Reversible Causes of Cardiac Arrest

The Hs and Ts

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Cardiac arrest

- Cardiac arrest is a sudden cessation of cardiac output
  - Loss of consciousness, plus any of:
    - Apnoea/agonal respirations
    - Non-palpable pulse

1. CPR
2. Rhythm and pulse check
3. Defibrillation
4. Resuscitation medications

- Simultaneously evaluating reversible causes of arrest – H's and T's

Reversible causes of cardiac arrest

- 4 H's and 4 T's

H_____

H_____

H_____

H_____

T_____ _____

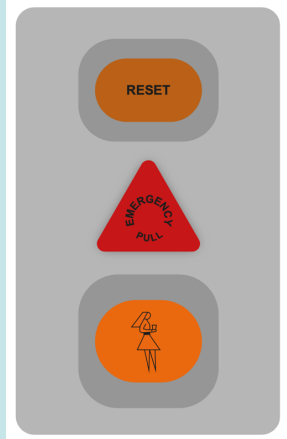
T_____

T_____

T_____

Case 1

- 34 year old female admitted to ED with acute severe asthma exacerbation, so far refractory to ambulance treatment.
- She becomes bradycardic, the wheezing quietens then stops. O2 sats are 'undetectable'
- The patient has gone into cardiac arrest
- Why?



Hypoxia

- Causes:
  - A – Airway obstruction – foreign body, aspiration, anaphylaxis, epiglottitis, retropharyngeal abscess
  - B – Asthma, COPD, pneumonia
  - C – Severe anaemia, CO poisoning
  - D – Neurological damage → respiratory depression
  - E - High altitudes (low FiO2)

Hypoxia

Recognition

- Signs of hypoxia:
  - Low oxygen saturation
  - Cyanosis of the skin or mucous membranes
  - Tachypnoea (prior to arrest)
  - Altered mental status (prior to arrest)
  - History of respiratory disease or exposure to CO
  - ABG – low pO2, high lactate
- Respiratory distress → ?peri-arrest

Treatment

- CPR, 2222, defib, drugs etc
- Provide supplemental oxygen - 15L/min via bag-valve mask/ventilator
- HTCL, OPA/NPA, iGel, ETT
- Identifying and treat the underlying cause
  - Intubation and mechanical ventilation if required
  - Pneumonia - sepsis screen and IV antibiotics
  - CO poisoning - secure airway and give 100% high-flow oxygen

Reversible causes of cardiac arrest

- 4 H's and 4 T's

Hypoxia
H_____
H_____
H_____

T_____ _____
T_____
T_____
T_____

Case 2

- A middle-aged homeless man was found unconscious on the grass in a local park by a member of the public. When the ambulance arrived he was bradycardic, bradypnoeic, GCS 3/15 and appeared cyanotic.
- The paramedics get him on the back of the ambulance, but he goes into asystole.
- Why?

Hypothermia

- Causes:
  - E – being really cold! Cold water. Cold weather
  - Hypothermia = <35°C
    - Primary – cold exposure
    - Secondary – conditions affecting temperature regulation – burns, surgery, sepsis, hypothyroidism

- Risk factors – children and the elderly, drug/alcohol use, dementia, homelessness/poor quality housing

Hypothermia

Recognition

- Low core temperature
- Cyanosis
- Bradycardia (initially tachycardic)
- Bradypnoea (initially tachypnoeic)
- Altered mental status
- Shivering (stops as hypothermia gets worse)
- Rigidity (pseudo-rigor mortis)
- History of cold exposure

Treatment

You're not dead until your warm and dead!

- Remove wet clothing
- Core temperature monitoring
- External rewarming
- Internal rewarming
- Extra-corporeal rewarming - haemodialysis or Extra-Corporeal Membrane Oxygenation (ECMO)

Hypothermia

- Swiss staging system
  - Hypothermia I – mild hypothermia (conscious, shivering, core temperature 32–35◦C)
  - Hypothermia II – moderate hypothermia (impaired consciousness without shivering, core temperature 28–32◦C)
  - Hypothermia III – severe hypothermia (unconscious, vital signs present, core temperature 24–28◦C)
  - Hypothermia IV – cardiac arrest or low flow state (no or minimal vital signs, core temperature <24◦C)
  - Hypothermia V – death due to irreversible hypothermia (core temperature <13.7◦C)

Reversible causes of cardiac arrest

- 4 H's and 4 T's

Hypoxia
Hypothermia
H_____
H_____

T_____ _____
T_____
T_____
T_____

Case 3

- A 66-year-old male presented with sudden-onset sharp central back pain. The pain was stabbing in nature, severe 9/10, had started suddenly around 30 mins ago and has been constant since. Associated with nausea, sweating and feeling faint.
- PMH – hypertension (amlodipine). Ex-smoker.
- Patient appears pale and clammy, very tender to palpation over the epigastrium. BP 88/52. Tachycardic.
- Goes into PEA in ED resus

