust • Murray's Toxicology Handbook 2.5e • eTG (Therapeutic Guidelines, current) • Tintinalli's Emergency Medicine 9e Ch 210

Question 8 | Bluebottle and Portuguese Man-of-War Sting (8 marks)

A 12-year-old girl is brought to your Sydney emergency department by her parents after a swimming-related sting at the beach 30 minutes ago. She has a 20 cm linear welt across her right thigh with characteristic 'string of beads' appearance, intense pain, and there are clear bluish residual nematocysts still adherent. She is otherwise systemically well: alert, heart rate 95, blood pressure 110/65, respiratory rate 16, afebrile.

a) Name 3 features distinguishing bluebottle (*Physalia*) sting from box jellyfish. (3 marks)

- **Bluebottle (*Physalia* / Portuguese man-of-war):** blue gas-filled float visible on the water; 'string of beads' linear welt; predominantly southern Australian waters; rarely systemic **[core]**
- **Box jellyfish (*Chironex*):** large boxy bell with multiple long tentacles; multiple whip-like welts; systemic features and cardiac arrest; tropical northern Australia **[core]**
- **Local effects only in 99% of *Physalia* stings:** pain, erythema, linear welts, occasional blistering; systemic envenomation is rare (reported with extensive contact) **[core]**
- Both contain nematocyst-containing tentacles; different toxins

b) Outline 3 specific management steps. (3 marks)

- **Hot water immersion (45 °C for 20 minutes)** — first-line for **bluebottle**, evidence-based for pain relief (heat denatures the protein toxin); shower or hot pack **[core]**
- **Do NOT use vinegar for bluebottle** — evidence shows it may worsen envenomation by triggering nematocyst discharge in *Physalia* (unlike *Chironex*). Use sea water (not fresh water) to remove tentacles **[core]**
- **Oral analgesia** (paracetamol, ibuprofen) and ice if hot water unavailable; tetanus prophylaxis; topical local anaesthetic gel; reassure — systemic effects extremely rare; discharge with usual analgesia **[core]**
- Public-health: surf lifesaving warnings; protective clothing

c) List 2 indications to escalate care. (2 marks)

- **Systemic features:** hypotension, respiratory distress, severe pain uncontrolled, anaphylactoid reaction, altered consciousness — extremely rare but described with extensive contact / Atlantic Portuguese man-of-war species **[core]**
- **Extensive stings** in young child / elderly / pregnant; large body surface area; sting to face/eye/airway; secondary bacterial infection of welts (*Vibrio*, *Aeromonas* — marine antibiotics doxycycline + ciprofloxacin) **[core]**
- Symptoms suggesting alternative cause (?rukandji, ?box jellyfish missed) — expect any tropical features

References: Loten et al. 2006 — hot water for bluebottle • Murray's Toxicology Handbook 2.5e • eTG (Therapeutic Guidelines, current)

Question 9 | Stonefish Envenomation (9 marks)

A 28-year-old fisherman is brought to your northern Queensland emergency department 2 hours after stepping on a stonefish (*Synanceia*) in shallow water at low tide. He describes excruciating pain in the right foot which is now markedly swollen with three puncture wounds over the plantar surface. He took paracetamol and applied a cold pack with minimal relief. On arrival: Glasgow Coma Score 15 (distressed), heart rate 110, blood pressure 145/85, respiratory rate 22, temperature 37.0 °C, diaphoretic.

a) Name 3 features of stonefish envenomation. (3 marks)

- **Excruciating local pain** — described as the worst pain a patient has ever experienced; rapidly progressive swelling, marked tenderness, multiple puncture wounds at the spine entry sites **[core]**
- **Systemic features:** hypertension (catecholaminergic), tachycardia, sweating, vomiting, syncope (rare); rarely pulmonary oedema, cardiac arrhythmia **[core]**
- **Local complications:** secondary infection (*Vibrio*, *Aeromonas*), tissue necrosis, ulceration, retained foreign body (spine fragments), tendinitis, compartment syndrome if extensive **[core]**
- Pain duration may be days; complete resolution weeks-months

b) Outline 4 management priorities. (4 marks)

- **Hot water immersion (45 °C for 30-90 minutes)** — first-line; **denatures the heat-labile protein venom** and provides analgesia (applies to all marine stings from scorpaenidae — stonefish, lionfish, scorpionfish — and stingray) **[core]**
- **Stonefish antivenom (CSL)** — **1 vial IM** per 2 puncture sites for severe envenomation (here 3 punctures → 2 vials), repeated every 30 min until pain controlled; **indications:** severe pain refractory to other measures, multiple puncture wounds, systemic features **[core]**
- **Multimodal analgesia:** opioids (morphine/fentanyl PCA), regional anaesthesia (tibial nerve block, ankle block); local anaesthetic infiltration around the puncture wounds — but caution as systemic toxicity risk if extensive **[core]**
- **Wound care:** thorough irrigation, search for retained spine fragments (may need imaging — X-ray, ultrasound), leave open if puncture wounds, secondary closure; **tetanus prophylaxis; marine antibiotics** — **ciprofloxacin + doxycycline** (cover *Vibrio vulnificus* and *Aeromonas*); admit if extensive or refractory pain **[core]**
- Avoid ice — minimal benefit and may worsen vasoconstriction; avoid pressure-immobilisation bandage

c) List 2 other Indo-Pacific marine envenomations managed with the same heat principle. (2 marks)

- **Stingray injury** — barbed spine with tissue laceration AND venom envenomation; heat for pain; remove barb; tetanus; antibiotics; consider cardiac/torso location (rare deaths from myocardial penetration) **[core]**
- **Lionfish / scorpionfish, catfish, weaverfish, sea urchin spines** — all heat-labile protein toxin; hot water immersion as first-line **[core]**
- Cone snail (*Conus*) — distinct (neurotoxic, tetrodotoxin-like); no antivenom; supportive (ventilation if paralysis)

References: CSL Antivenom Handbook • Murray's Toxicology Handbook 2.5e • eTG (Therapeutic Guidelines, current) • Tintinalli's Emergency Medicine 9e Ch 210

Question 10 | Stingray Barb Injury (9 marks)

A 30-year-old man is brought to your coastal emergency department after sustaining a stingray barb injury to the left thigh while spearfishing. There is a 4 centimetre laceration with a visible barb in the wound; the patient describes intense burning pain. On arrival: Glasgow Coma Score 15, heart rate 105, blood pressure 130/75, respiratory rate 18, peripheral oxygen saturation 99 percent. The wound is bleeding briskly.

a) Name 3 features of stingray injury. (3 marks)

