

FExNet 2026

Collated SAQs: Trauma — Chest, Abdomen & Pelvis

ANSWER BOOKLET

Model answers for the 22 CAP trauma SAQs. References cited at the foot of each question. Items marked [core] are required for full marks. Drug doses confirmed with current ATLS / EAST / World Society of Emergency Surgery / NSW ITIM guidelines and the National Blood Authority Patient Blood Management guidelines.

22 questions • 236 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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Question 1 | Tension Pneumothorax (12 marks)

A 32-year-old man is brought to your emergency department by ambulance after a high-speed motor vehicle collision in which he was the restrained driver. He has been intubated in the field for severe respiratory distress and a Glasgow Coma Score of 8. On primary survey, he has asymmetrical chest rise with reduced air entry on the left side, distended neck veins, and tracheal deviation to the right. His vital signs deteriorate during your assessment to a heart rate of 130 beats per minute and a systolic blood pressure of 70 millimetres of mercury, with peripheral oxygen saturation of 88 percent on 100 percent oxygen via the bag-valve circuit. The assistant is having increasing difficulty bag-ventilating the patient with rising peak inspiratory pressures.

a) List 4 clinical features that confirm tension pneumothorax in a ventilated trauma patient. (4 marks)

- Severe haemodynamic compromise — hypotension, tachycardia, cardiac arrest **[core]**
- Unilateral decreased or absent breath sounds with ipsilateral hyper-resonance on percussion **[core]**
- Tracheal deviation AWAY from the affected side (late sign) **[core]**
- Distended neck veins (in absence of hypovolaemia); rising peak inspiratory pressures in ventilated patient **[core]**
- Subcutaneous emphysema
- Hypoxia despite adequate oxygenation
- Reduced cardiac output / electromechanical dissociation

b) Describe the immediate decompression procedure (4 components: indication, anatomical landmarks, technique, alternative sites). (4 marks)

- **Indication** — clinical diagnosis of tension pneumothorax should not await chest radiograph; decompression is empirical and life-saving **[core]**
- **Primary anatomical landmark** — **fifth intercostal space, mid-axillary line** (per current ATLS, due to higher success rate than second intercostal space, mid-clavicular line in adults with thicker chest wall) **[core]**
- **Technique** — large-bore (14-gauge or larger) intravenous cannula or finger thoracostomy; advance over the upper border of the rib (avoiding neurovascular bundle); listen for hiss of escaping air; convert to formal intercostal catheter (28-32 French) as soon as possible **[core]**
- **Alternative** — second intercostal space, mid-clavicular line (second-line in adults; first-line in children); finger thoracostomy is preferred over needle decompression in adult trauma due to higher reliability **[core]**

c) List 4 differential diagnoses for unilateral absent breath sounds in a ventilated trauma patient. (4 marks)

- Mainstem (right or left) endobronchial intubation — the endotracheal tube is positioned beyond the carina **[core]**
- Massive haemothorax — blood in the pleural cavity (would also cause percussion dullness) **[core]**
- Large simple pneumothorax (without tension) **[core]**
- Pulmonary contusion or consolidation with atelectasis **[core]**
- Diaphragmatic rupture with bowel herniation into the thorax
- Tracheobronchial injury / disruption
- Endotracheal tube obstruction (blood, secretions, biting)

References: ATLS 10th edition (current) • EAST Practice Management Guidelines (current) • Tintinalli's Emergency Medicine 9e Ch 65 • NSW Institute of Trauma & Injury Management (ITIM) guideline

Question 2 | Penetrating Chest Wound — Sucking Chest Injury (11 marks)

A 6-year-old boy is brought to your urban emergency department by ambulance after a domestic incident at home where his older brother accidentally fired a knitting needle at him from a homemade rubber-band launcher. The needle penetrated his right anterior chest wall in the fourth intercostal space, mid-clavicular line. On arrival, the child is alert but distressed, and you can hear an audible sucking noise through the chest wound on inspiration. His respiratory rate is 40 breaths per minute, heart rate 160 beats per minute, blood pressure 60 millimetres of mercury systolic, peripheral oxygen saturation 98 percent on room air.

a) Name the injury AND describe the underlying physiological problem (3 marks). (3 marks)

- **Open pneumothorax (sucking chest wound)** — a chest wall defect larger than two-thirds of the diameter of the trachea allows air to preferentially enter the pleural cavity through the wound rather than the trachea on inspiration **[core]**
- Air entry through the defect equalises pleural and atmospheric pressures, abolishing the negative intrapleural pressure required for lung expansion, leading to ipsilateral lung collapse and ineffective ventilation **[core]**
- Mediastinal shift can occur with each breath; if the wound creates a one-way flap, can progress to tension physiology **[core]**

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

- **Three-sided occlusive dressing** over the wound — sealed on three sides, open on the fourth to act as a one-way valve allowing air to escape on expiration but preventing entry on inspiration; alternative — commercial vented chest seal (e.g. HALO, Russell) **[core]**
- **Definitive intercostal catheter** placed AWAY from the wound site (typically fourth or fifth intercostal space, mid-axillary line on the same side); 16-20 French in this child **[core]**
- **High-flow oxygen** via face mask; consider early intubation for fatigue, deteriorating consciousness, or anticipated transfer **[core]**
- **Volume resuscitation** with weight-based boluses — 0.9% saline 20 mL/kg or warmed packed red blood cells 10 mL/kg if shocked; activate paediatric massive transfusion protocol **[core]**
- Cardiothoracic / paediatric surgical consultation; operative exploration if persistent air leak or large defect requiring formal repair
- Tetanus prophylaxis; broad-spectrum intravenous antibiotics (cefazolin) given penetrating injury through skin
- Estimated weight (age 6 years $\times 2 + 8 = 20$ kg per APLS) for drug calculations

c) List 4 possible complications of penetrating chest trauma in this anatomical location. (4 marks)

- Pneumothorax progressing to tension pneumothorax **[core]**
- Haemothorax from internal mammary, intercostal vessels, or pulmonary parenchyma **[core]**
- Pulmonary contusion with hypoxaemia **[core]**
- Cardiac injury — penetration of right ventricle is anatomically possible at this site (cardiac tamponade, ventricular laceration, valve injury) **[core]**
- Mediastinal injury — great vessels, oesophagus, trachea
- Diaphragmatic injury (especially below the fifth intercostal space)
- Empyema if not adequately drained / antibiotic-treated
- Bronchopleural fistula

References: ATLS 10th edition (current) • EAST Practice Management Guidelines (current) • Tintinalli's Emergency Medicine 9e Ch 65 • NSW Institute of Trauma & Injury Management (ITIM) guideline

Question 3 | Cardiac Tamponade — Penetrating Chest Trauma (12 marks)

A 25-year-old man presents to the emergency department having sustained a single stab wound to the precordium during an altercation thirty minutes earlier. On arrival, he is anxious and dyspnoeic with cool peripheries. His heart rate is 130 beats per minute, blood pressure 78 millimetres of mercury systolic with a narrow pulse pressure, respiratory rate 28 breaths per minute, peripheral oxygen saturation 96 percent on room air, Glasgow Coma Score 14. His neck veins are distended despite hypotension, and heart sounds are difficult to auscultate over the precordium. A bedside subxiphoid ultrasound view demonstrates a moderate pericardial effusion with right ventricular diastolic collapse.

a) List the 3 components of Beck's triad AND state which feature in this patient is the most specific. (3 marks)

- **Hypotension** (systolic blood pressure low, narrow pulse pressure) [core]
- **Distended jugular venous pressure** (raised neck veins despite hypotension — diagnostically counter-intuitive) [core]
- **Muffled heart sounds** (difficult to auscultate; least specific clinically) [core]
- **Pulsus paradoxus** (decrease in systolic blood pressure greater than 10 millimetres of mercury during inspiration) — additional supporting feature
- Echocardiographic right ventricular diastolic collapse is the most specific bedside finding (sensitivity and specificity above 90 percent)