Hypovolaemia

- Causes:
  - Vascular – AAA (?rupture), GI bleed etc
  - Infection – severe diarrhoea/vomiting, ‘third-spacing’ in sepsis
  - Trauma – amputation, burns, internal bleeding
  - Metabolic - DKA
  - Iatrogenic - surgery

Hypovolaemia

Recognition

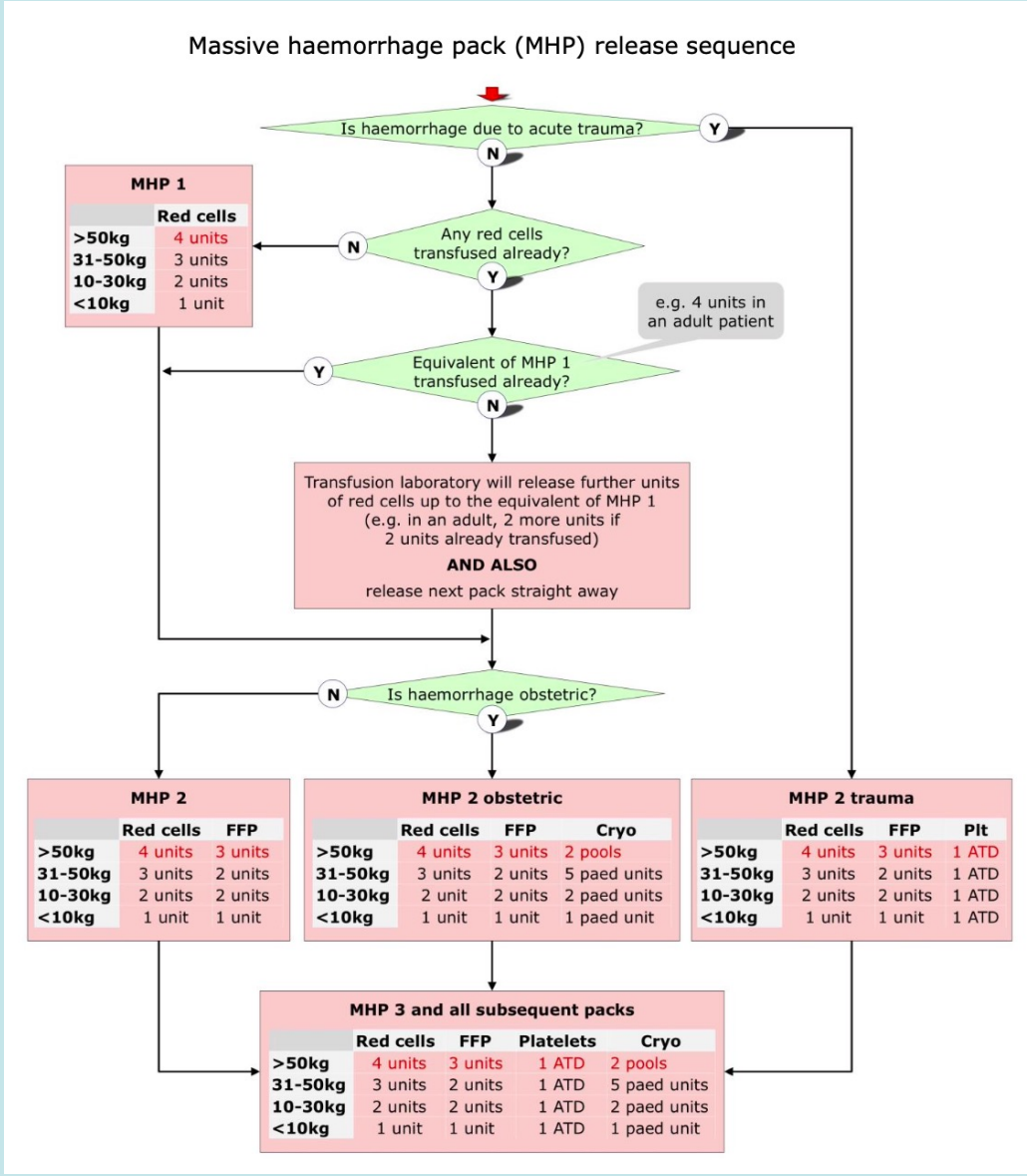
- Low blood pressure
- Tachycardia (compensation prior to arrest)
- Decreased urine output
- Signs of dehydration
- Active bleeding
- History of recent blood loss, vomiting diarrhoea etc
- Use of anticoagulants

Treatment

- For all causes - fluid resuscitation with IV crystalloid to restore circulating volume
- For refractory hypovolaemia - blood products
- For haemorrhage - give packed red cells from the start
- Antifibrinolytic agents (e.g. tranexamic acid) to stabilise blood clotting
- Vasopressors and inotropes can be given to increase the blood pressure
- Treat the cause!
  - E.g. vascular surgery for AAA

Hypovolaemia

- Activate massive haemorrhage protocol if relevant:
  - Loss of more than one blood volume in 24 hours
  - Loss of 50% total blood volume in less than 3 hours
  - Bleeding in excess of 150ml/min
  - Any bleeding which results in a systolic BP <90mm/Hg or a heart rate >110 bpm
- Emergency O- blood is available from various locations



Reversible causes of cardiac arrest

- 4 H's and 4 T's

Hypoxia	T_____ _____
Hypothermia	T_____
Hypovolaemia	T_____
H_____	T_____

Case 4

- An 84 year old female on the cardiac ward was placed on a furosemide infusion ~ 1hour ago for acute pulmonary oedema. She has a PMH of AKI.
- The FY1 comes to see you as they're concerned about her ECG. While you're having the conversation she goes into VF cardiac arrest.
- Why?

