MAINTAINING CARDIOVASCULAR PERFUSION IN ACUTE TRAUMATIC INJURIES

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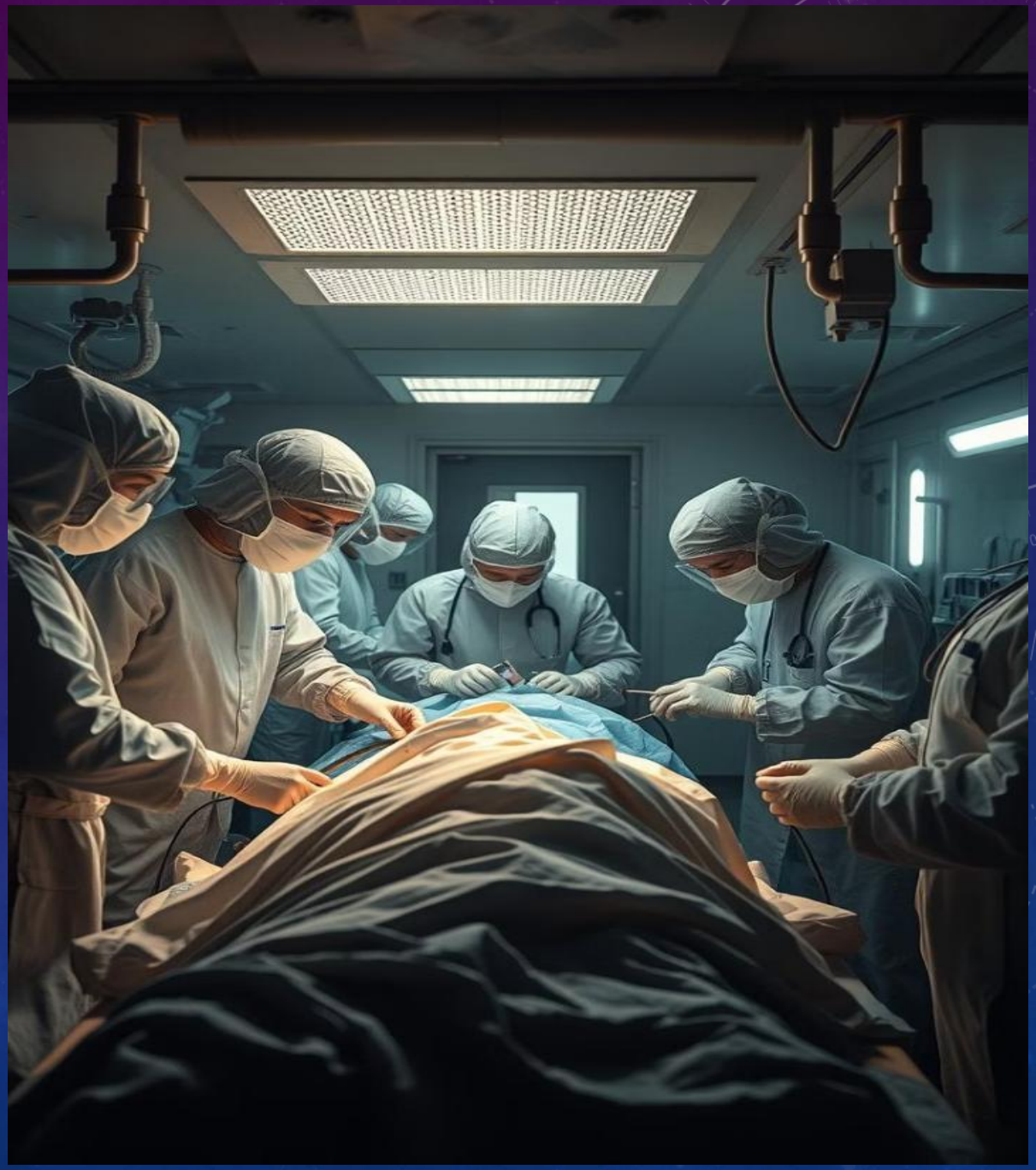
“THEY MAY FORGET YOUR NAME, BUT THEY WILL NEVER FORGET HOW YOU MADE THEM FEEL.”



INTRODUCTION

- Cardiovascular perfusion in acute traumatic injuries is critical for maintaining tissue oxygenation and preventing end-organ damage.
- Maintaing perfusion in trauma - very much important
- High mortality