- **Mechanical trauma** from the barb — puncture wound, laceration, can be deep; **retained barb fragments common** (remove or image with X-ray/ultrasound) **[core]**
- **Venom envenomation** — heat-labile protein toxin causing severe pain, vasoconstriction, local tissue necrosis; occasionally systemic (hypotension, syncope, arrhythmia, weakness) **[core]**
- **Wound complications**: bacterial infection (*Vibrio vulnificus* particularly in warm sea water — high mortality in cirrhosis/immunocompromised); foreign body retention; cellulitis; necrotising fasciitis **[core]**
- **Cardiothoracic stingray injury** (truncal — the cause of Steve Irwin's death) — case fatality high from direct cardiac penetration; consider thoracic injury with chest wounds

b) Outline 4 management priorities. (4 marks)

- **Hot water immersion (45 °C for 30-90 minutes)** for pain relief; **regional anaesthesia** (femoral nerve block here) for severe pain; opioid analgesia **[core]**
- **Wound exploration and barb removal** under local/regional anaesthesia; **imaging** with X-ray, ultrasound or CT to localise retained barb fragments; **leave wound open** for delayed primary closure (high infection risk) **[core]**
- **Prophylactic antibiotics** — **ciprofloxacin 500 mg BD + doxycycline 100 mg BD for 5-7 days** (*Vibrio* + *Aeromonas* cover); add metronidazole if deep wound; **tetanus prophylaxis** **[core]**
- **Search for systemic features** — if hypotension, weakness, arrhythmia (supportive care; no antivenom); **truncal injury imaging** (FAST, CT) if chest/abdomen involvement; **admit for observation** if extensive or systemic features **[core]**
- Surgical consultation for thoracic/abdominal involvement

c) Name 2 high-risk hosts for marine wound infection. (2 marks)

- **Chronic liver disease (cirrhosis)** — marked susceptibility to *Vibrio vulnificus* septicaemia and haemorrhagic bullae with high mortality (~50%) **[core]**
- **Immunocompromised** (HIV, chemotherapy, chronic steroid use, diabetes mellitus); **haemochromatosis** (iron-loving *Vibrio*); elderly; previous splenectomy **[core]**
- Pregnancy; chronic kidney disease

References: Murray's Toxicology Handbook 2.5e • eTG (Therapeutic Guidelines, current) • Tintinalli's Emergency Medicine 9e Ch 210 • Auerbach Wilderness Medicine

Question 11 | Blue-Ringed Octopus Envenomation (Tetrodotoxin) (10 marks)

A 19-year-old man is brought to your emergency department by paramedics 45 minutes after a presumed octopus bite while playing in a rockpool at low tide. He noticed a small painless puncture wound on his right hand, then 10 minutes later began to feel peri-oral numbness, weakness, and difficulty breathing. On arrival: Glasgow Coma Score 15 but unable to speak or move, heart rate 85 beats per minute, blood pressure 130/80 millimetres of mercury, respiratory rate 8 with shallow effort, peripheral oxygen saturation 89 percent on 6 litres oxygen mask, bilateral fixed dilated pupils, no spontaneous limb movement.

a) Name 4 features of tetrodotoxin envenomation. (4 marks)

- **Rapid-onset (minutes-tens of minutes) flaccid descending paralysis:** peri-oral paraesthesia, then weakness and respiratory failure, full body paralysis; classic '**locked-in**' state — conscious but unable to respond **[core]**
- **Fixed dilated pupils** with absent corneal reflexes — **does NOT mean brain death**; mimic apparent death; patient retains awareness throughout **[core]**
- **Mechanism:** tetrodotoxin (TTX) blocks **voltage-gated sodium channels** → prevents action potential propagation in peripheral nerves and skeletal muscle (NOT myocardium — heart unaffected, preserved HR and BP) **[core]**
- **Painless bite** — patient often unaware of envenomation; small puncture marks; **no antivenom available**; duration of paralysis 24-48 hours (occasionally longer) **[core]**
- Also caused by **puffer fish (fugu) ingestion** and rare marine sources (cone snail; some sea snails); ciguatera and saxitoxin are different (different toxins, related mechanism)

b) Outline 4 management priorities. (4 marks)

- **Immediate airway protection and mechanical ventilation** — RSI with ketamine (preserves haemodynamics, reduces awareness) — avoid sedation depending on tolerance; assume awareness throughout. **Patient remains conscious and can hear staff [core]**
- **Pressure-immobilisation bandage** should be applied if not done — remove once ventilatory support secured; **no antivenom**; treatment is supportive ventilation through paralysis (24-48 hours) **[core]**
- **ICU admission for ventilation**; continuous communication with the patient (they can hear and feel); **maintain analgesia and anxiolysis**; early prognostication is favourable (full recovery if ventilated) **[core]**
- **Avoid declaration of brain death** based on absent brain stem reflexes in this context; full recovery typically within 24-48 hours as channels recover; may need physiotherapy after extubation **[core]**
- Forensic / public-health implications if intentional puffer fish ingestion (food poisoning in Japanese restaurant — fugu)

c) List 2 other causes of fixed dilated pupils with preserved consciousness/paralysis. (2 marks)

- **Severe organophosphate / neuromuscular-blocking-agent intoxication; botulism** (foodborne or wound) — descending paralysis with autonomic features; **Lambert-Eaton myasthenic syndrome [core]**
- **Snake envenomation** (taipan, death adder — post-synaptic neurotoxin; responds to antivenom unlike TTX); **brain death** (assess clinical context — must exclude reversible causes like TTX) **[core]**
- Cone snail venom (conotoxin — similar Na channel blockade)

References: Murray's Toxicology Handbook 2.5e • eTG (Therapeutic Guidelines, current) • Tintinalli's Emergency Medicine 9e Ch 210 • ACEM clinical policies and statements

Question 12 | Ciguatera Fish Poisoning (9 marks)

A 35-year-old man presents to your tropical regional emergency department 6 hours after a dinner of barramundi caught from a coral reef. He complains of vomiting and diarrhoea, followed by intense peri-oral and limb paraesthesia. He also describes a peculiar sensation of cold objects feeling burning hot to touch ('temperature reversal'). His two dinner companions present with similar symptoms. On arrival: Glasgow Coma Score 15, heart rate 55 beats per minute, blood pressure 95/55 millimetres of mercury, respiratory rate 18, afebrile, with cool peripheries.

a) Name 4 features of ciguatera poisoning. (4 marks)

- **Gastrointestinal phase (early — 6-12 h):** nausea, vomiting, diarrhoea, abdominal cramps; **shared exposure** (group of diners with same fish source — characteristic large reef fish: barramundi, coral trout, snapper, Spanish mackerel) **[core]**
- **Neurological phase (delayed — hours-days, persists weeks):** peri-oral and limb paraesthesia, dysaesthesia, **pathognomonic 'cold allodynia / temperature reversal'** (cold objects feel burning hot) **[core]**
- **Cardiovascular phase:** bradycardia (this patient HR 55), hypotension, occasionally cardiac conduction abnormalities — typically mild and self-limiting **[core]**
- **Mechanism:** ciguatoxin (produced by dinoflagellate *Gambierdiscus* on coral, bioaccumulates in large reef fish) — **opens voltage-gated sodium channels** (opposite to tetrodotoxin which blocks them) → neuronal hyperexcitability and persistent depolarisation **[core]**
- Symptoms can persist months-years; may recur with alcohol, fish, caffeine, exercise

b) Outline 3 management priorities. (3 marks)