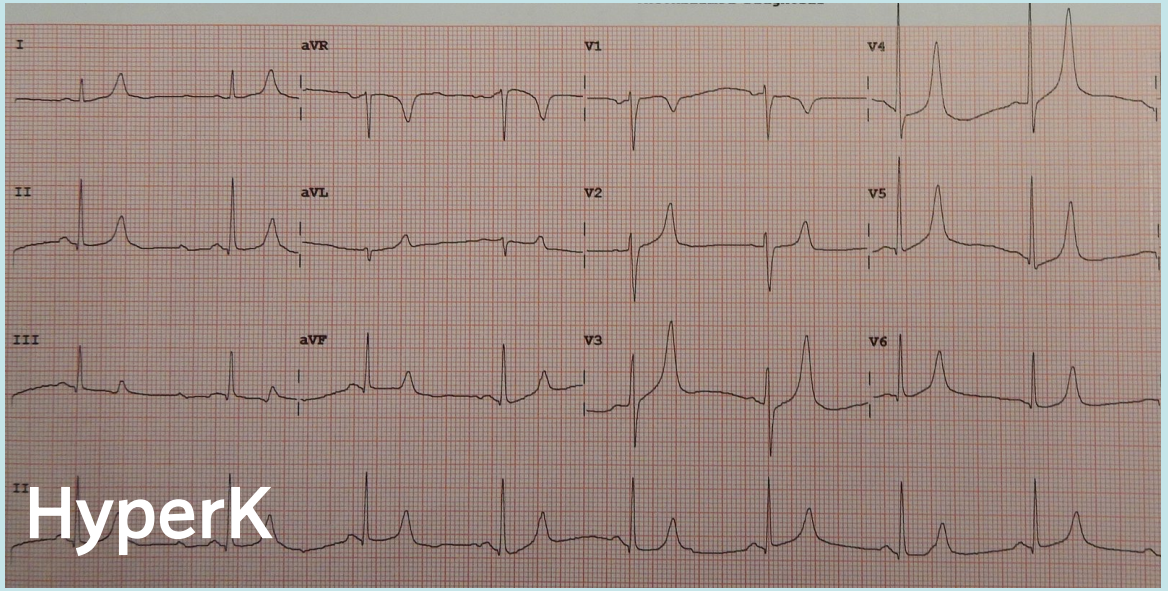
Hypo/Hyper-kalaemia

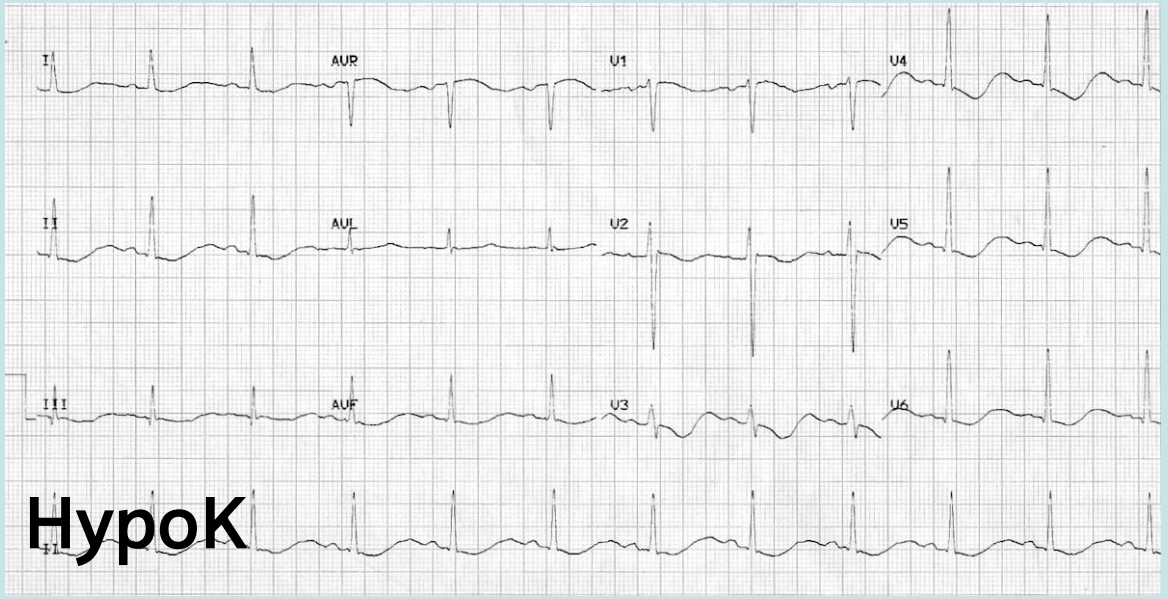
- **Hypokalaemia** - K+ less than 3.5 mEq/L
- **Hyperkalaemia** - K+ greater than 5 mEq/L
- Causes:
  - **HypoK** – diuretics, alkalosis, D+V, AKI/CKD, insulin infusions, dietary deficiency
  - **HyperK** - K+ sparing diuretics, acidosis, ACEi/ARBs, Digoxin, diabetes, rhabdomyolysis, high intake