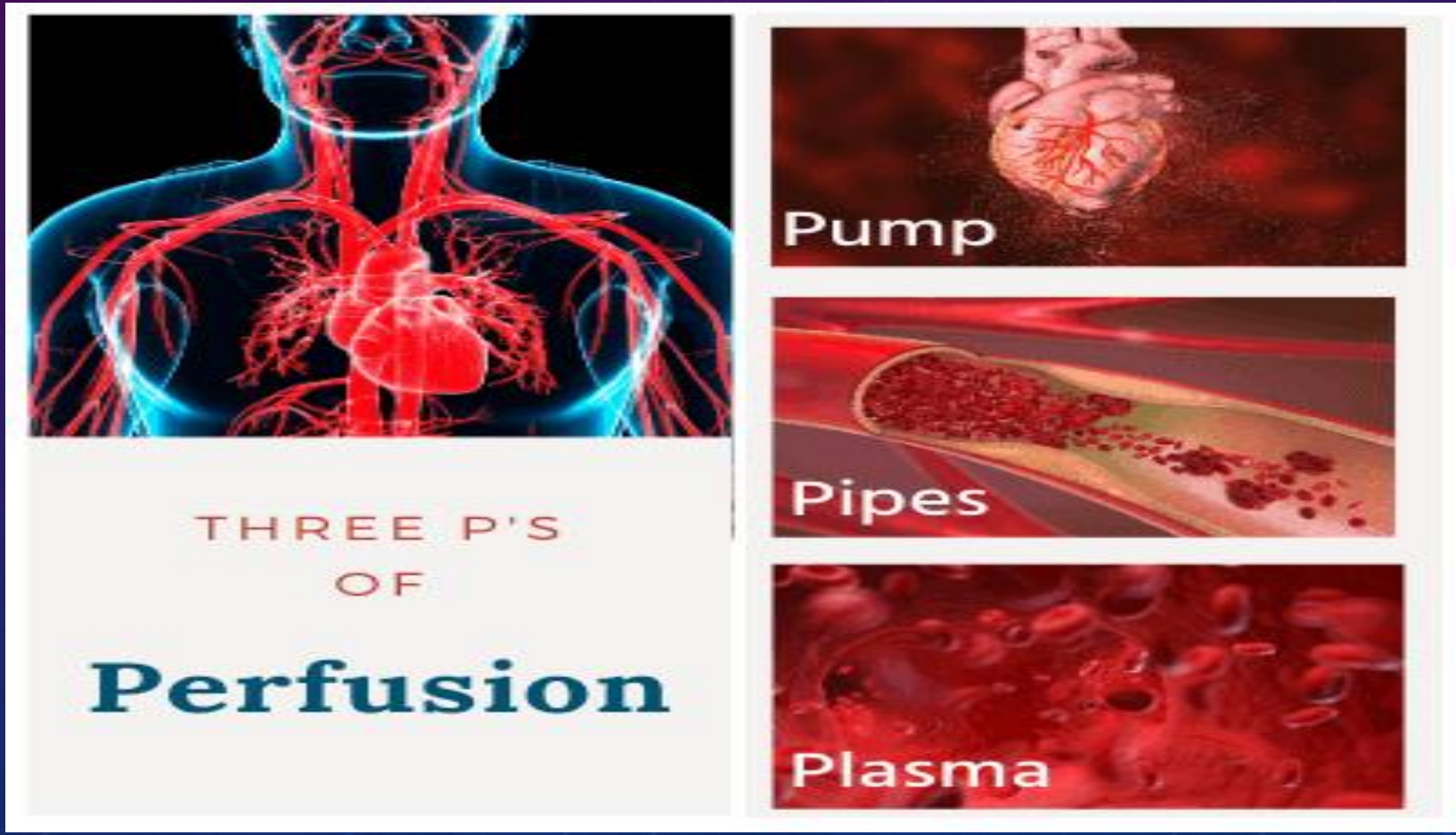
GOALS OF INITIAL TRAUMA CARE

- ✓ Preserve life by ensuring perfusion of vital organs
- ✓ Rapid hemorrhage control
- ✓ Restore circulating volume
- ✓ Minimize secondary injury (e.g., from hypoxia or hypoperfusion)

WHY PERFUSION MATTERS IN TRAUMA

- Definition: Perfusion = delivery of oxygen/nutrients to tissues.
- Golden Hour: Rapid restoration of perfusion critical for survival.
- Warzone Context: Delayed evacuation → prolonged ischemia → higher mortality.

PHYSIOLOGY OF PERFUSION



- Cardiac output = heart rate × stroke volume
- Adequate perfusion depends on:

➢ Blood volume

➢ Vascular tone

➢ Cardiac function

- Triad of Death:

✓ Hypothermia

✓ Acidosis

✓ Coagulopathy

- Oxygen Debt: Cumulative deficit → irreversible shock.

TYPES OF SHOCK :-

- **Hemorrhagic Shock**: Major blood loss reduces preload, cardiac output (CO), and perfusion pressure, leading to tissue hypoxia.

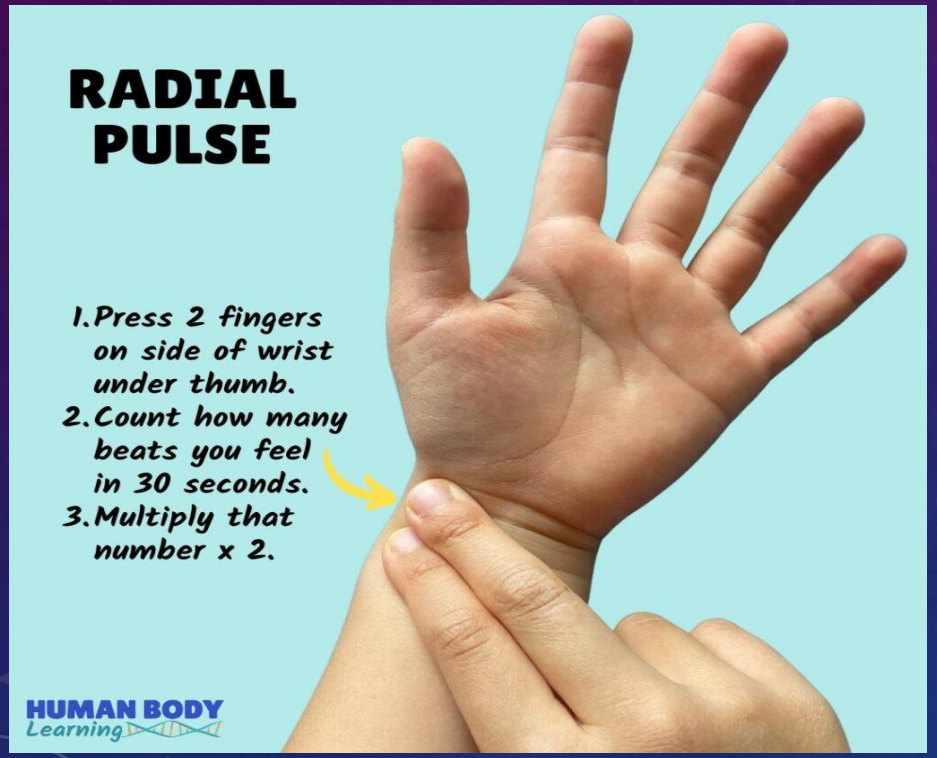
- **Distributive Shock (e.g., Neurogenic/Spinal Shock)**: Vasodilation reduces systemic vascular resistance (SVR), impairing perfusion despite normal blood volume.