- **Supportive care:** IV rehydration; anti-emetics; **atropine 0.5-1 mg IV** for symptomatic bradycardia; cardiac monitoring; admit if cardiovascular instability **[core]**
- **Mannitol 1 g/kg IV over 30-45 minutes** for severe / refractory neurological symptoms — anecdotal but widely used historically; **evidence is weak** (RCT showed no benefit over saline); only consider in severe cases without contraindications. Pregabalin / gabapentin for chronic neuropathic pain **[core]**
- **Patient education:** **avoid fish, shellfish, alcohol, caffeine, nuts, exercise** for 3-6 months (precipitants of recurrence); avoid further large reef fish ingestion; notify health authorities (notifiable in some jurisdictions); follow-up neurology for chronic symptoms **[core]**
- Recovery typically over weeks-months but can be very prolonged

c) Name 2 other seafood toxin syndromes and a distinguishing feature. (2 marks)

- **Scombroid (histamine fish poisoning)** — large pelagic fish (tuna, mackerel) stored at warm temperatures — bacterial conversion of histidine to histamine; **onset minutes**; flushing, urticaria, tachycardia, headache; treat with antihistamines; **NOT an allergy [core]**
- **Paralytic shellfish poisoning** (saxitoxin from dinoflagellates concentrated in shellfish — mussels, oysters) — Na-channel blocker like TTX; paralysis; respiratory failure; **tetrodotoxin (puffer fish); amnesic shellfish poisoning** (domoic acid — confusion, memory loss); **diarrhetic shellfish poisoning [core]**
- **Vibrio parahaemolyticus** gastroenteritis from raw shellfish; **Norovirus**

References: FSANZ Ciguatera and Marine Biotoxins • Murray's Toxicology Handbook 2.5e • eTG (Therapeutic Guidelines, current) • Tintinalli's Emergency Medicine 9e Ch 210

Question 13 | Hymenoptera Anaphylaxis and Massive Sting Envenomation (10 marks)

A 45-year-old beekeeper is brought to your rural emergency department by ambulance after disturbing a beehive on his property. He has approximately 80 visible bee stings scattered over his torso and arms. He felt unwell within minutes, with generalised urticaria, dyspnoea and collapse. Paramedics administered intramuscular adrenaline 500 micrograms en route with partial response. On arrival: Glasgow Coma Score 12, heart rate 130 beats per minute, blood pressure 75/45 millimetres of mercury, respiratory rate 32, peripheral oxygen saturation 90 percent on 10 litres oxygen, generalised urticaria, audible wheeze, tongue swelling. He has not previously had bee sting anaphylaxis.

a) State the diagnosis AND name 2 distinguishing features from typical anaphylaxis. (3 marks)

- **Anaphylactic shock** from bee sting (Hymenoptera) — IgE-mediated immediate hypersensitivity; **AND concomitant toxic envenomation** from massive sting load (estimated approximate lethal dose: 500-1500 stings in adults, lower in children — but anaphylaxis kills with a single sting) **[core]**
- **Massive envenomation features** (non-allergic, dose-dependent toxin effects): direct cardiotoxicity, rhabdomyolysis, haemolysis, hepatotoxicity, renal failure, coagulopathy — may progress over 24-72 hours after the anaphylactic phase **[core]**
- **Bee stings retain venom sac and stinger** in skin (apid honey bees only — die after stinging); **wasp/hornet stings do not** — can sting multiple times. Sting removal is important to limit envenomation **[core]**
- Africanised 'killer' bees — multiple aggressive stings

b) Outline 5 management priorities. (5 marks)

- **Adrenaline 500 micrograms IM (1:1000) to the lateral thigh**, repeat every 5-10 minutes if not improving; **commence adrenaline IV infusion** (1 mg in 1000 mL 0.9% NaCl at 1-10 microgram/min titrated to BP) for refractory anaphylaxis with shock; consider **glucagon** 1-5 mg IV if on β -blocker **[core]**
- **Aggressive IV crystalloid** 20 mL/kg boluses titrated to BP (up to 50 mL/kg may be required for distributive shock); **high-flow oxygen**, secure airway (intubate early if angioedema progressing — anticipate difficult airway from tongue/laryngeal oedema); consider RSI with ketamine + suxamethonium (or rocuronium if K rising) **[core]**
- **Remove all stingers** by scraping with credit card / fingernail (NOT pinching — squeezes venom sac); count and document; clean wounds; tetanus prophylaxis **[core]**
- **Adjuncts**: nebulised salbutamol 5 mg for bronchospasm; antihistamines (diphenhydramine 25-50 mg IV / promethazine 25 mg IV) for ongoing urticaria; corticosteroid (hydrocortisone 200 mg IV) — limited evidence in acute phase, may reduce biphasic reactions **[core]**
- **Monitor for massive envenomation complications** over 24-72 hours: rhabdomyolysis (CK, urine myoglobin), renal function, haemolysis (haptoglobin, Hb, LDH, blood film), hepatic function, coagulopathy — supportive care; haemodialysis for refractory; **admit to monitored bed minimum 24 hours** **[core]**
- Discharge planning: **EpiPen 300 micrograms** prescription; allergy/immunology referral for specific IgE testing and venom immunotherapy; ASCIA action plan; MedicAlert; consider occupational implications

c) State 2 indications for venom immunotherapy (desensitisation) referral. (2 marks)

- **Documented systemic anaphylaxis** (beyond local reaction) to bee or wasp with positive specific IgE or skin prick test for the same insect — 75-95% effective for bee, >95% for vespid; 3-5 year course **[core]**
- **High-risk occupation or environment**: beekeeper (this patient), forestry worker, gardener, outdoor athlete; **co-morbidity** (cardiovascular disease, mastocytosis with raised baseline tryptase, β -blockers, ACEi use, advanced age) — increased risk of severe outcome **[core]**

- Children at lower risk of future systemic reaction; adults higher; biphasic anaphylaxis risk informs admission length

References: ASCIA Anaphylaxis Guidelines • ANZAAG Drug-induced anaphylaxis • Murray's Toxicology Handbook 2.5e • eTG (Therapeutic Guidelines, current) • ACEM clinical policies and statements

Question 14 | Tick Paralysis and Tick-Borne Mammalian Meat Allergy (10 marks)

A 4-year-old girl is brought to your eastern Australian rural emergency department by her parents with a 3-day history of progressive weakness. She is now unable to walk and is drooling. Her mother noted a small swelling behind the left ear during today's bath. Examination: Glasgow Coma Score 14, heart rate 70 beats per minute, blood pressure 90/50, respiratory rate 28 with shallow effort, peripheral oxygen saturation 94 percent on room air, ptosis, ophthalmoplegia, weak gag, flaccid limb weakness (more proximal than distal), absent reflexes. An engorged adult tick (*Ixodes holocyclus*) is found embedded in the left post-auricular region.