Hypo/Hyper-kalaemia

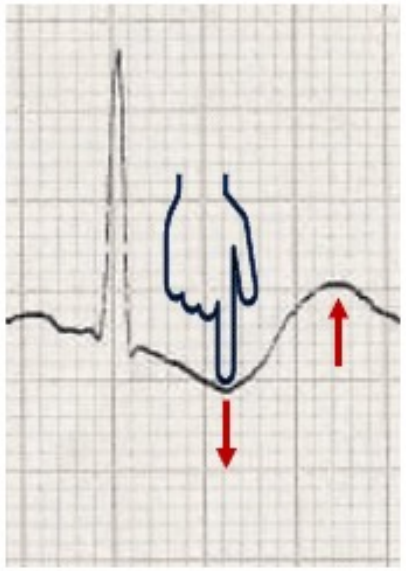
Recognition

- ECG changes!
- Muscle weakness or paralysis
- Decreased deep tendon reflexes
- Nausea and vomiting
- Confusion
- Abnormal glucose
- History of kidney disease, certain medications, or nutritional deficiencies



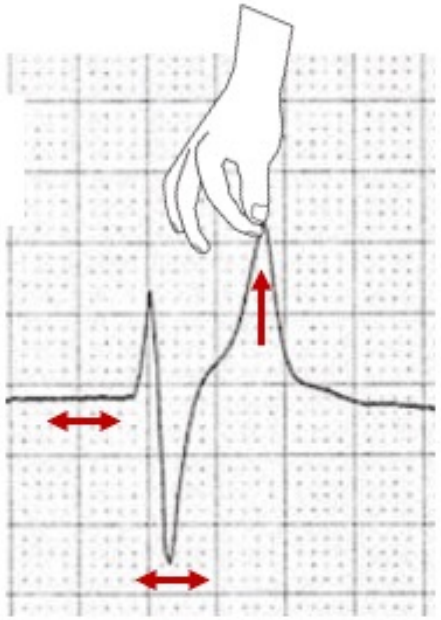


Hypo/Hyper-kalaemia



Hypokalaemia

T wave inversion
ST depression
Prominent U wave



Hyperkalaemia

Peaked T waves
P wave flattening
PR prolongation
Wide QRS complex

LIFE IN THE FASTLANE

L.W.E.M.S.
LEICESTER WILDERNESS AND EMERGENCY MEDICINE SOCIETY

Hypo/Hyper-kalaemia

Treatment

- Treat the underlying cause – medications, D+V etc
- HypoK
  - K+ repletion with IV fluids
  - Continuous cardiac monitoring
- HyperK
  - Stabilise the cardiac membrane - IV calcium gluconate (30ml of 10% solution)
  - Short-acting insulin with dextrose (IV 10 units of Actrapid in 50mls of 50% dextrose over 15 mins)
  - SABAs
  - Haemodialysis