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

- **Activate cardiothoracic surgical / theatre team and trauma team immediately** — definitive treatment is operative (sternotomy or thoracotomy) for repair of the cardiac wound [core]
- **Two large-bore intravenous access**; activate massive transfusion protocol; aim for balanced 1:1:1 component therapy; warm fluids [core]
- **Cautious volume loading** (250-500 mL bolus increments) to maintain right ventricular filling and preload; avoid excessive volume (does not address the underlying obstruction) [core]
- **Emergency pericardiocentesis** via subxiphoid approach under ultrasound guidance as a temporising measure if patient is in extremis OR cardiothoracic surgery delayed; removal of as little as 10-20 mL can restore haemodynamics [core]
- Avoid positive pressure ventilation if possible (reduces preload, worsens tamponade)
- Maintain blood pressure with vasopressor support (noradrenaline) as bridging therapy
- Prepare for emergency department thoracotomy if patient deteriorates to peri-arrest

c) List 5 indications for emergency department (resuscitative) thoracotomy. (5 marks)

- Penetrating thoracic injury with witnessed cardiac arrest in the emergency department or with signs of life within the preceding 10-15 minutes [core]
- Penetrating injury with profound persistent hypotension despite resuscitation and unable to reach theatre safely [core]
- Pericardial tamponade where pericardiocentesis fails or unavailable, in a peri-arrest patient [core]
- Air embolism from major vascular injury (cross-clamping descending aorta, releasing trapped air) [core]
- Exsanguinating thoracic haemorrhage requiring aortic cross-clamping for distal control of bleeding [core]
- Blunt thoracic injury with witnessed arrest is generally NOT an indication (extremely poor outcomes)

References: ATLS 10th edition (current) • EAST Practice Management Guidelines (current) • Tintinalli's Emergency Medicine 9e Ch 65 • NSW Institute of Trauma & Injury Management (ITIM) guideline

Question 4 | Massive Haemothorax (11 marks)

A 27-year-old female restrained driver is brought to your tertiary emergency department after a head-on motor vehicle collision at high speed. On arrival, she is alert, complaining of severe left-sided chest pain. Her heart rate is 130 beats per minute, blood pressure 85 millimetres of mercury systolic, respiratory rate 32 breaths per minute, peripheral oxygen saturation 92 percent on a non-rebreather mask. On examination, the trachea is central, but the left hemithorax is dull to percussion with absent breath sounds. A chest radiograph confirms complete opacification of the left hemithorax. A 32-French intercostal catheter is inserted into the fifth intercostal space, mid-axillary line, with immediate drainage of 1500 millilitres of blood.

a) Define massive haemothorax AND state 2 indications for emergency thoracotomy in this patient. (3 marks)

- **Massive haemothorax** = initial drainage of more than 1500 mL of blood OR more than one-third to one-half of the patient's blood volume on intercostal catheter insertion [core]
- **Indications for thoracotomy**: initial drainage greater than 1500 mL (this patient meets criteria) [core]
- Ongoing drainage of more than 200 mL/hour for 2-4 consecutive hours OR persistent transfusion requirement; haemodynamic instability despite resuscitation [core]

b) List 4 likely sources of bleeding in massive haemothorax. (4 marks)

- Intercostal artery laceration (especially associated with rib fractures) [core]
- Internal mammary (thoracic) artery — sternal or parasternal injury [core]
- Pulmonary parenchymal laceration [core]
- Pulmonary hilar / great vessel injury — pulmonary artery, vein, aorta [core]
- Heart laceration (penetrating) or chamber rupture (blunt)
- Tracheobronchial injury with bronchovascular bleeding
- Diaphragmatic vessel

c) State 4 management priorities while transferring to theatre. (4 marks)

- **Activate massive transfusion protocol** with balanced 1:1:1 (packed cells : fresh frozen plasma : platelets) component therapy; tranexamic acid 1 g intravenous bolus then 1 g over 8 hours (CRASH-2 evidence) [core]
- **Two large-bore intravenous access** in the upper limbs (avoid lower limb access if potential cava injury); permissive hypotension (target systolic 80-90 millimetres of mercury) until haemorrhage controlled [core]
- **Definitive airway** — early intubation given respiratory distress and likely surgical intervention; rapid sequence induction with ketamine (haemodynamic-sparing) and rocuronium [core]
- **Auto-transfusion** of intercostal catheter drainage (sterile collection bag) if available; warm patient and fluids; correct coagulopathy and electrolyte derangements (especially calcium) [core]
- Cardiothoracic surgical team attendance; theatre / interventional radiology preparation
- Reverse anticoagulation if relevant
- Continuous electrocardiographic, arterial line, and end-tidal carbon dioxide monitoring

References: ATLS 10th edition (current) • EAST Practice Management Guidelines (current) • Australian National Blood Authority Patient Blood Management guidelines • Tintinalli's Emergency Medicine 9e Ch 65

Question 5 | Flail Chest and Pulmonary Contusion (11 marks)

A 65-year-old woman is brought to the emergency department by ambulance after she fell approximately four metres from her roof while clearing leaves. She complains of severe right-sided chest pain that is worse with respiration, and she is unable to take a deep breath. Her medical history includes chronic obstructive pulmonary disease and atrial fibrillation, for which she takes apixaban. On arrival, she is alert, with a respiratory rate of 32 breaths per minute, peripheral oxygen saturation 89 percent on room air rising to 94 percent on 6 litres oxygen via Hudson mask, heart rate 120 beats per minute, blood pressure 130/85 millimetres of mercury. On inspection of her chest, you observe paradoxical movement of a segment of the right anterolateral chest wall.

a) Define flail chest AND state the underlying physiological mechanism of respiratory compromise. (3 marks)

- **Flail chest** = fracture of three or more consecutive ribs in two or more places, creating a free-floating segment of chest wall that moves paradoxically with respiration (inwards on inspiration, outwards on expiration) **[core]**
- **Mechanical instability** impairs respiratory mechanics and increases work of breathing **[core]**
- **Underlying pulmonary contusion** is the principal driver of hypoxaemia — alveolar haemorrhage, oedema, ventilation-perfusion mismatch, and shunt; hypoxia worsens over the first 24-72 hours **[core]**
- Pain restricts deep inspiration and coughing → atelectasis and retained secretions

b) List 4 specific concerns regarding management of this patient given her age and comorbidities. (4 marks)

- **Anticoagulant-related bleeding risk** — apixaban requires reversal (andexanet alfa if available, or 4-factor prothrombin complex concentrate 50 IU/kg) for major bleeding; consider tranexamic acid 1 g intravenous **[core]**
- **Reduced respiratory reserve** from chronic obstructive pulmonary disease — increased risk of respiratory failure and need for mechanical ventilation **[core]**
- **Increased mortality** from rib fractures in older adults — each additional rib fracture increases mortality by ~19 percent in patients over 65 **[core]**
- **Atrial fibrillation rate response** to pain, hypoxia, and stress; consider rate control after volume status assessed **[core]**
- Cumulative radiation dose considerations
- Polypharmacy and potential drug interactions
- Frailty / pre-existing functional status will affect rehabilitation outcomes

c) List 4 components of multimodal analgesia for rib fractures in this patient. (4 marks)

- **Regular paracetamol** 1 g orally every 6 hours (maximum 4 g per 24 hours) **[core]**
- **Patient-controlled intravenous analgesia** with morphine or fentanyl, with bolus and lock-out settings; titrated cautiously to respiratory rate **[core]**
- **Regional anaesthesia** — serratus anterior plane block, erector spinae plane block, or thoracic epidural (consider apixaban cessation and timing) **[core]**
- **Intercostal nerve blocks** with bupivacaine 0.5 percent or ropivacaine — short-term but useful for early relief **[core]**
- Avoid non-steroidal anti-inflammatory drugs given anticoagulant use and renal/cardiac risk in elderly
- Lignocaine intravenous infusion (off-label) — emerging evidence
- Ketamine low-dose intravenous adjunct

References: EAST Practice Management Guidelines (current) • ATLS 10th edition (current) • eTG (Therapeutic Guidelines, current) • Tintinalli's Emergency Medicine 9e Ch 65 • NSW Institute of Trauma & Injury Management (ITIM) guideline

Question 6 | Blunt Traumatic Aortic Injury (11 marks)