a) Name 3 features of Australian tick paralysis. (3 marks)

- **Ascending flaccid paralysis** over days from ***Ixodes holocyclus*** (paralysis tick — east-coast eucalypt forest from Cairns to Lakes Entrance, Vic); peak in spring/summer; **holocyclotoxin** blocks presynaptic acetylcholine release **[core]**
- **Cranial nerve involvement**: ptosis, ophthalmoplegia, bulbar palsy, dysphagia, drooling; progresses to respiratory failure; **distinguishes from Guillain-Barré** (typically ascending limb weakness BEFORE cranial nerves; CSF protein elevated; tick search negative) **[core]**
- **Children most severely affected** (smaller body mass); recovery slow after tick removal (12-48 hours often before improvement; can paradoxically worsen 24-48 hours post-removal) **[core]**
- **North American tick paralysis** (*Dermacentor*) — more rapid improvement after tick removal (within 24 hours)

b) Outline 4 management priorities including tick removal technique. (4 marks)

- **Tick removal — freeze with ether-containing aerosol spray** (e.g. tick-removal sprays containing ethyl chloride or commercial preparations like WART-OFF/Lyclear), **then remove with fine forceps grasping close to skin** with steady traction — **do NOT squeeze the body** (injects more saliva/toxin/allergen) **[core]**
- **Examine thoroughly** for further ticks (often more than one) — scalp, behind ears, axillae, groin, umbilicus; clip hair if needed; **document removal**; **no tick antitoxin in Australia** (was previously available; withdrawn) **[core]**
- **Respiratory support**: anticipate **respiratory failure**; admit ICU; intubate if FVC <15 mL/kg, respiratory distress, bulbar dysfunction with aspiration risk; supportive ventilation for days-week **[core]**
- **Other supportive care**: NG feeds; fluid management; **thromboprophylaxis**; pressure-area care; physiotherapy; **long-term follow-up** for **α -gal mammalian meat allergy** (see below) — common sequel in eastern Australian tick bites **[core]**
- Most patients recover fully with supportive care

c) List 3 tick-borne illnesses other than paralysis in Australia. (3 marks)

- **Mammalian Meat Allergy (α -gal syndrome)** — delayed-onset (3-8 hours after eating beef/lamb/pork) anaphylaxis; **caused by tick saliva inducing IgE to galactose- α -1,3-galactose**; Australian eastern coast (*Ixodes holocyclus*); avoidance of red meat **[core]**
- **Australian Tick-Borne Rickettsiosis (Spotted Fever group)**: Queensland tick typhus (*Rickettsia australis*), Flinders Island spotted fever (*R. honei*); fever, headache, eschar at tick site, maculopapular rash; treat with doxycycline 100 mg BD **[core]**
- **Lyme-like disease** — Australian endemic Lyme borreliosis is contested; **'DSCATT'** (Debilitating Symptom Complexes Attributed to Ticks) recognised by Royal College physicians; imported Lyme disease from overseas travel — doxycycline if classic erythema migrans **[core]**
- Tick-borne encephalitis (overseas); babesiosis; anaplasmosis

References: ASCIA Tick Allergy Position Statement • RCH Tick Removal Guideline • Murray's Toxicology Handbook 2.5e • eTG (Therapeutic Guidelines, current)

Question 15 | Carbon Monoxide Poisoning (11 marks)

A 35-year-old woman is brought to your emergency department by ambulance after being found obtunded in her bathroom adjacent to a malfunctioning gas hot-water system in winter. Her partner, also obtunded, has been taken to another facility. On arrival: Glasgow Coma Score 10, heart rate 110 beats per minute, blood pressure 100/60 millimetres of mercury, respiratory rate 22, peripheral oxygen saturation 99 percent on 6 litres oxygen mask, temperature 36.8 °C. Examination: cherry-red lips, no external trauma, scattered crackles in both lung bases. Arterial blood gas on 100% oxygen: pH 7.31, partial pressure of oxygen 380 millimetres of mercury, partial pressure of carbon dioxide 32, bicarbonate 18, base excess -5, lactate 5.8 millimoles per litre, carboxyhaemoglobin 38 percent.

a) Name 4 features of severe carbon monoxide poisoning. (4 marks)

- **Markedly elevated carboxyhaemoglobin** (here 38% — severe; normal <3% in non-smokers, <10% in smokers); **SpO₂ is unreliable** (reads HbCO as HbO₂); use **co-oximetry (CO-oximeter or arterial blood gas)** for accurate measurement **[core]**
- **Neurological dysfunction**: decreased GCS (10), headache, dizziness, nausea, confusion; **delayed neuropsychiatric sequelae (DNS)** in 10-40% within 2-40 days — cognitive impairment, parkinsonism, depression, leukoencephalopathy **[core]**
- **Lactic acidosis** (lactate 5.8) — from impaired cellular oxygen utilisation (CO binds cytochrome oxidase) and tissue hypoxia **[core]**
- **Cardiovascular: myocardial ischaemia** with elevated troponin, arrhythmias, hypotension; **rhabdomyolysis**; pulmonary oedema; non-cardiogenic pulmonary oedema; **cherry-red lips/skin is uncommon** in living patients (typically post-mortem) **[core]**
- **Pregnancy considerations**: fetal Hb has greater CO affinity; fetal carboxyhaemoglobin exceeds maternal; fetus more susceptible; lower treatment threshold and longer normobaric oxygen

b) Outline 5 management priorities AND state the indications for hyperbaric oxygen therapy. (5 marks)

- **Remove from source; 100% oxygen via non-rebreather mask** immediately (reduces CO half-life from ~250 minutes on air to ~75 min on 100% O₂); maintain until HbCO <5% AND clinically improved **[core]**
- **Airway and ventilation**: intubate if GCS <9, severe respiratory compromise, refractory hypoxia, imminent failure; mechanical ventilation with 100% oxygen until HbCO normalised **[core]**
- **Investigate and treat complications**: 12-lead ECG and troponin (myocardial injury); CK, U&E, lactate; CT head if altered consciousness or focal deficit (to exclude trauma); **also screen for cyanide co-poisoning** in fire victims (CO + cyanide is common; cyanide kit — hydroxocobalamin 5 g IV) **[core]**
- **Hyperbaric oxygen therapy (HBOT) indications** (Weaver criteria — most widely accepted; controversy persists): (1) HbCO >25% (or >20% in pregnant), (2) loss of consciousness at any time, (3) neurological signs or persistent neurological deficit, (4) cardiac ischaemia or arrhythmia, (5) severe metabolic acidosis, (6) pregnancy with elevated HbCO. Discuss with local hyperbaric service **[core]**
- **Public-health and screening**: notify health authorities; **screen all household members** (here partner already affected); CO detector advocacy; gas-fitter investigation of source; psychiatric review if deliberate exposure suspected **[core]**
- Goal: HbCO <5% AND clinical resolution before discharge

c) List 2 reasons HbCO level does not always reflect severity. (2 marks)