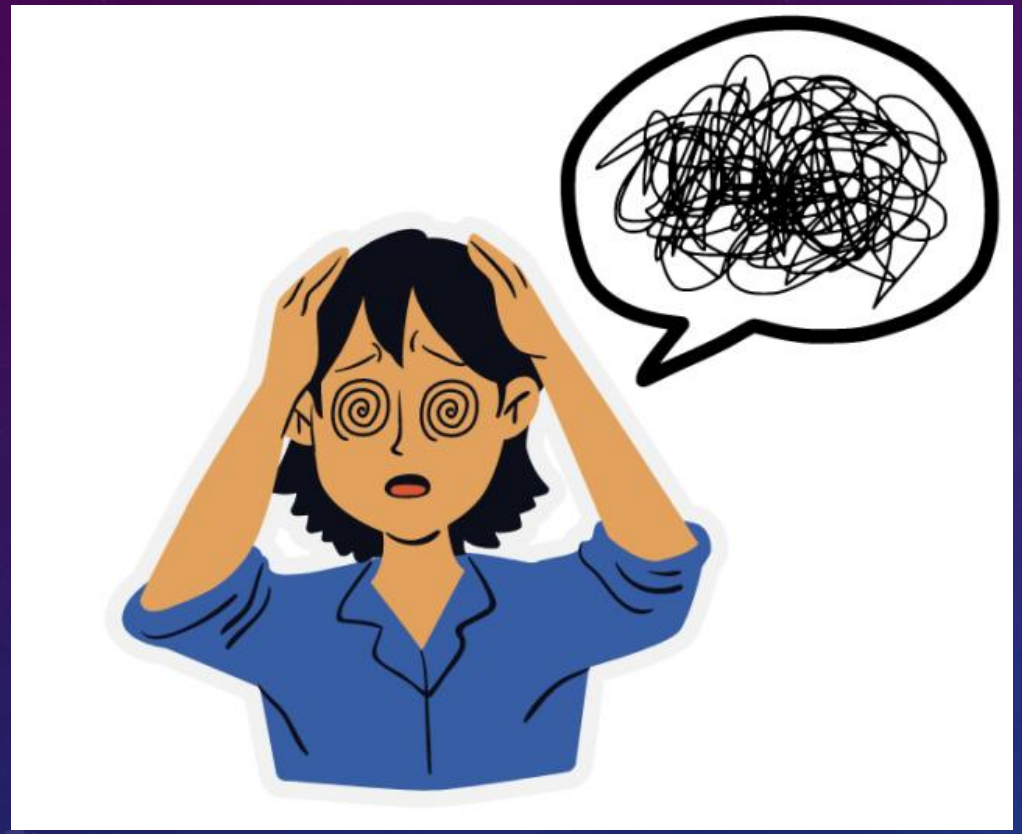
- **Obstructive Shock (e.g., Tension Pneumothorax, Cardiac Tamponade):** External compression impedes venous return or cardiac filling.

- **Cardiogenic Shock (e.g., Myocardial Contusion, ACS)**: Direct trauma or ischemia reduces cardiac contractility.

RECOGNIZING SHOCK IN TRAUMA

- Clinical signs:
  - Tachycardia
  - Hypotension (late sign)
  - Altered mental status
  - Cool, clammy skin
  - Delayed capillary refill


RADIAL PULSE
1. Press 2 fingers on side of wrist under thumb.
2. Count how many beats you feel in 30 seconds.
3. Multiply that number x 2.
HUMAN BODY
Learning



Shock Index

$$\frac{\text{Heart Rate}}{\text{Systolic BP}} = \text{Shock Index}$$

No Shock	Mild Shock	Moderate Shock	Severe Shock
<0.6	6≥ to <1.0	1.0≥ to <1.4	≥ 1.4

*there may be variations of this scale. Some scales may list 0.5-0.7 as normal range

OTHER SUPPORTIVE INVESTIGATIONS:

ABG :-

Lactate (>2 mmol/L) and base deficit indicate anaerobic metabolism.

Low Hb (Late menifestation)

Low PaO2.

Acidosis .

Pulse pressure variation (PPV) or ultrasound (IVC assessment) can guide fluid responsiveness.

If you are working in hospital setting - one can opt for -

- FAST & eFAST
- Pneumo Scan
- NCCT head, neck , abdomen

CLASSIFICATION OF HEMORRHAGIC SHOCK

- Most common cause .