Reversible causes of cardiac arrest

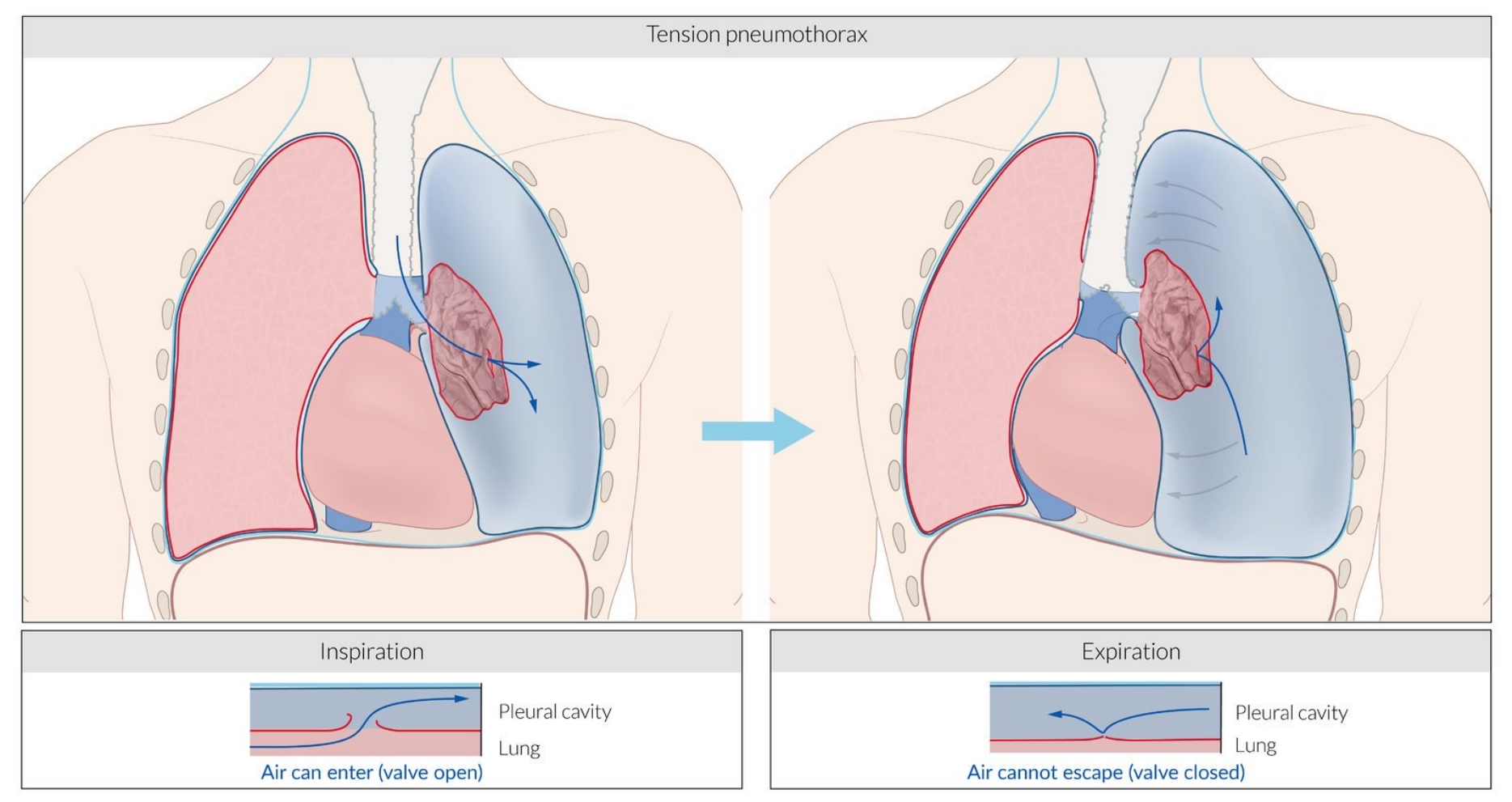
- 4 H's and 4 T's

Hypoxia	T_____ _____
Hypothermia	T_____
Hypovolaemia	T_____
Hypo/hyper-kalaemia	T_____

Case 5

- 21 year old male brought in by ambulance after being stabbed in the right side of his chest. The knife is not in situ.
- In transit he has become progressively hypotensive, tachycardic and short of breath.
- He goes into cardiac arrest shortly after arrival in ED.
- Why?

Tension pneumothorax



Tension pneumothorax

- Causes:
  - Pulmonary TB, Pneumocystis pneumonia
  - Blunt force or penetrating trauma
  - Subpleural blebs, COPD bullae
  - Mechanical ventilation, bronchoscopy, lung biopsy
  - Lung malignancy
  - Cystic Fibrosis, Marfan's