- **Pre-hospital oxygen reduces measured HbCO** by the time of ED arrival — true peak HbCO unknown; severity should be assessed by **clinical features** (GCS, end-organ effects, lactate) NOT HbCO alone **[core]**

- **Tissue CO binding** to cytochrome oxidase and intracellular distribution is not reflected in blood HbCO; **delayed neuropsychiatric sequelae** correlate poorly with peak HbCO; **fetal vs maternal HbCO** dissociate (fetal levels higher and clearance slower) **[core]**
- Smokers have a chronic baseline HbCO up to 10-15% — interpret accordingly

References: Weaver et al. HBOT for CO poisoning • Murray's Toxicology Handbook 2.5e • eTG (Therapeutic Guidelines, current) • Tintinalli's Emergency Medicine 9e Ch 217 • ANZHMG (hyperbaric medicine)

Question 16 | Acute Mountain Sickness and High-Altitude Cerebral Oedema (10 marks)

You are the expedition doctor for a 14-day trek to Everest Base Camp. On day 5, after ascending from 3500 metres to 4400 metres, a 42-year-old previously fit male trekker presents to your expedition tent with severe headache, vomiting, and progressive ataxia. Examination: Glasgow Coma Score 13, peripheral oxygen saturation 78 percent on ambient air at altitude, heart rate 110 beats per minute, respiratory rate 30, afebrile, drowsy and confused, marked truncal ataxia, no focal neurological signs. He took no altitude prophylaxis.

a) Name 4 features of acute mountain sickness (AMS) AND state the diagnosis of high-altitude cerebral oedema (HACE). (4 marks)

- **AMS — Lake Louise consensus** (headache mandatory) plus ≥ 1 of: **gastrointestinal symptoms** (nausea, vomiting, anorexia), **fatigue/weakness**, **dizziness/lightheadedness**, **sleep disturbance** [core]
- **HACE definition:** AMS PLUS **altered mental status** (confusion, drowsiness, behavioural change — GCS 13 here) OR **ataxia** (this patient — truncal ataxia is characteristic); represents progression of AMS to a **life-threatening cerebral oedema** [core]
- **Time course:** typically 1-3 days after ascent to >2500 m; can occur as low as 2000 m in susceptible. **Rate of ascent >500 m/day above 3000 m** is the main risk factor [core]
- **Other findings:** papilloedema, retinal haemorrhages, hyperventilation, progresses to coma over hours-days if untreated; **distinguish from** viral meningoencephalitis, intracranial haemorrhage, dehydration, hyponatraemia, hypothermia [core]
- Risk factors: rapid ascent, prior history of altitude illness, vigorous exertion at altitude, youth (paradoxically higher), male

b) Outline 4 specific management steps in this expedition setting. (4 marks)

- **Immediate descent — minimum 1000 metres** — most important intervention and definitive treatment; **do NOT delay descent for any other treatment**; assist as required (stretcher, helicopter if available); evacuate to definitive medical care [core]
- **Dexamethasone 8 mg PO/IM/IV stat, then 4 mg 6-hourly** — first-line drug for HACE; reduces cerebral oedema; buys time during descent [core]
- **Supplemental oxygen** 2-4 L/min via nasal prongs (target $\text{SpO}_2 >90\%$ but at altitude this may not be achievable); **portable hyperbaric chamber (Gamow / CertacBag) at 2 psi for 1 hour** simulates descent of 2000 m — useful while preparing descent [core]
- **Other adjuncts:** **acetazolamide 250 mg PO BD** (speeds acclimatisation — diuretic and respiratory drive); analgesia (paracetamol/ibuprofen); anti-emetics; **avoid sedatives** (worsen hypoventilation); maintain hydration [core]
- Do not re-ascend until fully asymptomatic; delay further ascent by 24-72 hours minimum; expedition medical kit should include dexamethasone, acetazolamide, nifedipine, sildenafil, antibiotics, oximeter

c) Name 2 strategies for prevention of altitude illness on future expeditions. (2 marks)

- **Graded ascent** — sleep no more than 500 m higher than the previous night above 3000 m; **rest day every 3-4 days** ('climb high, sleep low'); avoid sudden altitude gains via transportation [core]
- **Pharmacological prophylaxis with acetazolamide 125-250 mg PO BD** starting 24 h before ascent and continuing for 2 days at maximum altitude — for previously affected trekkers, rapid ascent profiles, or altitudes >3500 m; **dexamethasone 4 mg 6-hourly** as alternative (typically reserved for treatment) [core]
- Adequate hydration; avoid alcohol; recognise warning signs early; descend immediately if altitude illness develops

References: Wilderness Medical Society Altitude Illness Guidelines 2024 • Lake Louise AMS Score • eTG (Therapeutic Guidelines, current) • Tintinalli's Emergency Medicine 9e Ch 215

Question 17 | High-Altitude Pulmonary Oedema (10 marks)

A 35-year-old man is brought to your alpine ski resort clinic 36 hours after rapidly ascending to 3200 metres for a ski holiday. He reports progressive dyspnoea, dry cough now productive of pink frothy sputum, and exhaustion on minimal exertion. On arrival: Glasgow Coma Score 15, heart rate 130, blood pressure 100/65, respiratory rate 32, peripheral oxygen saturation 65 percent on room air, temperature 37.2 °C, bilateral coarse crackles on auscultation, cyanosis.

a) Name 3 features that confirm HAPE. (3 marks)

- **Recent altitude exposure** (typically ascent to >2500 m within 2-5 days; here 3200 m at 36 hours) with progressive **dyspnoea at rest**, dry cough progressing to pink frothy sputum, exhaustion **[core]**
- **Lake Louise diagnostic criteria — HAPE:** ≥2 symptoms (dyspnoea at rest, cough, weakness/decreased exercise performance, chest tightness/congestion) AND ≥2 signs (crackles or wheeze in at least 1 lung field, central cyanosis, tachypnoea, tachycardia) **[core]**
- **Pathophysiology:** hypoxic pulmonary vasoconstriction → uneven distribution → over-perfusion of less-constricted areas → high-pressure capillary leak (non-cardiogenic pulmonary oedema, normal LV function) **[core]**
- Risk factors: rapid ascent, prior HAPE, intercurrent infection, cold exposure, male sex; **often coexists with HACE**

b) Outline 5 specific management priorities. (5 marks)