☐ Class I: <15% blood loss — normal vitals

☐ Class II: 15–30% — tachycardia, narrowed pulse pressure

☐ Class III: 30–40% — hypotension, tachypnea, confusion

☐ Class IV: >40% — life-threatening, obtundation

CASE SCENARIO

- A hospital near a conflict zone in a desert region. Limited blood products, minimal imaging, and basic surgical capability are available. Evacuation routes are delayed due to ongoing shelling.

- Patient Unknown (combatant, ~30 years old)

- Presentation: Brought in by medics after an improvised explosive device (IED) blast. Found unconscious with heavy bleeding.

How will you proceed ????

Early Assessment and Rapid Hemorrhage Control

1. Primary Survey
2. Identify Bleeding Sources
3. Apply Hemorrhage Control
4. Prepare for Evacuation

PRIMARY SURVEY

- A – Airway with cervical spine protection
- B – Breathing and ventilation
- C – Circulation with hemorrhage control
- D – Disability (neurological status)
- E – Exposure/environment control

IDENTIFY BLEEDING SOURCE

- Locate external and internal hemorrhages through physical exam and signs of shock
- Extremity Hemorrhage

☐Most common and often most survivable if promptly managed.

☐Causes: Gunshot wounds, blasts, shrapnel injuries.

Junctional Hemorrhage

- Occurs at junctions of the torso and limbs (e.g., groin, axilla, neck).
- Difficult to control with standard tourniquets.
- Causes: Penetrating trauma to femoral or axillary vessels

Torso (Non-compressible) Hemorrhage

- Includes intra-abdominal, pelvic, and thoracic bleeding.
- Most lethal type due to difficulty in pre-hospital control.
- Causes: High-velocity gunshots, blast injuries, blunt trauma

Head and Neck Bleeding

- ☐ Includes scalp lacerations (which can bleed profusely), facial trauma, carotid injury.
- ☐ Can compromise airway and circulation simultaneously.

Internal Bleeding from Blast Injuries

- ☐ Often due to barotrauma or blunt mechanisms.
- ☐ Organs affected: Lungs, liver, spleen, bowel (hollow viscus rupture).

Secondary Bleeding Sources

- ☐ Coagulopathy-induced: Due to hypothermia, acidosis, or dilution from resuscitation.
- ☐ Requires correction of the “lethal triad”

HEMORRHAGE CONTROL

- ✓ Apply tourniquets for limb bleeding
- ✓ Use hemostatic dressings
- ✓ Direct pressure and pressure dressings
- ✓ Pelvic binders for pelvic fractures

TOURNIQUET USE IN SEVERE BLEEDING

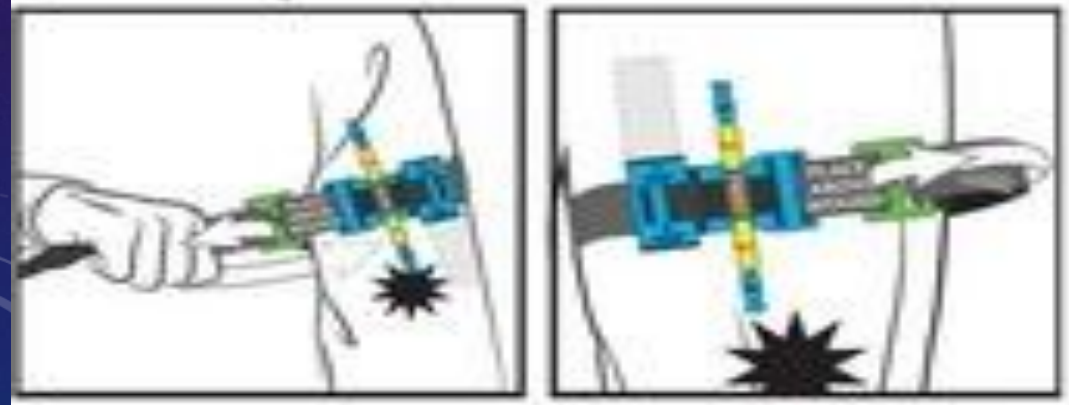
- Locate the source of bleeding.
- Apply the tourniquet 5–7 cm (2–3 inches) above the bleeding site, but not over a joint.
- Tighten until bleeding stops completely.
- Note the time of application — prolonged use (>2 hours) can cause damage.

- Important Notes:
- Only use for limb bleeding.
- Should be wide and flat for effectiveness and reduced tissue damage.
- Commercial tourniquets (like CAT or SOF-T) are preferred, but improvised ones can be used in emergencies.

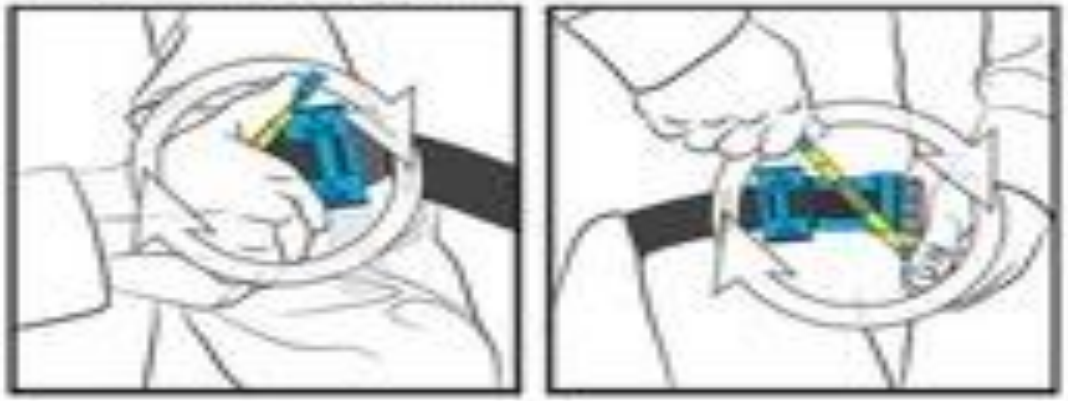
Tourniquet* Application Instructions

Place the tourniquet above the wound (closer to the torso).