A 45-year-old male restrained driver is brought to your tertiary emergency department by helicopter retrieval after being involved in a head-on motor vehicle collision at approximately 100 kilometres per hour. He was extricated from significant vehicle deformity. On arrival, he is conscious with a Glasgow Coma Score of 15 but is complaining of severe interscapular back pain. His heart rate is 110 beats per minute, blood pressure 175/105 millimetres of mercury in the right arm but 140/90 millimetres of mercury in the left arm. The supine chest radiograph shows a widened mediastinum, obscured aortic knob, and depression of the left main bronchus.

a) List 5 chest radiograph features suggesting blunt thoracic aortic injury. (5 marks)

- **Widened mediastinum** (greater than 8 centimetres or greater than 25 percent of transverse chest diameter on supine film at level of aortic knob) [core]
- **Obscured or abnormal aortic knob / aortic outline** [core]
- **Left apical pleural cap** (apical haematoma) [core]
- **Depression of the left main bronchus** below 40° from the horizontal (haematoma displacing inferiorly) [core]
- **Tracheal deviation to the right** (rightward shift due to mediastinal haematoma) [core]
- Deviation of the nasogastric tube to the right
- Left haemothorax
- Sternal or upper rib (1, 2) fractures (high-energy transfer)
- Loss of aortopulmonary window

b) Name the anatomical site of injury most commonly involved AND state the imaging modality of choice. (3 marks)

- **Aortic isthmus** — the segment immediately distal to the origin of the left subclavian artery, where the aorta is tethered by the ligamentum arteriosum and therefore vulnerable to deceleration shearing forces [core]
- **Computed tomography angiography of the chest** with arterial-phase contrast — first-line investigation; sensitivity and specificity greater than 95 percent [core]
- Transoesophageal echocardiography is alternative if computed tomography contraindicated or unavailable; digital subtraction angiography is gold standard but rarely needed for diagnosis

c) State 3 management priorities while awaiting definitive operative or endovascular repair. (3 marks)

- **Anti-impulse therapy** — reduce shear stress on aortic wall: target systolic blood pressure 100-120 millimetres of mercury and heart rate less than 80 beats per minute. First-line: **esmolol** infusion 25-200 micrograms/kg/min OR **labetalol** 10-20 mg intravenous bolus titrated; add nicardipine or glyceryl trinitrate if needed [core]
- **Cardiothoracic / vascular surgical consultation** — definitive treatment is thoracic endovascular aortic repair (TEVAR) in most cases; open repair for select anatomy [core]
- **Monitor for haemodynamic deterioration / free rupture** — arterial line, continuous electrocardiographic, peripheral oxygen saturation, blood pressure both arms; transfer without delay to operating theatre or interventional radiology [core]
- Identify and prioritise concurrent injuries (particularly head injury — opposing target pressures); balance neuroprotection (mean arterial pressure ≥ 80) and aortic protection
- Adequate analgesia (sympathetic surge worsens hypertension)

References: ATLS 10th edition (current) • EAST Practice Management Guidelines (current) • Tintinalli's Emergency Medicine 9e Ch 65 • SVS Practice Guideline

Question 7 | Diaphragmatic Rupture (10 marks)

A 28-year-old male restrained passenger has been brought to your emergency department after a side-impact motor vehicle collision. On arrival he is alert with a Glasgow Coma Score of 15, complaining of left shoulder-tip pain and shortness of breath. His vital signs are: heart rate 110 beats per minute, blood pressure 118/72 millimetres of mercury, respiratory rate 26 breaths per minute, peripheral oxygen saturation 94 percent on room air. On chest auscultation, breath sounds are reduced on the left side and you faintly hear bowel sounds in the left thorax. Chest radiograph shows an irregular elevated left hemidiaphragm with what appears to be a gastric bubble in the left thorax.

a) List 4 chest radiograph features suggesting diaphragmatic rupture. (4 marks)

- Elevated, irregular, or indistinct hemidiaphragm (particularly the left — left side affected in 75-85 percent due to liver protection on the right) **[core]**
- Visible abdominal viscera in the thoracic cavity — gastric or bowel gas pattern, nasogastric tube tip seen above the diaphragm **[core]**
- Mediastinal shift to the contralateral side **[core]**
- Pleural effusion / haemothorax on affected side **[core]**
- Loss of normal diaphragmatic outline
- Abnormal contour of the diaphragm with 'collar sign' on computed tomography (waist-like constriction at the diaphragmatic defect)

b) List 3 reasons that diaphragmatic rupture is often missed in the acute phase. (3 marks)

- Plain chest radiograph sensitivity is low (40-50 percent) — small defects may be missed **[core]**
- Co-existing major injuries (head, abdomen, pelvis) draw attention; symptoms are non-specific **[core]**
- Positive pressure ventilation can mask diaphragmatic elevation by pushing intra-abdominal contents down **[core]**
- Computed tomography may also miss small defects on axial slices — multiplanar reformatting (sagittal, coronal) and explicit search needed
- Delayed presentation — viscera herniate gradually over weeks to years (chronic / late-presenting diaphragmatic hernia)

c) State 3 management principles. (3 marks)

- **Surgical repair** via laparotomy (preferred — allows full assessment of intra-abdominal injury) or laparoscopy / thoracotomy depending on stability and associated injuries; definitive treatment is always operative **[core]**
- **Insert nasogastric tube** to decompress stomach and reduce risk of further intrathoracic visceral expansion; AVOID intercostal catheter insertion blindly on affected side (risk of perforating herniated viscus) **[core]**
- **Investigate for associated injuries** — splenic, gastric, liver, bowel, thoracic; computed tomography of chest, abdomen, pelvis with intravenous contrast **[core]**
- Maintain stable haemodynamics; ventilatory support as needed
- Antibiotic prophylaxis if hollow-viscus involvement suspected

References: EAST Practice Management Guidelines (current) • ATLS 10th edition (current) • Tintinalli's Emergency Medicine 9e Ch 65 • World Society of Emergency Surgery guidelines (current)

Question 8 | Pelvic Fracture — Haemodynamically Unstable (13 marks)

A 22-year-old male motorcyclist is brought to your tertiary emergency department after a high-speed collision with a tree. He is conscious but groaning with severe lower abdominal and pelvic pain. He is tachycardic and hypotensive despite paramedic-administered intravenous crystalloid and one unit of packed red cells. On arrival his heart rate is 140 beats per minute, blood pressure 70 millimetres of mercury systolic, respiratory rate 28 breaths per minute, peripheral oxygen saturation 96 percent on high-flow oxygen. The trauma team has applied a pelvic binder pre-hospital. Pelvic radiograph in the resuscitation bay shows widening of the pubic symphysis with vertical shear of the right hemipelvis. The extended focused assessment with sonography in trauma (extended FAST) is negative for free fluid, and the chest radiograph is unremarkable.

a) List 4 sources of pelvic haemorrhage AND state the predominant vascular source. (4 marks)

- **Venous plexus** (presacral, pre-vesical, lumbar) — the predominant source in 80-85 percent of pelvic bleeds; difficult to control with embolisation alone **[core]**
- **Cancellous bone bleeding** from fracture surfaces (substantial volume from large fragments) **[core]**
- **Arterial** — internal iliac branches (superior gluteal, internal pudendal, lateral sacral) — minority but amenable to embolisation **[core]**
- **External iliac vessels** with shear fractures (less common, more severe) **[core]**
- Visceral bleeding (rectum, bladder, ureter — often coexistent)

b) List 5 management priorities for haemodynamically unstable pelvic fracture. (5 marks)

- **Pelvic binder applied at the level of the greater trochanters** (NOT the iliac crests — common error); reduces volume of pelvic ring, tamponades venous bleeding; combined with internal rotation of the hips with knees tied together **[core]**
- **Activate massive transfusion protocol** with 1:1:1 packed cells : fresh frozen plasma : platelets; tranexamic acid 1 g intravenous bolus then 1 g over 8 hours **[core]**
- **Permissive hypotension** (target systolic blood pressure 80-90 millimetres of mercury) in absence of head injury; balanced fluid / blood rather than crystalloid **[core]**
- **Definitive haemorrhage control**: choice between pre-peritoneal pelvic packing in theatre (rapid, surgical) AND/OR angiographic embolisation (targets arterial bleed); modern algorithms favour combined approach with packing first if in extremis **[core]**
- **Resuscitative endovascular balloon occlusion of the aorta (REBOA) Zone III** — emerging option for in-extremis pelvic haemorrhage as a bridge to definitive control; controversial — use within established protocols only **[core]**
- Identify and exclude other haemorrhage sources — repeat extended FAST, computed tomography if stable enough, rectal/vaginal/urethral examinations
- Trauma orthopaedic surgical involvement for definitive external fixation

c) Compare ADVANTAGES and DISADVANTAGES of operative (packing/external fixation) vs angiographic (embolisation) management — list 1 of each. (4 marks)