- **Immediate descent — minimum 1000 metres** (highest priority — definitive treatment); evacuation by helicopter, vehicle or snow-mobile as available; **do NOT delay descent for any other treatment [core]**
- **High-flow supplemental oxygen 6-10 L/min** targeting $\text{SpO}_2 > 90\%$; **portable hyperbaric chamber** if available (Gamow bag — simulates descent); **continuous positive airway pressure (CPAP)** 5-10 cm H_2O if available — reduces work of breathing **[core]**
- **Nifedipine 30 mg slow-release PO 12-hourly** — pulmonary vasodilator; reduces pulmonary artery pressure; first-line drug therapy for HAPE **[core]**
- **Adjunctive: sildenafil or tadalafil** (phosphodiesterase-5 inhibitors — pulmonary vasodilators) if nifedipine unavailable or as adjunct; **dexamethasone 8 mg** if coexistent HACE features **[core]**
- **Avoid exertion**; assisted descent; **diuretics NOT routinely used** (non-cardiogenic — may worsen dehydration); broad-spectrum antibiotics **ONLY** if pneumonia suspected (often concurrent); reassessment after descent; definitive medical care **[core]**
- Recovery typically rapid (24-72 h) with descent + oxygen; re-ascent only after full recovery and with prophylaxis

c) List 2 prophylactic options for known HAPE-susceptible individuals. (2 marks)

- **Nifedipine slow-release 30 mg 12-hourly** starting 24 h before ascent and continued until 5 days at maximum altitude (first-line for HAPE-susceptible individuals) **[core]**
- **Sildenafil 50 mg 8-hourly** or **tadalafil 10 mg BD**; **dexamethasone 8 mg 12-hourly** as alternative; **acetazolamide 125-250 mg BD** (modest benefit for HAPE; main benefit AMS) **[core]**
- Graded ascent (most important non-pharmacological measure); avoid alcohol/sedatives; pre-acclimatisation

References: Wilderness Medical Society Altitude Illness Guidelines 2024 • eTG (Therapeutic Guidelines, current) • Tintinalli's Emergency Medicine 9e Ch 215

Question 18 | Decompression Illness (DCI) in Recreational SCUBA Diver (11 marks)

A 39-year-old recreational SCUBA diver presents to your tropical coastal emergency department with a rash on his torso, headache and joint pains 2 hours after surfacing from a dive. He completed three open-water dives to a maximum depth of 28 metres earlier today, with the longest dive 35 minutes long and the surface interval 45 minutes. He reports he 'skipped' a 5-minute decompression stop on the final dive to assist a panicking dive buddy. On arrival: Glasgow Coma Score 15, heart rate 105, blood pressure 130/75, respiratory rate 22, peripheral oxygen saturation 96 percent on room air. Examination: cutis marmorata over chest and abdomen, paraesthesia and weakness of the right leg, pain in both shoulders.

a) Name 4 features of decompression illness AND classify by type. (4 marks)

- **Type I DCI (musculoskeletal / cutaneous): 'the bends'** — joint pain (this patient — bilateral shoulders); **'cutis marmorata' (skin bends)** — mottled erythematous marbled rash from cutaneous venous stasis; itch; oedema [core]
- **Type II DCI (neurological): spinal cord** — paraesthesia, weakness (this patient — right leg weakness), bladder dysfunction, urinary retention; **cerebral** — headache, altered mental status, focal deficit; **vestibular ('staggers')** — vertigo, nausea; **pulmonary ('chokes')** — dyspnoea, retrosternal pain, cough [core]
- **Mechanism:** inert gas (nitrogen) comes out of solution as the diver ascends — too rapid ascent → bubble formation in tissues / blood; bubbles obstruct microcirculation and cause inflammation; reduced by following dive tables / computer with mandatory safety stops [core]
- **Risk factors:** rapid ascent / skipped decompression stops (this patient), repetitive dives, deep dives, dehydration, fatigue, alcohol, age, obesity, patent foramen ovale, recent exercise, flying or altitude exposure soon after diving [core]
- Onset typically within minutes-hours of surfacing (75% within 6 h; 95% within 24 h)

b) Outline 5 management priorities. (5 marks)

- **100% oxygen via non-rebreather mask** immediately — promotes inert gas washout, reduces bubble size; continue during transfer until hyperbaric oxygen therapy available [core]
- **Aggressive IV crystalloid 0.9% NaCl 1-2 L** (titrated to euvolaemia / urine output ≥ 2 mL/kg/h) — diving causes **immersion diuresis and dehydration**; haemoconcentration worsens DCI [core]
- **Contact Diver Alert Network (DAN) 24-hour line** for advice and **arrange urgent transfer to nearest recompression chamber** (Australian centres include Townsville, Sydney, Adelaide, Perth, Auckland, Wellington); **USN Treatment Table 6** typically used (4-5 hours) [core]
- **Avoid air transfer / altitude** — if helicopter required, fly at lowest altitude possible (<300 m); **do NOT delay recompression for full neurological recovery; even late treatment may benefit** [core]
- **Aspirin / NSAIDs** for inflammation (low-grade evidence); avoid antithrombotics; **investigate for patent foramen ovale** (bubble study) if Type II DCI — 1/3 of cases with PFO; post-treatment counselling re fitness to dive again [core]
- Note: **no flying for 24-72 hours after diving** (or as per dive tables) — and longer after DCI treatment

c) List 2 risk factors for DCI in this patient. (2 marks)

- **Skipped decompression stop** (the 5-minute stop) and rapid ascent; **multiple dives in a day** with inadequate surface interval (3 dives with only 45 min interval) [core]
- **Modifiable factors:** dehydration, exertion (assisting panicking buddy), alcohol the previous evening (commonly underreported), fatigue, obesity, advancing age; **non-modifiable:** patent foramen ovale (in 25-30% of population) — promotes paradoxical embolism [core]

- Cold water exposure

References: *Diver Alert Network — Diving Medicine Reference* • *South Pacific Underwater Medicine Society (SPUMS)* • *Murray's Toxicology Handbook 2.5e* • *eTG (Therapeutic Guidelines, current)* • *Tintinalli's Emergency Medicine 9e Ch 216*

Question 19 | Pulmonary Barotrauma and Arterial Gas Embolism (10 marks)

A 30-year-old male SCUBA diver is brought to your urban emergency department from a local dive boat. He surfaced rapidly from 18 metres after his weight belt accidentally jettisoned. Within 1 minute of surfacing, he developed sudden left hemiparesis, dysarthria and confusion. On arrival 30 minutes later: Glasgow Coma Score 12, heart rate 110, blood pressure 100/60, respiratory rate 24, peripheral oxygen saturation 92 percent on 6 litres oxygen, asymmetric chest movement with reduced air entry left base, subcutaneous emphysema in the neck. CT brain shows multiple small gas-density lesions in the right cerebral hemisphere.

a) Name 4 manifestations of pulmonary barotrauma from rapid uncontrolled ascent. (4 marks)

- **Cerebral arterial gas embolism (CAGE)** — pulmonary barotrauma → gas into pulmonary veins → left heart → cerebral circulation → focal neurological deficit (hemiparesis, dysarthria, seizure, coma) within seconds-minutes of surfacing; **CT shows intracerebral gas [core]**
- **Pneumothorax** — asymmetric chest movement, reduced air entry (this patient left base); may be tension; reduced breath sounds, hypoxia; **chest X-ray** confirms **[core]**
- **Pulmonary interstitial emphysema / pneumomediastinum / subcutaneous emphysema** (this patient — neck subcutaneous emphysema); Hamman's sign (crunching sound on auscultation); retrosternal chest pain; voice change **[core]**
- **Pulmonary haemorrhage and bronchospasm** from alveolar rupture; haemoptysis; '**pulmonary overinflation syndrome**' (POPS) — collective term **[core]**
- Pathophysiology: **holding breath during ascent** (or air-trapping from bullous lung disease, asthma) → expanding gas (Boyle's law) → alveolar rupture; classically with the panicked diver after equipment problem

b) Outline 4 management priorities including definitive treatment. (4 marks)