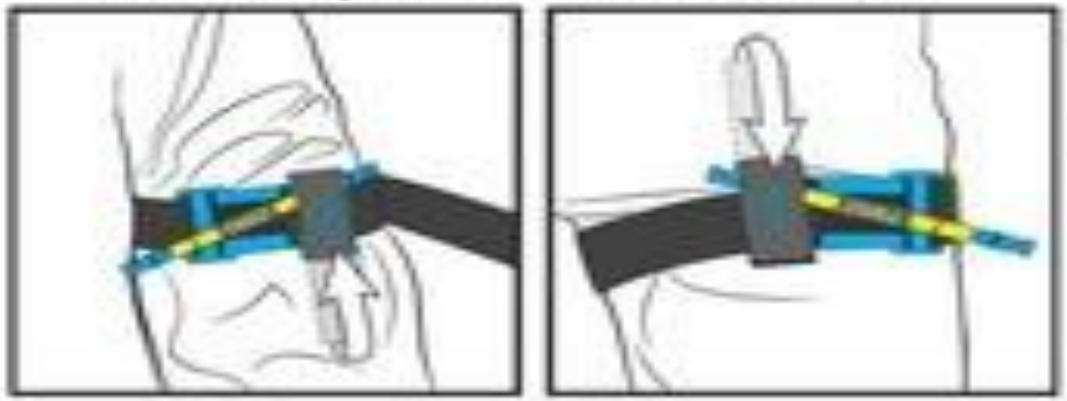
1. **Pull** the free end of Velcro strap, thread it through the buckle, & securely fasten it back onto itself.



2. **Twist** the rod until all bright red bleeding stops.



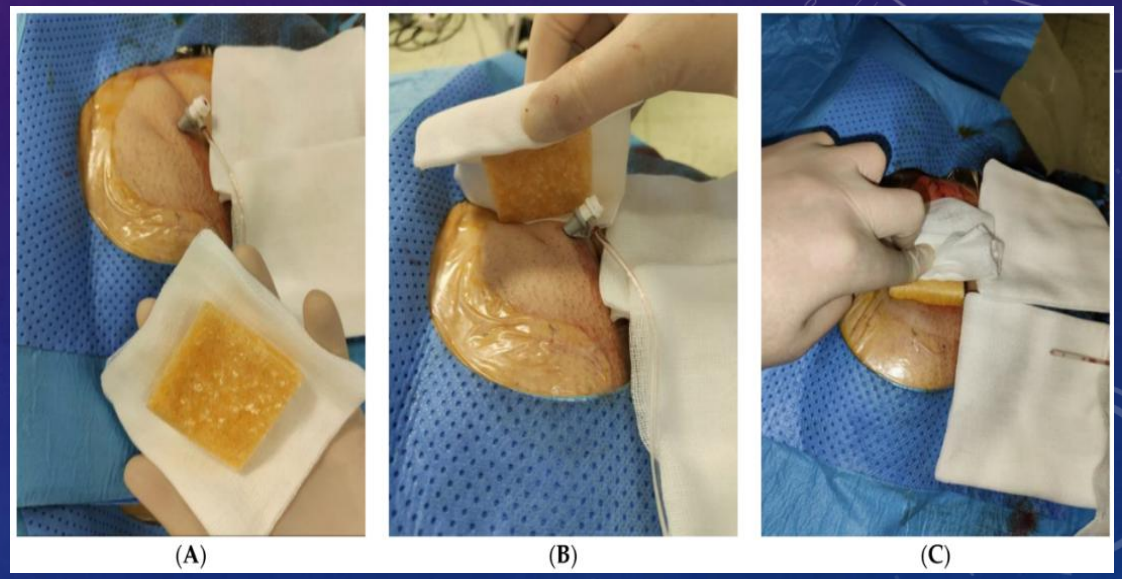
3. **Clip** & secure rod with the small Velcro strap so it does not untwist.



If bleeding continues apply a second tourniquet above the first (closer to torso).