- **Operative (pre-peritoneal packing) advantage**: rapid (less than 30 minutes), controls venous bleeding directly which is the predominant source **[core]**
- **Operative disadvantage**: invasive, requires re-operation for pack removal at 24-48 hours, infection risk, less effective for arterial bleeding **[core]**
- **Angiographic (embolisation) advantage**: highly effective for arterial bleeding (success rate 80-100 percent), minimally invasive, selective targeting **[core]**

- **Angiographic disadvantage:** requires interventional radiology availability and time (often 60-90 minutes), ineffective for venous or bony bleeding, contrast nephropathy risk, patient must tolerate the transfer and procedure **[core]**
- Modern algorithms favour combination — packing first if in extremis, then embolisation for ongoing transfusion requirement

References: *World Society of Emergency Surgery guidelines (current) • ATLS 10th edition (current) • EAST Practice Management Guidelines (current) • NSW Institute of Trauma & Injury Management (ITIM) guideline • Australian National Blood Authority Patient Blood Management guidelines*

Question 9 | Bladder and Urethral Injury (10 marks)

A 35-year-old male is brought to your emergency department after a high-speed motor vehicle collision. Examination reveals an unstable pelvic ring fracture, blood at the urethral meatus, scrotal haematoma, and a high-riding prostate on rectal examination. He is complaining of suprapubic pain and an inability to void.

a) List 3 examination findings supporting urethral injury. (3 marks)

- Blood at the urethral meatus **[core]**
- High-riding prostate on rectal examination (complete posterior urethral disruption) **[core]**
- Scrotal / perineal haematoma (butterfly haematoma in anterior urethral injury) **[core]**
- Inability to void or pass urinary catheter
- Penile / perineal swelling and ecchymosis

b) Name the imaging investigation of choice AND describe the procedure. (3 marks)

- **Retrograde urethrogram [core]**
- Insert 18-French Foley catheter just inside the urethral meatus; inflate balloon with 2-3 millilitres saline to occlude; inject 30-50 millilitres of water-soluble contrast (Conray, Omnipaque) under fluoroscopic visualisation **[core]**
- Look for contrast extravasation; partial vs complete disruption (any contrast reaching the bladder = partial) **[core]**
- If urethrogram normal, proceed to gentle catheterisation; subsequent cystogram can assess for bladder injury

c) List 4 management priorities for confirmed urethral disruption. (4 marks)

- **Avoid blind urethral catheterisation** — may convert partial to complete disruption; if necessary for bladder drainage, single gentle attempt by experienced clinician with smaller-calibre catheter, OR proceed directly to suprapubic catheter **[core]**
- **Suprapubic catheter insertion** by urology team (under ultrasound guidance) — definitive bladder drainage in complete posterior urethral disruption **[core]**
- **Urology consultation** — definitive repair (typically delayed primary realignment or open repair) **[core]**
- **Investigate for associated bladder injury** (CT cystogram with retrograde filling) and rectal/vaginal injury (open versus closed pelvic fracture); rectal examination for sphincter tone **[core]**
- Antibiotic prophylaxis (cefazolin) for open pelvic fracture / contaminated injury
- Tetanus update; analgesia; orthopaedic team for pelvic fixation planning

References: World Society of Emergency Surgery guidelines (current) • EAST Practice Management Guidelines (current) • Tintinalli's Emergency Medicine 9e Ch 95 • EAU Urological Trauma

Question 10 | Blunt Splenic Injury (11 marks)

A 28-year-old male is brought to your emergency department after a high-speed motor vehicle collision. He was the restrained driver. He complains of left upper quadrant abdominal pain and left shoulder-tip pain. On primary survey, his airway is patent, breath sounds are equal bilaterally, and his vital signs are: heart rate 105 beats per minute, blood pressure 115/75 millimetres of mercury, respiratory rate 22, peripheral oxygen saturation 98 percent on room air, Glasgow Coma Score 15. The extended FAST examination shows free fluid in the splenorenal recess. Computed tomography of the abdomen with intravenous contrast demonstrates a grade 3 splenic laceration (parenchymal laceration involving trabecular vessels) with moderate haemoperitoneum but no contrast blush.

a) Describe the AAST splenic injury grading scale (grades 1-5). (4 marks)

- **Grade 1:** subcapsular haematoma less than 10 percent surface area, OR capsular tear less than 1 centimetre depth **[core]**
- **Grade 2:** subcapsular haematoma 10-50 percent surface area, OR laceration 1-3 centimetres depth not involving trabecular vessels **[core]**
- **Grade 3:** subcapsular haematoma greater than 50 percent or expanding, ruptured subcapsular haematoma, intraparenchymal haematoma greater than 5 cm, OR laceration greater than 3 cm depth or involving trabecular vessels **[core]**
- **Grade 4:** laceration involving segmental or hilar vessels with major devascularisation (more than 25 percent) **[core]**
- **Grade 5:** shattered spleen OR hilar vascular injury devascularising the entire spleen **[core]**

b) List 4 criteria for non-operative management. (4 marks)

- **Haemodynamically stable** on initial resuscitation with no ongoing transfusion requirement **[core]**
- **No peritonitis** on examination (suggests no associated bowel injury) **[core]**
- **No active extravasation / pseudoaneurysm** on CT (or amenable to angiographic embolisation) **[core]**
- **Appropriate setting** — high-acuity bed with monitoring, surgical and interventional radiology services available, repeat clinical examination **[core]**
- Lower-grade injuries (grade 1-3) more amenable than high-grade (4-5)
- Patient cooperative for ongoing examination (not intoxicated, not heavily sedated)

c) List 3 considerations following splenectomy. (3 marks)

- **Vaccination against encapsulated organisms** — pneumococcus (Prevenar 13 then Pneumovax 23), meningococcus (B and ACWY), Haemophilus influenzae type b; ideally at 2 weeks post-operatively for optimal response, given as soon as practical and again at 5 years for pneumococcus **[core]**
- **Annual influenza vaccination** **[core]**
- **Lifetime prophylactic antibiotics** (amoxicillin 250 mg orally daily) OR education for self-administration of antibiotics with fever — reduces overwhelming post-splenectomy infection (OPSI) **[core]**
- Medic-alert bracelet; carry antibiotic supply when travelling; education on early sepsis recognition
- Australasian Society for Infectious Diseases (ASID) guidelines

References: EAST Practice Management Guidelines (current) • World Society of Emergency Surgery guidelines (current) • ATLS 10th edition (current) • eTG (Therapeutic Guidelines, current) • Tintinalli's Emergency Medicine 9e Ch 79

Question 11 | Blunt Hepatic Injury (11 marks)

A 23-year-old male presents to your emergency department after falling from a first-floor balcony onto concrete. He is intoxicated. He is complaining of isolated abdominal pain. His vital signs on arrival: heart rate 130 beats per minute, blood pressure 80/60 millimetres of mercury, respiratory rate 26, peripheral oxygen saturation 91 percent on room air, Glasgow Coma Score 15. Bedside extended FAST examination demonstrates significant free fluid in Morison's pouch. After resuscitation with one litre of 0.9 percent saline and two units of packed red cells, his blood pressure improves to 105/65. Computed tomography of the abdomen with contrast shows a grade 4 hepatic laceration involving 50 percent of the right lobe with active extravasation, and approximately 1500 millilitres of haemoperitoneum.

a) List 4 'most abnormal' features you would expect to see on this CT. (4 marks)

- **Hepatic parenchymal laceration** (hypodense, irregular linear or stellate defect) involving more than 50 percent of one lobe (grade 4) **[core]**
- **Active contrast extravasation / 'blush'** (focal hyperdense pooling within or beyond the liver) — indicates ongoing arterial haemorrhage **[core]**
- **Large volume haemoperitoneum** (perihepatic, perisplenic, paracolic, pelvic — quantified as moderate to large) **[core]**
- **Subcapsular haematoma** (lenticiform hypodensity beneath Glisson's capsule compressing parenchyma) **[core]**
- Pseudoaneurysm or arteriovenous fistula
- Free intraperitoneal gas (suggests bowel injury)
- Periportal tracking — bile leak

b) List 5 clinical goals you are aiming for whilst awaiting definitive management AND state the intervention to achieve each. (5 marks)