Tension pneumothorax

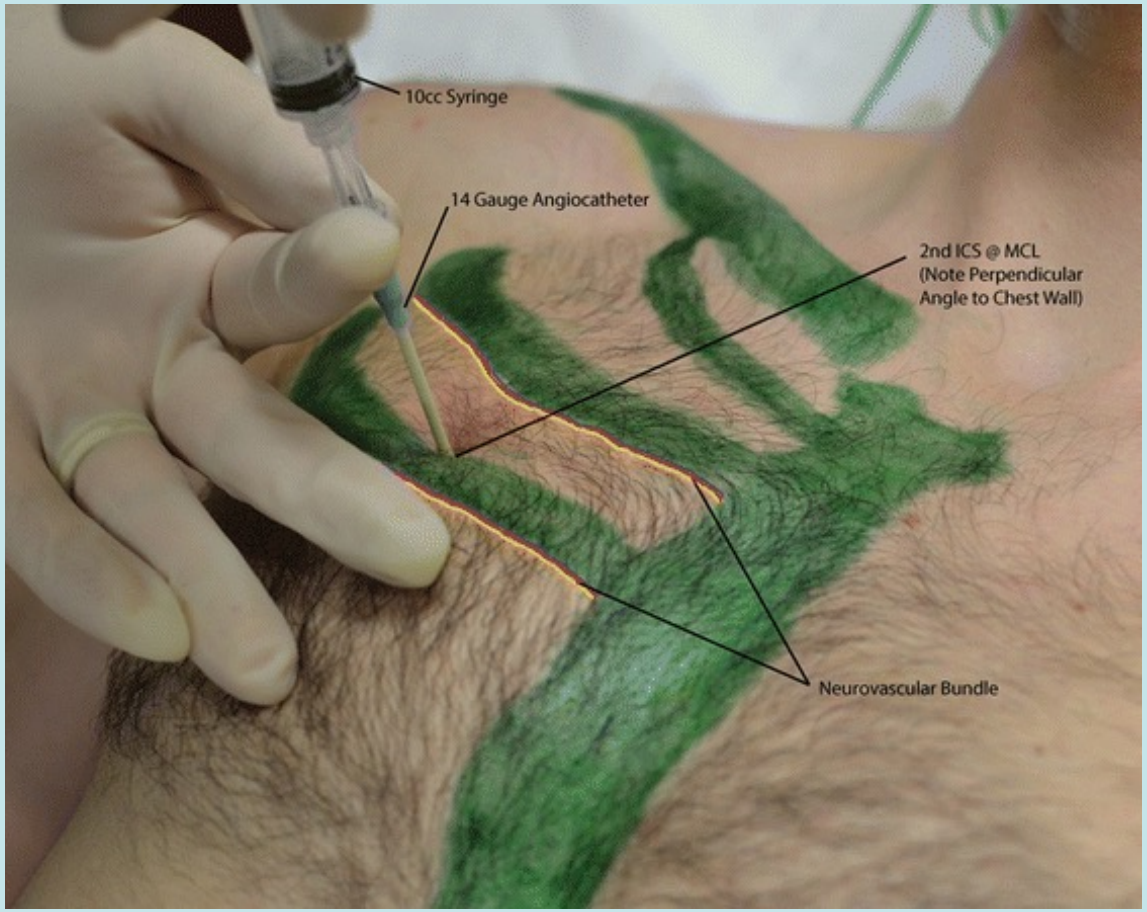
Recognition

- Low blood pressure
- Tachycardia
- Low oxygen saturation
- Dyspnoea
- Pleuritic chest pain
- Asymmetrical chest expansion
- Hyper-resonance to percussion
- Reduced/absent breath sounds
- Tracheal deviation away from affected side

Treatment

Clinical diagnosis – do not delay management for investigations

- Put out an immediate cardiac arrest call
- Give high-flow oxygen
- Perform emergency needle decompression. Insert a chest drain following this.



Reversible causes of cardiac arrest

- 4 H's and 4 T's

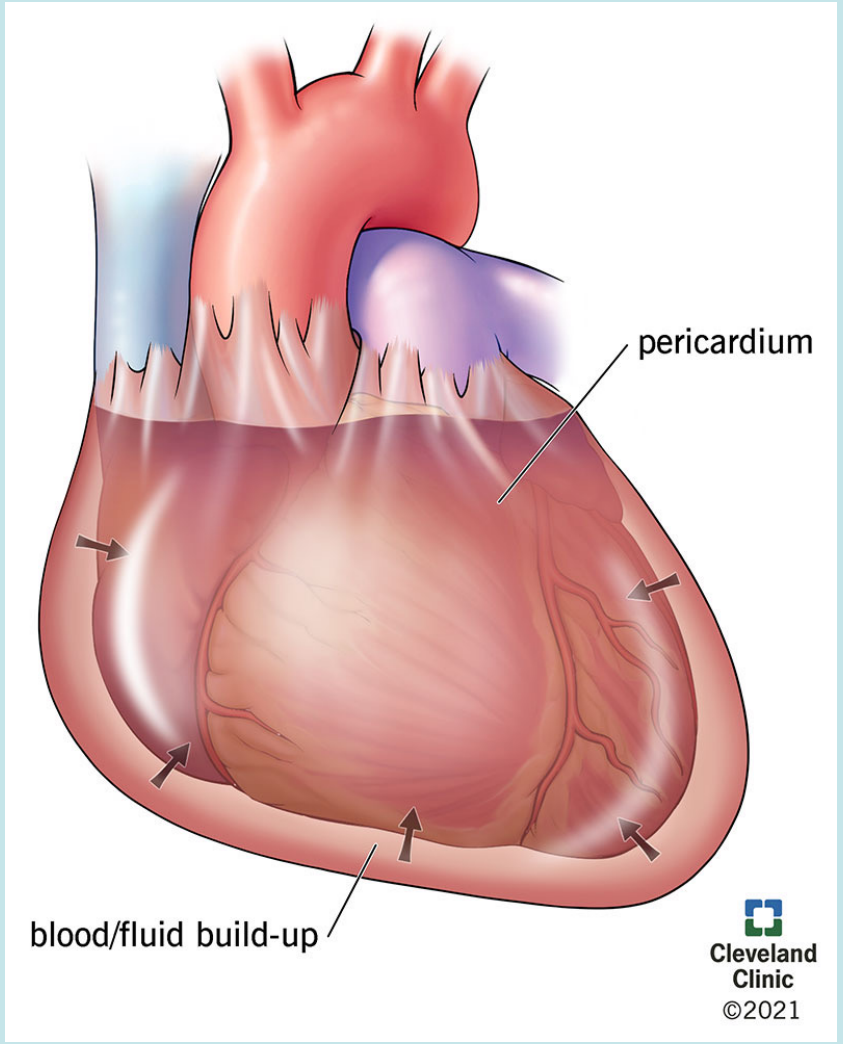
Hypoxia	Tension pneumothorax
Hypothermia	T_____
Hypovolaemia	T_____
Hypo/hyper-kalaemia	T_____

Case 6

- A 68 year old female is recovering post-MI on the cardiac ward.
- She develops hypotension and tachycardia. On examination she has distended neck veins and faint heart sounds.
- She goes into PEA cardiac arrest on the ward.
- Why?