*patent pending

HEMOSTATIC DRESSINGS



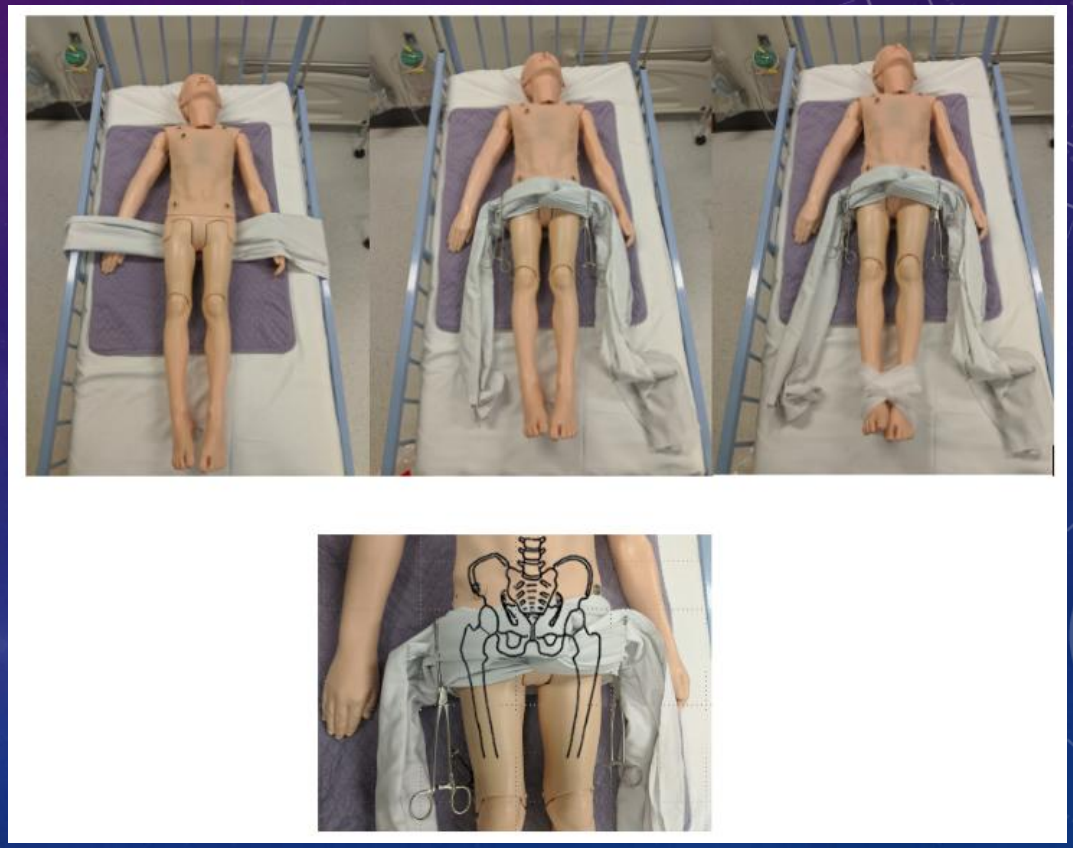
PELVIC BINDERS

When to Use:

- Suspected open book pelvic fractures.
- Patient with hypotension and pelvic instability.
- Pre-hospital and emergency department settings.

How to Apply:

- Place the binder at the level of the greater trochanters (not the iliac crest).
- Ensure symmetrical positioning.
- Tighten until the pelvis feels stabilized and resistance is met.
- Secure in place and reassess circulation to lower limbs.
- Important Tips:
- Do not delay application while waiting for imaging.



VASCULAR ACCESS IN TRAUMA

- Goals:
- Rapid resuscitation, medication delivery, and blood transfusion.
- Must be fast, reliable, and minimally invasive under hostile conditions.

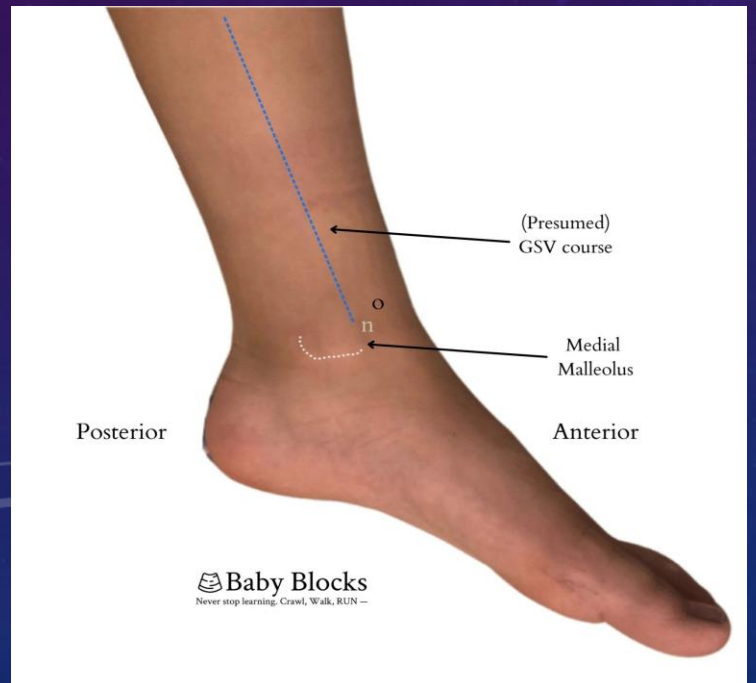
- Peripheral IV access, Central venous access, Intraosseous (IO) Access, Cut down.

PERIPHERAL IV

- Preferred if easily obtainable.
- Use large-bore catheters (14–16G).
- Common sites: antecubital, external jugular , saphanous vein ?