- **Goal: maintain perfusion (mean arterial pressure ≥ 65).** **Action:** balanced 1:1:1 transfusion (packed cells, fresh frozen plasma, platelets); permissive hypotension target systolic 80-90 until source control achieved **[core]**
- **Goal: minimise coagulopathy.** **Action:** tranexamic acid 1 g intravenous bolus then 1 g over 8 hours; balanced product use; aim fibrinogen above 1.5 g/L (replace with cryoprecipitate); calcium replacement (citrate binding from blood products) **[core]**
- **Goal: avoid hypothermia** (worsens coagulopathy). **Action:** warm fluids and blood products via fluid warmer; warm blankets / Bair Hugger; warm ambient temperature; remove wet clothing **[core]**
- **Goal: prevent acidosis.** **Action:** correct hypoperfusion with blood and appropriate vasopressor; avoid excessive crystalloid (hyperchloraemic acidosis); monitor lactate trend **[core]**
- **Goal: definitive haemostasis.** **Action:** angiographic embolisation (most appropriate for hepatic injury with active extravasation in a stable patient) OR operative (perihepatic packing, hepatic artery ligation, resection) **[core]**
- **Goal: prevent abdominal compartment syndrome.** **Action:** monitor intra-abdominal pressure; nasogastric decompression; consider open abdomen if abdominal compartment syndrome develops
- **Goal: identify other injuries.** **Action:** complete trauma series, repeat clinical examination, neurological checks if intoxication clears

c) List 2 indications for emergency operative intervention (laparotomy) over angiographic embolisation. (2 marks)

- Persistent haemodynamic instability despite appropriate resuscitation and ongoing transfusion requirement **[core]**
- Peritonitis or signs of associated hollow-viscus injury, bowel perforation, or diaphragmatic rupture **[core]**
- Failure of angiographic embolisation
- Inaccessibility / unavailability of interventional radiology

References: EAST Practice Management Guidelines (current) • World Society of Emergency Surgery guidelines (current) • ATLS 10th edition (current) • Australian National Blood Authority Patient Blood Management guidelines • Tintinalli's Emergency Medicine 9e Ch 79

Question 12 | Penetrating Abdominal Trauma (11 marks)

A 32-year-old man is brought to your emergency department after sustaining a single stab wound to the left lower abdomen during an altercation. The wound is located in the left iliac fossa, is approximately 3 centimetres in length, and there is some omentum protruding through the wound. He is alert, haemodynamically stable with heart rate 92 beats per minute and blood pressure 128/78 millimetres of mercury, but is complaining of significant abdominal pain with guarding on examination.

a) List 4 indications for immediate laparotomy in penetrating abdominal trauma. (4 marks)

- Haemodynamic instability not responding to initial resuscitation [core]
- Peritonitis on examination (generalised tenderness, guarding, rigidity, rebound) [core]
- Evisceration of abdominal contents (omentum or bowel through the wound) [core]
- Gunshot wound to the abdomen (high incidence of intra-abdominal injury — historical consensus for mandatory exploration; selective non-operative management possible in specialised centres) [core]
- Frank blood from gastric aspirate or rectal examination
- Diaphragmatic injury confirmed
- Free air on imaging

b) List 4 imaging or bedside investigations that may guide management in a haemodynamically stable patient with a stab wound (when laparotomy is not immediately indicated). (4 marks)

- **Local wound exploration** under sterile technique with local anaesthesia — to determine if peritoneum has been violated [core]
- **Computed tomography of the abdomen and pelvis with intravenous and triple-phase contrast** (with rectal contrast for left colon injury) — sensitivity for hollow-viscus and solid-organ injury [core]
- **Diagnostic laparoscopy** — particularly useful for tangential wounds, suspected diaphragmatic injury, equivocal computed tomography findings [core]
- **Serial clinical examination** over 12-24 hours — viable management for low-velocity stab wounds without other indications for laparotomy [core]
- Diagnostic peritoneal aspiration / lavage (largely supplanted by computed tomography)
- Extended focused assessment with sonography (eFAST) — less sensitive for solid organ in penetrating trauma than blunt

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

- **Cover the eviscerated bowel/omentum with moist sterile saline-soaked gauze; do NOT attempt to reduce;** cover with non-adherent dressing [core]
- **Surgical referral and theatre activation** — evisceration is an indication for immediate laparotomy regardless of haemodynamic status [core]
- **Wide-bore intravenous access; bloods including group and crossmatch (4 units), coagulation, lactate; broad-spectrum antibiotics** (cefazolin and metronidazole or per local antibiogram); tetanus update [core]
- Analgesia titrated; anti-emetics; nasogastric tube; indwelling urinary catheter
- Detailed wound description and photography for forensic purposes; police notification per local policy

References: EAST Practice Management Guidelines (current) • ATLS 10th edition (current) • World Society of Emergency Surgery guidelines (current) • eTG (Therapeutic Guidelines, current) • Tintinalli's Emergency Medicine 9e Ch 79

Question 13 | Focused Assessment with Sonography in Trauma (FAST) (10 marks)

A 23-year-old female is brought to your emergency department following a high-speed motor vehicle collision. She has normal vital signs but tenderness in the right upper quadrant abdomen with no peritoneal signs. The secondary survey reveals no other injuries. An abdominal focused assessment with sonography in trauma examination is performed.

a) Outline the role of FAST in haemodynamically stable blunt abdominal trauma. (3 marks)

- **Screening tool for haemoperitoneum** — sensitivity 60-85 percent for free fluid; specificity above 95 percent **[core]**
- **Triage tool** — positive FAST in stable patient prompts computed tomography to characterise injury; negative FAST does NOT exclude injury and should not delay computed tomography if mechanism / clinical concern warrant **[core]**
- **Repeatable and rapid** — bedside, allows serial assessment if patient deteriorates **[core]**
- Minimum amount of free fluid detectable: ~100-250 mL (less in skilled hands)

b) List 4 limitations of FAST in trauma. (4 marks)

- **Operator-dependent** — accuracy varies with credentialling, experience, and image quality **[core]**
- **Misses solid-organ injury without haemoperitoneum** — sub-capsular haematoma, intraparenchymal injury without rupture **[core]**
- **Poor sensitivity for retroperitoneal injury** (kidney, duodenum, pancreas, retroperitoneal vessels) **[core]**
- **Limited in obese patients, large amounts of subcutaneous emphysema, abdominal bowel gas, or post-laparotomy/peritoneal-dialysis patients** **[core]**
- Cannot distinguish blood from other free fluid (ascites, urine, bile)
- Small amount of pelvic free fluid may be physiological in females
- Cannot grade injury or guide non-operative management (needs computed tomography)

c) List 3 advantages AND 3 disadvantages of whole-body computed tomography ('pan scan') in trauma. (3 marks)

- **Advantages:** identifies occult injuries missed on examination (high sensitivity for thoracoabdominal, vascular, spine and retroperitoneal injuries); single examination rather than multiple studies; improves mortality in major trauma per Cochrane review **[core]**
- **Disadvantages:** high radiation dose (15-25 millisieverts versus 7-10 from selective imaging — equivalent to 7-10 years natural background) **[core]**
- **Disadvantages:** contrast load and associated nephropathy / allergic risk; cost; incidentaloma management burden **[core]**
- Selective imaging may be appropriate in lower-energy mechanism, isolated mechanism, or paediatric trauma where radiation concerns dominate

References: ACEP / ACEM ED Ultrasound Guidelines • ATLS 10th edition (current) • EAST Practice Management Guidelines (current) • REACT-2 trial (Lancet 2016)

Question 14 | Damage Control Resuscitation (12 marks)