- **100% oxygen via non-rebreather mask** OR intubation if GCS <9 / impaired airway protection — accelerates nitrogen washout from arterial bubbles **[core]**
- **Treat pneumothorax:** needle decompression / finger thoracostomy / intercostal catheter as indicated; **warn anaesthetic / hyperbaric team** of the pneumothorax (pneumothorax may expand in HBO chamber on ascent — chest drain MUST be in situ before recompression) **[core]**
- **Urgent hyperbaric oxygen therapy** (USN Treatment Table 6 or 6A) — first-line definitive treatment for AGE; reduces bubble size, restores tissue oxygenation, accelerates inert gas elimination; contact Diver Alert Network and nearest hyperbaric centre urgently **[core]**
- **Aggressive fluid resuscitation** for hypoperfusion; left-lateral decubitus / supine position (Trendelenburg position is NO LONGER recommended — does not redistribute cerebral bubbles and may worsen cerebral oedema); supportive care; treat seizures (benzodiazepine); tetanus; admit ICU **[core]**
- Counsel re fitness to dive — most divers with AGE are advised not to dive again

c) Name 2 differentials for confusion / focal deficit after diving. (2 marks)

- **Type II decompression illness (spinal or cerebral DCI)** — typically more gradual onset; may coexist with AGE; treatment is the same (hyperbaric oxygen) **[core]**
- **Inert gas (nitrogen) narcosis** (typically only at depth, resolves on ascent); **oxygen toxicity seizure** (deep technical diving with high oxygen partial pressures); **carbon monoxide contamination** of the air supply; **hypoglycaemia**; **middle-ear / inner-ear barotrauma** (vertigo); **stroke unrelated to diving [core]**
- Near-drowning with hypoxic encephalopathy

References: Diver Alert Network — Diving Medicine Reference • SPUMS • Murray's Toxicology Handbook 2.5e • eTG (Therapeutic Guidelines, current) • Tintinalli's Emergency Medicine 9e Ch 216

Question 20 | Inert Gas Narcosis and Oxygen Toxicity (8 marks)

A 35-year-old technical diver presents to your regional emergency department after a near-incident while diving to 50 metres on air. His buddy reported that he had become confused and euphoric at depth, attempted to remove his regulator, and was guided to the surface by his buddy with a controlled ascent. He has now recovered fully. He requests advice on a planned 60-metre dive next week on technical mixed gas.

a) Name 3 diving-related causes of behavioural change or confusion at depth. (3 marks)

- **Inert gas (nitrogen) narcosis** — 'rapture of the deep' / 'Martini's law' (one alcoholic drink equivalent per 10 m depth below 30 m on air); euphoria, impaired judgement, slow thought, fixation, hallucination, loss of consciousness at extreme depth; **resolves rapidly on ascent** [core]
- **Carbon dioxide retention (hypercapnia)** — increased breathing resistance with regulator at depth; 'skip breathing' to conserve gas; elevated PaCO_2 increases cerebral blood flow → potentiates inert gas narcosis AND oxygen toxicity [core]
- **Oxygen toxicity (CNS — Paul Bert effect)** at $\text{PO}_2 > 1.4$ atmospheres — twitching, seizure, tunnel vision, irritability, tinnitus, nausea; occurs deep diving on enriched air (nitrox), technical mixed gas, or pure oxygen at depth [core]
- Other: **carbon monoxide contamination of compressed air; hypothermia; hypoglycaemia; pre-existing medical conditions**

b) Complete the table for changes in bubble size with altitude or depth (3 items). (3 marks)

- **Sea level (1 atmosphere absolute = 760 mmHg)**: bubble size = 1 (reference) — surface [core]
- **10 metres sea water depth (2 ATA = 1520 mmHg)**: bubble size = $\frac{1}{2}$ (halved — Boyle's Law: $PV = \text{constant}$); deeper → smaller bubbles → less symptoms [core]
- **Altitude 5000 m (~0.5 ATA)**: bubble size = 2 (doubled) — **airplane cabin at 2400 m / 0.75 ATA** → **bubble approximately 1.3× larger**; explains why flying after diving is contraindicated for 24-72 h [core]
- Practical implication: **increasing pressure (diving deep, hyperbaric chamber) shrinks bubbles; decreasing pressure (ascent, altitude, flight) expands them**

c) List 2 strategies to reduce risk on planned deep dive. (2 marks)

- **Use trimix (helium-oxygen-nitrogen) or heliox** instead of air — **helium replaces nitrogen** and is not narcotic; reduces narcosis; widely used in technical diving below 30-40 m [core]
- **Reduce oxygen fraction at depth** (hypoxic mixes for deep dives) to maintain $\text{PO}_2 < 1.4$ ATA — avoid oxygen toxicity; **graduated decompression schedule** with mandatory stops; backup gas; buddy diving with technical training (IANTD/TDI/PADI Tec) [core]
- Avoid alcohol the previous night; avoid heavy exertion at depth; pre-dive medical fitness review

References: Diver Alert Network — Diving Medicine Reference • SPUMS Diving Medicine Manual • Murray's Toxicology Handbook 2.5e • eTG (Therapeutic Guidelines, current) • Tintinalli's Emergency Medicine 9e Ch 216

Question 21 | Marine Animal Attack — Crocodile and Shark Bite (11 marks)

A 28-year-old man is brought by helicopter ambulance from a remote saltwater estuary in Far North Queensland to your tertiary emergency department with a saltwater crocodile (*Crocodylus porosus*) bite to the right lower limb. He was swimming when attacked approximately 90 minutes ago and was pulled from the water by his companions. The right thigh has extensive crush and avulsion injuries with multiple bite punctures, a partial degloving wound, and ongoing bleeding. Tourniquet was applied at scene. On arrival: Glasgow Coma Score 13, heart rate 130, blood pressure 85/55, respiratory rate 26, peripheral oxygen saturation 96 percent on 8 litres oxygen, temperature 35.4 °C.

a) Outline 4 priorities of resuscitation. (4 marks)