Color-coding of IV cannulas

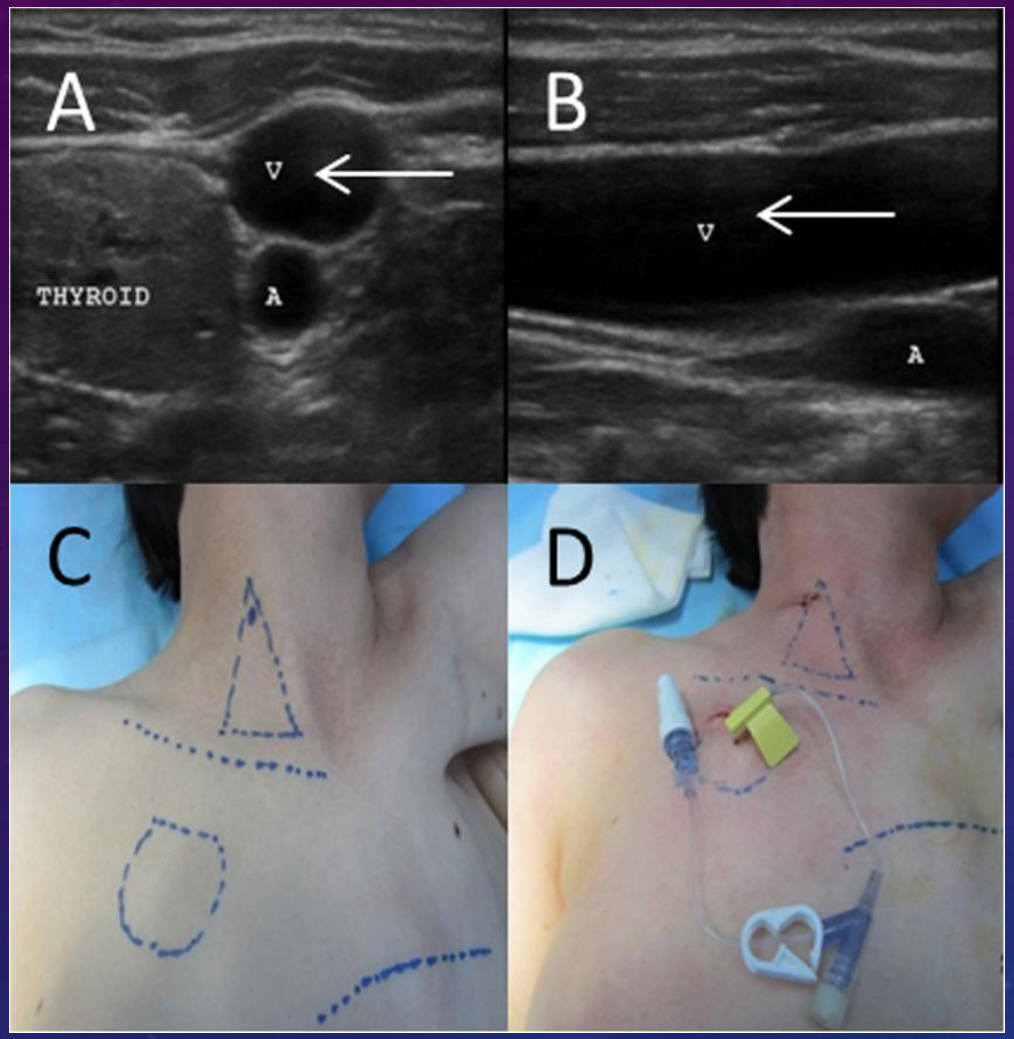
Color	Gauge	Maximal Flow Rate(mL/min)
Yellow	24G	13
Blue	22G	31
Pink	20G	67
Green	18G	103
Gray	16G	236
Orange	14G	270