A 32-year-old male has been involved in a high-speed motor vehicle collision. He is intubated on arrival with severe respiratory distress and obvious chest, abdominal, and pelvic injuries. The pre-hospital team has performed bilateral finger thoracostomies and given two units of packed red cells. His vital signs: heart rate 117 beats per minute, blood pressure 110/60 millimetres of mercury, peripheral oxygen saturation 96 percent on 100 percent inspired oxygen, temperature 35.7 degrees Celsius. Initial venous blood gas: pH 7.18, base excess -8, lactate 4.5 mmol/L, ionised calcium 0.78.

a) Define the 'lethal triad' of trauma AND describe how each component perpetuates the others. (4 marks)

- **Hypothermia** (core temperature less than 35°C) — impairs platelet function and coagulation factor activity **[core]**
- **Acidosis** (pH less than 7.2) — reduces thrombin generation, impairs coagulation, and reduces inotropy; vasopressor responsiveness diminished **[core]**
- **Coagulopathy** — combination of dilution (crystalloid resuscitation), consumption (active bleeding), hypothermia, acidosis, and trauma-induced coagulopathy (TIC) from tissue injury and shock **[core]**
- **Vicious cycle**: each component worsens the others; bleeding worsens shock → acidosis; transfusion of cold blood → hypothermia; dilution and consumption → coagulopathy → ongoing bleeding **[core]**
- More recent literature recognises hypocalcaemia as a fourth component ('lethal diamond')

b) List the 4 principles of damage control resuscitation. (4 marks)

- **Permissive hypotension** — target systolic blood pressure 80-90 millimetres of mercury (higher in head injury — minimum systolic 110); limits dilution and clot disruption **[core]**
- **Haemostatic resuscitation with balanced products (1:1:1)** — packed cells : fresh frozen plasma : platelets in equal ratio; minimise crystalloid (target less than 1 litre in first hour) **[core]**
- **Damage control surgery** — abbreviated operative procedures for haemorrhage and contamination control, deferring definitive repair to physiologically restored patient **[core]**
- **Early use of tranexamic acid** — 1 g intravenous bolus within 3 hours of injury, then 1 g over 8 hours (CRASH-2 evidence — mortality benefit) **[core]**
- Restoration of physiology (warm, normocalcaemic, near-normal pH) before definitive surgery

c) List 4 specific measures to address coagulopathy in this patient. (4 marks)

- Activate massive transfusion protocol with 1:1:1 ratio; aim packed cells, fresh frozen plasma, platelets balanced **[core]**
- **Active warming** — fluid warmer, warm blankets, Bair Hugger, warm ambient room temperature; remove wet clothing **[core]**
- **Calcium replacement** — calcium gluconate 10 percent 10 millilitres intravenous after every 4 units of blood products (citrate binding causes hypocalcaemia) **[core]**
- **Cryoprecipitate or fibrinogen concentrate** if fibrinogen less than 1.5 g/L (use ROTEM/TEG where available) **[core]**
- Tranexamic acid 1 g intravenous (within 3 hours) then 1 g over 8 hours
- Reverse known anticoagulants (vitamin K + 4-factor prothrombin complex concentrate for warfarin; specific agents for direct oral anticoagulants)
- Goal-directed transfusion guided by point-of-care viscoelastic testing (ROTEM, TEG) where available

References: *Damage Control Resuscitation principles (US Joint Trauma System / ATLS)* • *Australian National Blood Authority Patient Blood Management guidelines* • *ATLS 10th edition (current)* • *EAST Practice Management Guidelines (current)* • *CRASH-2 (Lancet 2010)* • *PROPPR trial (JAMA 2015)*

Question 15 | Blunt Renal Trauma (9 marks)

A 26-year-old man is brought to your emergency department after he was thrown from his horse landing on his right flank. He has visible right flank bruising, marked tenderness over the right costovertebral angle, and macroscopic haematuria. His vital signs are stable. Computed tomography shows a grade 4 right renal laceration involving the collecting system with moderate perinephric haematoma, but no contrast extravasation.

a) List 3 indications for surgical exploration in renal trauma. (3 marks)

- Haemodynamic instability attributable to renal haemorrhage [core]
- Expanding or pulsatile peri-renal haematoma discovered at laparotomy [core]
- Renal pedicle (vascular hilar) injury — grade 5 [core]
- Avulsion of the pelvi-ureteric junction
- Penetrating injury with associated organ injury requiring laparotomy

b) List 3 management options for non-operative renal injury. (3 marks)

- Observation with bed rest, serial haemoglobin, serial examination, and repeat imaging at 48-72 hours to assess for haematoma stability [core]
- Angiographic embolisation for active extravasation or pseudoaneurysm [core]
- Ureteric stent or percutaneous nephrostomy for urinary extravasation / urinoma [core]
- Antibiotic prophylaxis if significant urinary leak

c) List 3 complications of renal trauma. (3 marks)

- Delayed haemorrhage / pseudoaneurysm rupture [core]
- Urinoma / urinary fistula formation [core]
- Hypertension (Page kidney — extrinsic compression with renin-angiotensin activation) [core]
- Hydronephrosis / loss of renal function
- Abscess formation
- Chronic kidney disease

References: World Society of Emergency Surgery guidelines (current) • EAST Practice Management Guidelines (current) • Tintinalli's Emergency Medicine 9e Ch 95 • EAU Urological Trauma Guidelines

Question 16 | Hollow Viscus Injury (10 marks)

A 38-year-old woman is brought to your emergency department after a high-speed motor vehicle collision in which she was the restrained driver. Her seatbelt had a transverse abrasion across her abdomen ('seatbelt sign'). On arrival 1 hour post-injury, she is haemodynamically stable but has progressively increasing diffuse abdominal pain. The first computed tomography of abdomen with contrast performed 30 minutes after arrival showed only mesenteric stranding and a small amount of free fluid between bowel loops, but no organ injury. Six hours later she develops generalised peritonism.

a) List 4 computed tomography findings that should raise concern for hollow-viscus or mesenteric injury. (4 marks)

- Free intraperitoneal gas (pneumoperitoneum) — specific but insensitive (less than 50 percent) **[core]**
- Free intra-abdominal fluid without solid-organ injury (suggests bowel perforation or mesenteric bleed) **[core]**
- Mesenteric haematoma, mesenteric stranding, or active extravasation in mesentery **[core]**
- Bowel wall thickening, pneumatosis, abnormal wall enhancement (or non-enhancement = ischaemia) **[core]**
- Discontinuity of bowel wall
- Extraluminal contrast extravasation if oral / rectal contrast given
- Inter-loop fluid

b) Explain why hollow-viscus injury is often missed on early computed tomography. (3 marks)

- Findings evolve over hours — initial scan may show only minimal changes; serial imaging at 8-12 hours improves sensitivity **[core]**
- Sensitivity of first computed tomography for bowel perforation is only 75-85 percent; subtle findings (minimal free fluid, mesenteric stranding) easily overlooked **[core]**
- Low-velocity injuries may not produce immediate transmural disruption — develop delayed perforation as bowel wall ischaemia progresses **[core]**
- Operator / interpreter dependent — multiplanar reformatting required

c) State 3 management priorities for delayed presentation of bowel perforation. (3 marks)

- **Urgent operative laparotomy** for source control — repair / resection of perforation, peritoneal washout **[core]**
- **Broad-spectrum intravenous antibiotics** — piperacillin-tazobactam 4.5 g intravenous every 8 hours, OR ceftriaxone 2 g + metronidazole 500 mg as alternative **[core]**
- **Aggressive resuscitation** per Surviving Sepsis Campaign — 30 millilitres/kg crystalloid in first 3 hours, vasopressors if persistently hypotensive, lactate-guided **[core]**
- Nasogastric decompression; nil by mouth; analgesia and anti-emetics
- Tetanus update if breach of skin
- Intensive care admission post-operatively

References: EAST Practice Management Guidelines (current) • World Society of Emergency Surgery guidelines (current) • eTG (Therapeutic Guidelines, current) • ATLS 10th edition (current) • Tintinalli's Emergency Medicine 9e Ch 79

Question 17 | Tracheobronchial Injury (10 marks)

A 35-year-old man is brought to your emergency department after a high-energy chest crush injury when a metal beam fell across his anterior chest. He arrives intubated by paramedics and on positive pressure ventilation. Despite an apparently well-positioned endotracheal tube, he has a continuous large air leak from his right intercostal catheter, and his peripheral oxygen saturation remains at 89 percent on 100 percent inspired oxygen. There is significant subcutaneous emphysema extending from his neck to his lower abdomen.