- **<C>ABC approach:** catastrophic haemorrhage control first — maintain tourniquet if effective; direct pressure; **haemostatic dressings** (QuikClot, Combat Gauze); junctional tourniquet if proximal limb **[core]**
- **Massive transfusion activation** — hypotensive shock (BP 85/55, HR 130, lactate likely elevated, cold); **balanced ratio 1:1:1 PRBC:FFP:PLT**; tranexamic acid 1 g IV within 3 h (CRASH-2); permissive hypotension (target SBP 80-90 mmHg) until haemorrhage controlled **[core]**
- **Theatre / damage-control surgery** for ongoing bleeding, vascular injury, extensive soft-tissue damage; **warming** (this patient 35.4 °C — trauma triad of death prevention with active warming, warmed fluids, underbody warmer); consider IO/IV access × 2 **[core]**
- **Antibiotics:** broad-spectrum IV for crocodile bite — **piperacillin-tazobactam 4.5 g IV** (covers *Pseudomonas*, *Aeromonas*, *Vibrio*, anaerobes, *Burkholderia*, *Aspergillus*); ALTERNATIVELY meropenem 1 g IV; specific cover for ***Burkholderia pseudomallei*** (melioidosis — common in northern Australia, particularly in freshwater/mud exposure) **[core]**
- Tetanus prophylaxis; analgesia (titrated opioids); urinary catheter; monitor for rhabdomyolysis; admit ICU

b) Outline 4 specific considerations for crocodile (vs shark) attack. (4 marks)

- **Crush mechanism** dominates — crocodile teeth crush rather than slice; '**death roll**' causes torsional injury with avulsion and fracture; multi-system injury common (limb amputation, abdominal/thoracic injury); **massive contamination** (estuarine/freshwater) **[core]**
- **Polymicrobial wound infection** (crocodile mouth has very high bacterial load): Gram-negatives (***Aeromonas***, ***Pseudomonas***, ***Vibrio***, ***Burkholderia pseudomallei*** — melioidosis), anaerobes (*Clostridium*), enterococci; require broad-spectrum cover; aggressive surgical debridement **[core]**
- **Sharks (vs crocodile): slicing/laceration mechanism** from triangular serrated teeth; vascular injury / exsanguination is the primary killer; marine bacterial contamination (***Vibrio vulnificus***, ***Aeromonas***); antibiotics ciprofloxacin + doxycycline; tetanus **[core]**
- **Public-health and forensic:** notify wildlife authorities; **document injury extent** (photographs); psychological impact (PTSD, survivor guilt) — refer; communication with family / coroner if fatal; counsel re future water activities **[core]**
- Hyperbaric oxygen therapy considered for necrotising soft tissue infection / clostridial myonecrosis

c) Name 3 organisms specifically associated with saltwater crocodile bites in northern Australia. (3 marks)

- ***Burkholderia pseudomallei* (melioidosis)** — Gram-negative soil/water bacterium; tropical northern Australia and SE Asia; pneumonia, septicaemia, abscess formation; **treat with meropenem 1 g IV 8-hourly** for 2-4 weeks acute, then trimethoprim-sulfamethoxazole for 3-6 months eradication **[core]**
- ***Aeromonas hydrophila* / *sobria* and *Vibrio vulnificus*** — Gram-negatives in freshwater/saltwater; rapidly progressive cellulitis, necrotising soft tissue infection, septicaemia (*Vibrio* in cirrhosis) **[core]**

- **Pseudomonas aeruginosa**; anaerobes including **Clostridium species**; coagulase-negative staphylococci; enterococci; **Mycobacterium** species; fungal (*Aspergillus*, *Apophysomyces* — agents of mucormycosis in tropical wound contamination) **[core]**
- Tetanus (*Clostridium tetani*) — give tetanus vaccine ± immunoglobulin per Australian Immunisation Handbook

References: eTG (Therapeutic Guidelines, current) • Royal Darwin Hospital Crocodile Bite Protocol • Auerbach Wilderness Medicine • Tintinalli's Emergency Medicine 9e Ch 210

Question 22 | Remote Wilderness Retrieval and Pre-Hospital Management (9 marks)

You are the duty consultant at a rural emergency department. A satellite phone call is patched through from an expedition group with a 44-year-old man who has sustained a snake bite and partial paralysis on day 4 of a 14-day remote bushwalk. The group is 7 hours' walk from the nearest vehicle access point in a mountainous national park, with helicopter access possible with daylight remaining (3 hours). They have a first-aid kit but no antivenom or ventilation capability.

a) Outline 4 priorities for telephone advice to the expedition leader. (4 marks)

- **Call emergency services / activate retrieval:** 000 → ambulance, police, national park ranger; **helicopter retrieval** while daylight permits; give GPS coordinates and detailed location **[core]**
- **Apply pressure-immobilisation bandage** from distal limb proximally (if not already applied); immobilise the affected limb with a splint; **patient must lie still and NOT walk** — muscle movement disseminates venom **[core]**
- **Recovery position / monitor airway:** if patient has bulbar weakness / ptosis, place in lateral position; **clear secretions**; oxygen if available (some expeditions carry small cylinders); be prepared to support airway with manual manoeuvres **[core]**
- **Identify nearest evacuation point** and stay with the patient; **identify the snake** if safe (photograph from distance — do NOT approach); regular SatPhone contact with retrieval team and ED to update status **[core]**
- Document time of bite (helps with venom timing); log GPS / map reference; consider weather deterioration

b) Outline 3 retrieval considerations for this patient. (3 marks)

- **Mode and time:** helicopter is fastest in this remote terrain — daylight operations only for most rural services (some night-vision capable); **winching** if no landing site; **4WD ambulance** as backup (long transit); commitment from retrieval service is critical decision **[core]**
- **Crew composition:** doctor-paramedic team with airway and antivenom capability; ED to prepare polyvalent antivenom + adrenaline + appropriate tiger/brown monovalents based on region; consider mid-flight intubation if deteriorating during retrieval **[core]**
- **Receiving facility:** tertiary ED with ICU, dialysis, mass-transfusion capability — direct retrieval to tertiary preferred over local rural facility if travel time similar; early ED activation **[core]**
- Logistic: refuel locations; weather minimums; rescue team safety (do not put crew at risk)

c) List 2 components of an expedition medical kit for snake-bite country. (2 marks)

- **Pressure-immobilisation bandages × 2 (10-15 cm wide);** rigid splint or SAM splint; permanent marker pen (mark bite site); waterproof notebook **[core]**
- **Communication device — satellite phone OR personal locator beacon (PLB); first-aid manual; medications** for non-venomous emergencies — paracetamol, ibuprofen, antihistamine, loperamide, ondansetron, broad-spectrum antibiotic, EpiPen if known anaphylaxis-risk member; **oximeter**; thermal blanket; **tourniquet (for severe haemorrhage only — NOT snake bite)** **[core]**
- Tick-removal device for endemic areas; anti-emetic; oral rehydration salts; hyposmolar / hyperosmolar saline tablets for altitude / heat; nitrofurantoin / trimethoprim for UTI; dexamethasone / acetazolamide / nifedipine for altitude expeditions

References: Wilderness Medical Society Practice Guidelines (current) • Auerbach Wilderness Medicine 7e • Royal Flying Doctor Service / Careflight / Ambulance Victoria retrieval protocols • eTG (Therapeutic Guidelines, current)