Cardiac Tamponade

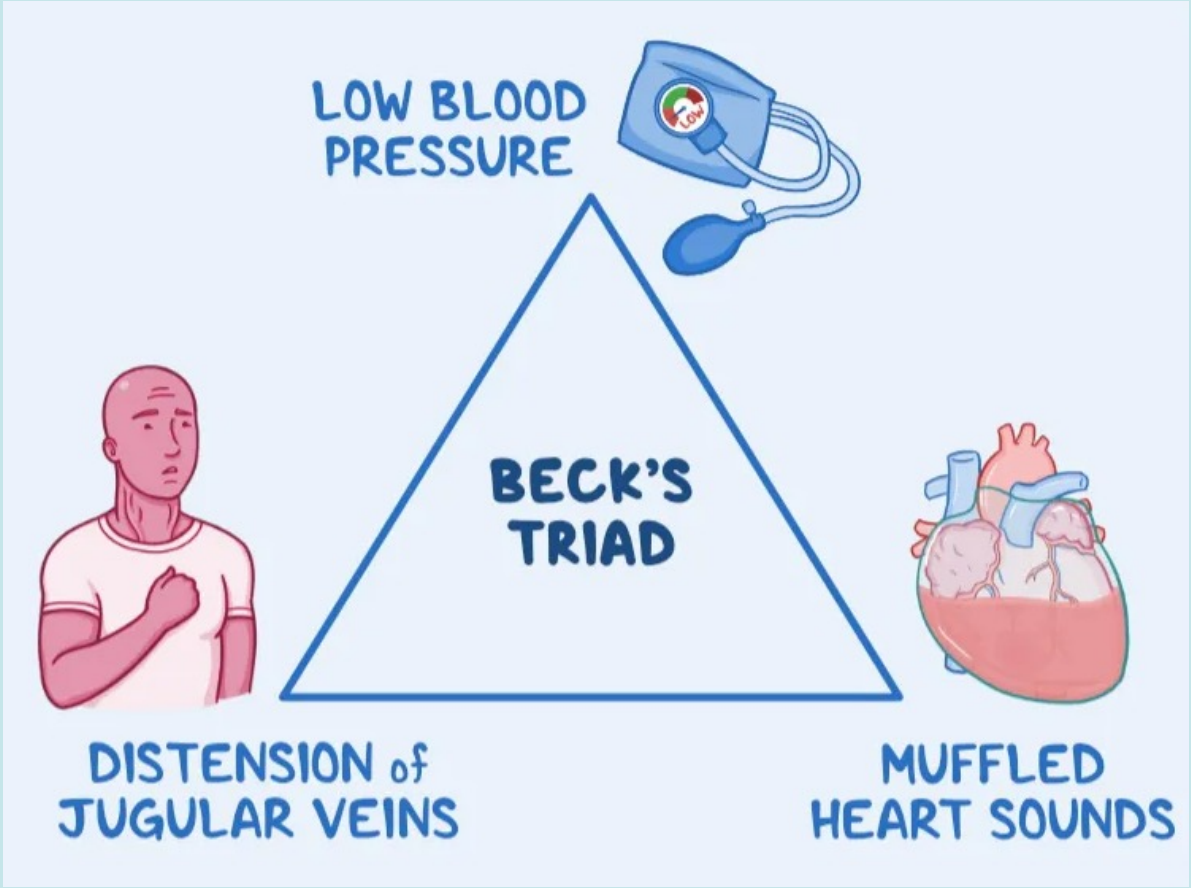
- Causes:
  - Aortic dissection, cardiac wall rupture
  - Pericarditis (especially viral), TB
  - Chest trauma
  - Uraemic pericarditis
  - Idiopathic, cardiac surgery
  - Malignancy
  - Hypothyroidism (myxoedema)



Cardiac Tamponade

Recognition

- Tachycardia
- Hypotension
- Muffled heart sounds
- Distended neck veins
- Fever – if infective
- The patient may also have difficulty breathing, chest pain and dysphagia



Cardiac Tamponade

Treatment

- Small effusions - NSAIDs or colchicine
- Surgical drainage – pericardiotomy
  - Preferred in haemopericardium, trauma, purulent effusion or neoplastic disease
  - Where there is potential for complications or immediate reaccumulation
- Needle aspiration - pericardiocentesis
  - Preferred when there is no haemorrhage, trauma, neoplasm or purulence OR as emergency management in cardiac arrest/peri-arrest
  - Perform under guidance of ultrasound or fluoroscopy
  - If no imaging is immediately available, it is possible to go in blind using anatomical landmarks only
- Be cautious with fluid resuscitation - excessive fluids will exacerbate tamponade.