a) List 4 clinical or radiological features suggesting major tracheobronchial injury. (4 marks)

- **Persistent large air leak through intercostal catheter** despite adequate drainage / suction **[core]**
- **Massive subcutaneous emphysema** (neck/face/chest/abdomen) **[core]**
- **Pneumomediastinum** on chest radiograph or computed tomography **[core]**
- **'Fallen lung' sign** — collapsed lung drops away from the hilum (typically inferiorly and laterally) **[core]**
- Dyspnoea, haemoptysis, hoarseness, voice change
- Pneumothorax that fails to re-expand with adequate drainage
- Endotracheal tube cuff visible adjacent to bronchus on imaging

b) Name the diagnostic investigation of choice AND state what it should evaluate. (3 marks)

- **Flexible bronchoscopy** — direct visualisation of trachea and bronchi **[core]**
- Identifies site, size, and extent of injury; allows guided positioning of endotracheal tube distal to the injury (single-lung ventilation if needed) **[core]**
- Allows tissue assessment for primary repair vs resection; coordinates surgical approach **[core]**
- Computed tomography of chest with thin slices is complementary but bronchoscopy is gold standard

c) List 3 ventilation modifications for management. (3 marks)

- **Reduce tidal volume and peak inspiratory pressure** — keep tidal volume 4-6 millilitres/kg ideal body weight; minimise positive end-expiratory pressure to reduce ongoing air leak **[core]**
- **Position endotracheal tube past the injury if possible** — bronchoscopic guidance; consider single-lung ventilation with double-lumen tube or selective bronchial intubation **[core]**
- **Permissive hypercapnia** may be required to limit mechanical injury; high-frequency ventilation or extracorporeal membrane oxygenation in severe cases as a bridge to surgical repair **[core]**
- Spontaneous ventilation (avoiding paralysis) preferred where possible — reduces air leak

References: EAST Practice Management Guidelines (current) • ATLS 10th edition (current) • Tintinalli's Emergency Medicine 9e Ch 65 • STS Guidelines

Question 18 | Blunt Cardiac Injury (10 marks)

A 45-year-old male restrained driver was involved in a head-on motor vehicle collision. He arrives with anterior chest wall bruising in a pattern consistent with steering-wheel impact. Despite adequate volume resuscitation, he remains hypotensive (blood pressure 95/60 millimetres of mercury), tachycardic at 110 beats per minute, and has new-onset atrial fibrillation on his electrocardiogram. His chest radiograph and extended FAST for haemothorax/pneumothorax/tamponade are unremarkable. Troponin is 0.45 (normal less than 0.04).

a) List 4 manifestations of blunt cardiac injury. (4 marks)

- Cardiac arrhythmias — sinus tachycardia, atrial fibrillation, ectopy, ventricular tachycardia / fibrillation, conduction blocks **[core]**
- Myocardial contusion — wall motion abnormalities on echocardiography, raised troponin **[core]**
- Cardiac failure / cardiogenic shock from myocardial dysfunction **[core]**
- Valve disruption — most commonly aortic or mitral valve leaflet rupture or papillary muscle injury **[core]**
- Cardiac chamber rupture (often fatal pre-hospital — right atrium most common)
- Septal defects
- Coronary artery dissection / occlusion
- Pericardial effusion / tamponade

b) List 3 investigations to assess blunt cardiac injury. (3 marks)

- **12-lead electrocardiogram** — initial and serial; ST changes, arrhythmia, conduction block **[core]**
- **Troponin** (high-sensitivity) — initial and 6-hour repeat; raised in blunt cardiac injury but not specific for prognosis **[core]**
- **Transthoracic echocardiography** — wall motion, valvular function, pericardial effusion, ejection fraction; transoesophageal if poor windows **[core]**
- Cardiac magnetic resonance imaging if subacute / delayed assessment
- Cardiac catheterisation if coronary injury suspected

c) State 3 management priorities. (3 marks)

- **Continuous telemetry / monitored bed** for minimum 24 hours; arrhythmia management as per standard protocols (rate / rhythm control for atrial fibrillation; advanced cardiac life support for malignant arrhythmias) **[core]**
- **Cardiology consultation** — particularly if echocardiography abnormal, raised troponin, or arrhythmia present **[core]**
- **Optimise haemodynamics** — judicious fluid given myocardial dysfunction (avoid overload); inotropic support (dobutamine) if cardiogenic shock from contusion **[core]**
- Investigate and treat associated injuries — chest wall, vascular, sternal fracture
- Anticoagulation considerations for new atrial fibrillation

References: EAST Practice Management Guidelines (current) • ATLS 10th edition (current) • Tintinalli's Emergency Medicine 9e Ch 65

Question 19 | Paediatric Thoracoabdominal Trauma (10 marks)

A 7-year-old girl (estimated weight 22 kilograms) was a restrained passenger in a moderate-speed motor vehicle collision. She is brought to your tertiary emergency department complaining of right upper quadrant abdominal pain. Her vital signs are: heart rate 130 beats per minute, blood pressure 90/55 millimetres of mercury, respiratory rate 28 breaths per minute, peripheral oxygen saturation 99 percent on room air. Computed tomography shows a grade 2 hepatic laceration with small haemoperitoneum.

a) List 4 anatomical and physiological differences in paediatric trauma compared to adults. (4 marks)

- **Larger ratio of body surface area to mass** — rapid heat loss; hypothermia risk **[core]**
- **Smaller, more compliant skeleton** with greater elasticity — energy transferred to underlying organs without overlying fractures (pulmonary contusion without rib fractures, internal injuries without external evidence) **[core]**
- **Solid organs proportionally larger** (liver, spleen, kidneys) and less protected by ribs and abdominal musculature **[core]**
- **Greater physiological reserve** — children maintain blood pressure until ~30 percent blood volume loss, then decompensate rapidly; tachycardia is the principal early indicator **[core]**
- Higher metabolic rate and oxygen demand → hypoxia develops more rapidly
- Difficult vascular access — intraosseous access is first-line if intravenous fails
- Disproportionately large head — TBI is the leading cause of paediatric trauma death

b) Calculate this child's resuscitation parameters: fluid bolus volume, blood transfusion volume, and tranexamic acid dose. (3 marks)

- **Crystalloid fluid bolus:** 20 millilitres/kg = **440 mL** 0.9 percent saline (or balanced crystalloid) **[core]**
- **Packed red cell transfusion:** 10 millilitres/kg = **220 mL**; consider 1:1:1 balanced ratio in massive transfusion **[core]**
- **Tranexamic acid:** 15 milligrams/kg = **330 mg** intravenous bolus, then 2 mg/kg/h infusion (or 30 mg/kg single dose per CRASH-3 for paediatric TBI) **[core]**
- Maintenance fluid (4/2/1 rule): 4 mL/kg first 10 kg + 2 mL/kg next 10 kg + 1 mL/kg/h thereafter = 62 mL/h

c) State 3 considerations specific to paediatric non-operative management of solid-organ injury. (3 marks)

- **Higher success rate** than adults for non-operative management — solid-organ preservation is preferred where possible **[core]**
- **Bed rest duration** typically grade plus 1 days (e.g. grade 2 = 3 days bed rest); shorter activity restrictions than historical guidelines **[core]**
- **Splenic preservation** particularly important — overwhelming post-splenectomy infection risk significant in paediatrics **[core]**
- Family / carer support and clear discharge advice for delayed bleed warning signs
- Paediatric trauma centre referral for major injury

References: APLS — Advanced Paediatric Life Support • RCH Trauma Guidelines • EAST Practice Management Guidelines (current) • ATLS 10th edition (current)

Question 20 | Major Trauma in Pregnancy (11 marks)

A 28-year-old woman at 30 weeks gestation has been brought to your tertiary emergency department by ambulance after a high-speed motor vehicle collision. She was the restrained driver and the airbag deployed. She is conscious with a Glasgow Coma Score of 15 but is reporting severe abdominal pain and a small amount of vaginal bleeding. Her vital signs: heart rate 120 beats per minute, blood pressure 100/80 millimetres of mercury, respiratory rate 24 breaths per minute, peripheral oxygen saturation 95 percent on room air, temperature 37.0 degrees Celsius. Examination reveals a tense, tender uterus and a transverse seatbelt mark across her gravid abdomen.

a) List 4 management priorities specific to trauma in pregnancy. (4 marks)

- **Manual left uterine displacement** (displace gravid uterus to left of midline) OR **15-30° left lateral tilt** on rigid spine board to relieve aortocaval compression — compression by gravid uterus reduces venous return and cardiac output **[core]**
- **Maternal resuscitation takes precedence** — best initial treatment for the fetus is optimal maternal resuscitation; high-flow oxygen, fluid resuscitation, blood transfusion as needed **[core]**
- **Obstetric and neonatal team early engagement**; continuous cardiotocographic monitoring (minimum 4 hours, longer if any concerning features); ultrasound for fetal wellbeing **[core]**
- **Anti-D 625 IU intramuscular** if maternal Rh-negative (within 72 hours of trauma); Kleihauer-Betke testing to quantify fetomaternal haemorrhage and guide additional anti-D dosing **[core]**
- Continue with standard trauma assessment and management — do not deny imaging or contrast based on pregnancy if clinically required
- Identify and treat shock — pregnant women maintain blood pressure until ~30 percent loss

b) List 4 examination findings supporting placental abruption. (4 marks)

- Vaginal bleeding (although blood may be concealed in 20-35 percent of cases — absence does NOT exclude abruption) **[core]**
- Tense, tender, irritable uterus ('woody' uterus) with frequent contractions or increased baseline tone **[core]**
- Cardiotocographic abnormalities — frequent uterine contractions, late decelerations, fetal bradycardia, loss of variability **[core]**
- Disseminated intravascular coagulation features out of proportion to apparent blood loss (thromboplastin release from disrupted placenta) **[core]**
- Maternal hypotension / shock disproportionate to visible loss
- Fetal demise on ultrasound or absent fetal heart sounds

c) List 3 indications for emergency / perimortem Caesarean delivery in the trauma setting. (3 marks)

- **Maternal cardiac arrest with no return of spontaneous circulation by 4 minutes** AND fundal height at or above the umbilicus (~20 weeks gestation) — aim delivery by 5 minutes to relieve aortocaval compression and improve maternal resuscitation **[core]**
- **Fetal distress with maternal stability and viable gestation** (≥24 weeks) — emergency Caesarean by obstetric team **[core]**
- **Significant placental abruption with fetal compromise** — operative delivery if viable; vaginal delivery if controlled **[core]**
- Severe maternal trauma with deteriorating physiology where uterine evacuation aids resuscitation

References: ATLS 10th edition (current) • RANZCOG Statement (current) • NSW Institute of Trauma & Injury Management (ITIM) guideline • Tintinalli's Emergency Medicine 9e Ch 254

Question 21 | Abdominal Compartment Syndrome (10 marks)

A 42-year-old man, day 1 post-emergency damage-control laparotomy with abdominal packing for severe intra-abdominal haemorrhage, has been transferred to your intensive care unit. Despite ongoing resuscitation his haemodynamic status is deteriorating. Over the past 4 hours his urine output has dropped to less than 20 millilitres per hour, peak airway pressures have risen from 28 to 42 centimetres of water, his abdomen is tense and distended, and his bladder pressure (intra-abdominal pressure) is measured at 24 millimetres of mercury.

a) Define abdominal compartment syndrome AND state the diagnostic threshold. (3 marks)

- **Abdominal compartment syndrome** = sustained intra-abdominal pressure greater than 20 millimetres of mercury (with or without abdominal perfusion pressure less than 60 millimetres of mercury) **AND** new organ dysfunction or failure **[core]**
- **Intra-abdominal hypertension** = sustained intra-abdominal pressure greater than 12 millimetres of mercury (graded I-IV by severity) **[core]**
- Measured via bladder pressure with patient supine, 25 millilitres saline instilled, end-expiration, no abdominal contractions **[core]**

b) List 4 organ-system manifestations. (4 marks)

- **Renal:** oliguria, acute kidney injury (reduced renal perfusion + venous congestion) **[core]**
- **Respiratory:** rising peak inspiratory pressures, hypercapnia, hypoxia (diaphragm splinting, reduced functional residual capacity, ventilation-perfusion mismatch) **[core]**
- **Cardiovascular:** reduced venous return → low cardiac output, hypotension; elevated central venous pressure (interpretation challenging) **[core]**
- **Gastrointestinal / hepatic:** reduced splanchnic perfusion → bowel ischaemia, translocation; hepatic dysfunction **[core]**
- Neurological: raised intracranial pressure
- Abdominal wall ischaemia

c) List 3 management options. (3 marks)

- **Decompressive laparotomy** — definitive treatment; leave abdomen open (negative-pressure wound dressing, ABTHERA, or vacuum pack) until compartment syndrome resolved and physiology restored **[core]**
- **Medical management** — gastric and rectal decompression; deep sedation and neuromuscular blockade; reverse fluid overload with diuretics or renal replacement therapy; drainage of ascites if present **[core]**
- **Optimise abdominal perfusion pressure** (target greater than 60 millimetres of mercury) with vasopressors and balanced fluid management **[core]**
- Avoid prone positioning; minimise crystalloid resuscitation (refractory abdominal compartment syndrome often driven by fluid overload)

References: World Society for Abdominal Compartment Syndrome (current) • EAST Practice Management Guidelines (current) • ATLS 10th edition (current) • Tintinalli's Emergency Medicine 9e Ch 79

Question 22 | Mass Casualty Field Triage (10 marks)

You are the duty trauma director. Pre-hospital control informs you that a multi-vehicle pile-up on the freeway has produced 8 confirmed casualties. The first three are arriving at your emergency department in 10 minutes: Patient A: A 35-year-old female with a bilateral femur fracture and pelvic fracture; conscious; heart rate 130 beats per minute; blood pressure 80/50. Patient B: A 48-year-old male with an obvious flail chest; respiratory rate 38; peripheral oxygen saturation 86 percent. Patient C: An 18-year-old male with isolated wrist fracture; vitals normal.

a) Assign field triage category (red / yellow / green / black) to each patient AND justify briefly. (4 marks)

- **Patient A — RED (immediate, life-threatening, salvageable)** — haemorrhagic shock with pelvic and bilateral femur fractures; requires immediate haemorrhage control **[core]**
- **Patient B — RED (immediate)** — flail chest with hypoxia and respiratory failure; immediate intervention required **[core]**
- **Patient C — GREEN (minor / walking wounded)** — isolated peripheral injury, vitals stable, can wait for definitive treatment **[core]**
- **Yellow (delayed)**: not life-threatening but requires medical care within hours
- **Black (expectant / deceased)**: deceased or unsalvageable injuries given available resources

b) List 3 ED preparation actions on receiving the pre-hospital notification. (3 marks)

- Activate hospital mass-casualty / disaster plan; designate incident commander, treatment areas (red, yellow, green, black), and leadership for each **[core]**
- Mobilise resources — staff recall, blood bank for massive transfusion protocol, theatre, intensive care unit, radiology, blood products; create surge capacity by discharging or transferring stable patients **[core]**
- Notify and coordinate with regional retrieval service, neighbouring hospitals (load balancing), police, hospital security, family-information area **[core]**
- Prepare equipment — additional intravenous lines, trauma packs, intercostal catheters, FAST machines
- Triage area at emergency department entry; tagged documentation

c) State the principles of mass-casualty triage that differ from routine emergency department care. (3 marks)

- **Greatest good for greatest number** — resources allocated to those with greatest chance of meaningful survival; opposite of routine ED where most-unwell-first applies **[core]**
- **Triage is dynamic and iterative** — re-triage as physiology changes and as more victims arrive; categories may shift **[core]**
- **Brief assessment** — typically less than 60 seconds per patient using START / SALT or similar systems based on respiration, perfusion, and mental status **[core]**
- Black (expectant) category may include patients who would receive maximal effort in routine practice (e.g. asystole) — context-dependent
- Documentation simplified — triage tags, abbreviated records
- Senior leadership essential to maintain ethical and operational consistency

References: ACEM clinical policies and statements • ATLS 10th edition (current) • NSW Institute of Trauma & Injury Management (ITIM) guideline • AIIMS / EMA / ACEM Major Incident Plans