Reversible causes of cardiac arrest

- 4 H's and 4 T's

Hypoxia
Hypothermia
Hypovolaemia
Hypo/hyper-kalaemia

Tension pneumothorax
Tamponade
T_____
T_____

Case 7

- A 43 year old man was admitted to hospital with pneumonia. After sputum sample MC&S he was put onto IV clarithromycin.
- He also take chlorpromazine for schizophrenia.
- Later that day he goes into ventricular fibrillation.
- Why?

Toxins

- Causes:
  - Respiratory depression – sedatives/alcohol, opioids, nerve agents
  - Circulatory depression – sodium channel blockers (lidocaine, phenytoin, cocaine), beta blockers, digoxin, amphetamines
  - CNS depression – antidepressants, benzodiazepines, barbiturates, salicylates
  - Other – hypoglycaemic agents, cyanide, paracetamol, heavy metal poisoning

Toxins

Recognition

- Such a variety of toxins, no specific test or features
- Consider:
  - Items found with the patient – blister packs, needles etc.
  - The patient's medical history (i.e. drug abuse Hx, current medications)
  - Medication that could taken from family and friends
  - Were any interacting drugs prescribed?
  - Herbal supplements or OTC medications
  - Send blood and urine samples to toxicology

- Symptoms/signs (e.g. bradycardia, reduced GCS, pupils, seizures, paralysis, vomiting) or investigations (e.g. arrhythmia on ECG, ABG result) can offer clues

Toxins

Treatment

- Early airway management
- IV fluids and vasopressor support (e.g. noradrenaline infusion) if hypotensive
- Correct hypoxia, acidosis, electrolyte abnormalities and hypo/hyperthermia
- Activated charcoal

- Antidotes depend on the toxin:
  - Opioid toxicity – naloxone
  - Sodium channel blocker – sodium bicarbonate infusion
  - Benzodiazepines – flumazenil
  - Amphetamines – benzodiazepines
  - Digoxin - digoxin-specific antibody

Reversible causes of cardiac arrest

- 4 H's and 4 T's

Hypoxia
Hypothermia
Hypovolaemia
Hypo/hyper-kalaemia

Tension pneumothorax
Tamponade
Toxins
T_____

Case 8

- A 62 year old male is admitted with central crushing chest pain, tachycardia and syncope.
- As the ED nurse is performing the 12-lead ECG he goes into cardiac arrest.
- Why?

Thrombus

- Causes:
  - Pulmonary embolism – pulmonary artery obstruction
    - Venous thromboembolism from DVT (surgery, immobilisation, long haul travel)
    - Fat embolism (long bone fractures)
    - Air embolism (IV lines, penetrating trauma)
    - Amniotic fluid embolism (amniotic fluid and foetal debris enter maternal circulation – e.g. placental abruption)
  - Acute coronary syndrome – coronary artery obstruction
    - Atherosclerosis (plaque rupture)
    - Coronary ulceration/fissure/dissection (results in thrombus)
    - Infectious embolism (Infective Endocarditis)

Thrombus - Recognition

Pulmonary

- Dyspnoea
- Tachycardia, hypotension, tachypnoea
- Pleuritic chest pain
- Haemoptysis
- Low O2 saturations
- Drop in end-tidal CO2

Coronary

- Typically central crushing chest pain radiating to left arm/jaw (but may be atypical - e.g. epigastric pain, back pain, sharp pain, no pain)
- Tachycardia
- Syncope
- ECG and troponin findings
- Consider if in VF/VT - coronary occlusion is the most common cause

Thrombus - Treatment

Pulmonary

- IV fluids (if hypotensive) and high-flow oxygen
- Thrombolysis with alteplase (tPA)
- Embolectomy – if thrombolysis is contraindicated (intracranial haemorrhage, stroke, recent surgery) or unsuccessful
- Consider ECMO

Coronary

- IV fluids (if hypotensive) and high-flow oxygen
- Dual anti-platelet therapy (aspirin + antiplatelet agent - e.g. prasugrel or clopidogrel)
- Emergency PCI (can be done with CPR ongoing) or thrombolysis if PCI unavailable (alteplase)
- Consider ECMO

Reversible causes of cardiac arrest

- 4 H's and 4 T's

Hypoxia
Hypothermia
Hypovolaemia
Hypo/hyper-kalaemia

Tension pneumothorax
Tamponade
Toxins
Thrombus

Some other causes…

- Arrhythmias – SVT, AF, heart blocks
- Trauma - commotio cordis
- Other electrolyte abnormalities - hypoglycaemia, hyper/hypomagnesaemia, hyper/hypocaalcaemia
- Neurological - neurological insults such as subarachnoid haemorrhage, intracranial haemorrhage, ischaemic stroke or seizures
- Electric shock - exposure to a high-voltage shock
- Hypertrophic cardiomyopathy
- Congenital heart defects - structural abnormalities in the heart

Thank you for listening

- Any questions?
- Basics of ED: Shock
  - 23rd March @ 7pm

https://lwems.co.uk/education/articles/reversible-causes-of-cardiac-arrest