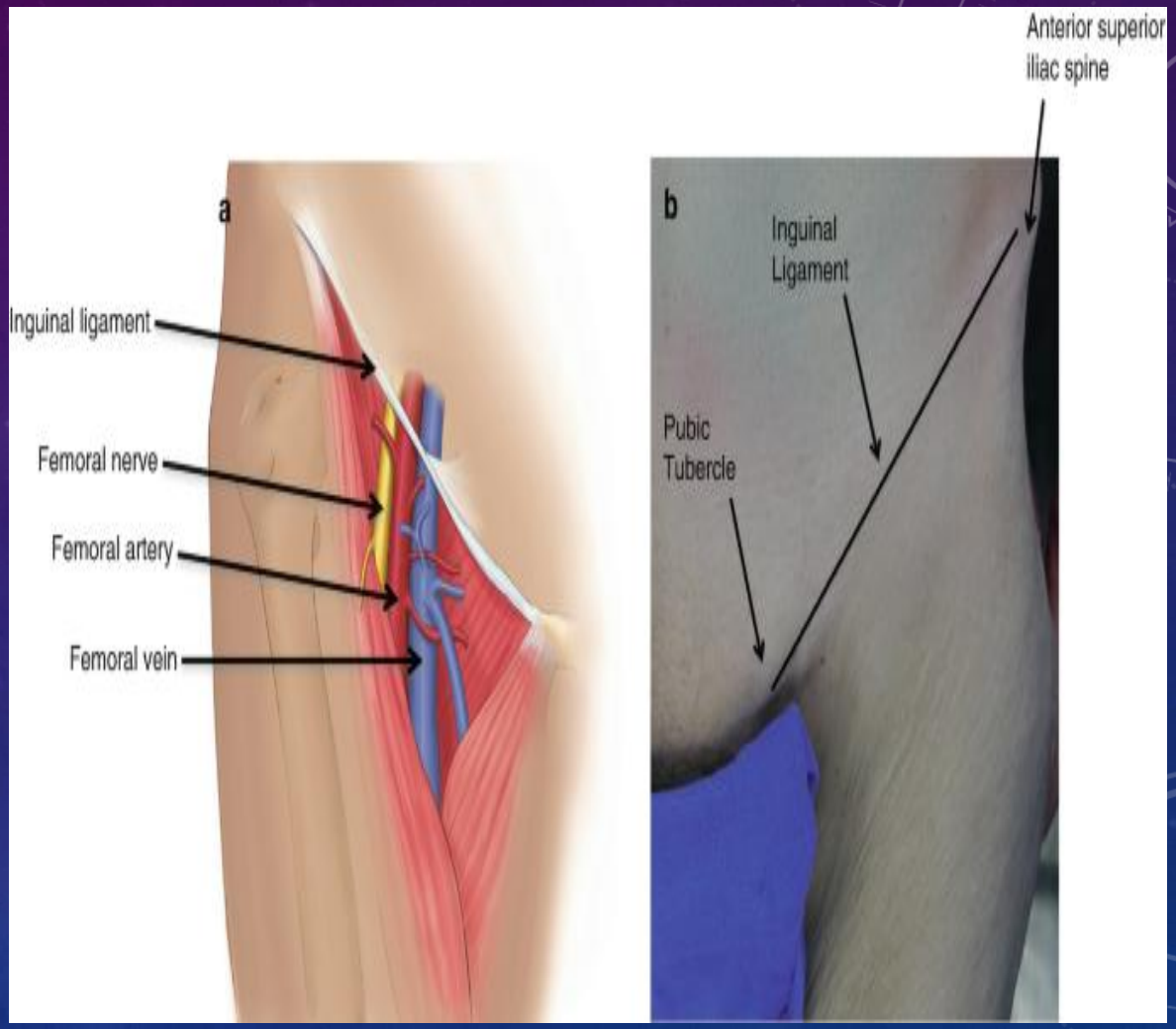


CENTRAL VENOUS ACCESS (CVC)

- Reserved for prolonged resuscitation or CVP monitoring.

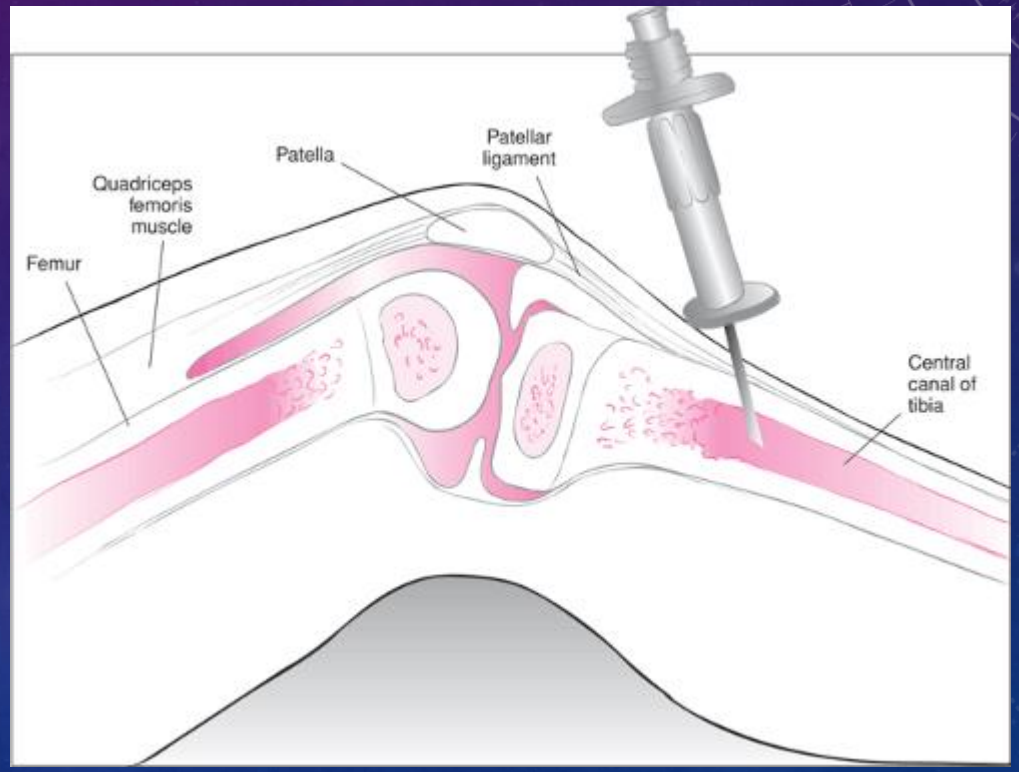
- Risky in warzones due to time and skill needed.
- Commonly cannulated veins are - IJV, Femoral Vein , Subclavian Vein


A
V
THYROID
A
B
V
A
C
D


a
Inguinal ligament
Femoral nerve
Femoral artery
Femoral vein
b
Anterior superior iliac spine
Inguinal Ligament
Pubic Tubercle

INTRAOSSEOUS (IO) ACCESS

- Sites: Proximal tibia, humeral head, sternum (combat preferred).
- Used when IV access is difficult or delayed.



CUT-DOWN TECHNIQUE

- Surgical method when veins collapse or access fails.
- Time-consuming, but life-saving in desperate cases.

- ➢ Choose site based on injury location and accessibility.
- ➢ Maintain sterility as much as possible even in field settings.
- ➢ Always secure devices and monitor for dislodgement.

FLUID RESUSCITATION

- Permissive hypotension (SBP 80–90 mmHg) until bleeding controlled
- Crystalloids only for immediate resuscitation (500–1000 ml boluses)
- Avoid over-resuscitation (dilutional coagulopathy, dislodged clots)

Prioritize blood over crystalloids

BLOOD TRANSFUSION

- Golden standard: balanced transfusion (1:1:1 – PRBC:Plasma:Platelets)
- Whole blood preferred in field settings (if available)
- Maintain minimum circulatory volume until surgical control
- Monitor for signs of fluid overload or ongoing bleeding

Massive Blood Transfusion in Major Trauma

1

- Transfusion of >10 units PRBCs in 24 hrs
- OR >4 units in 1 hour with ongoing hemorrhage
- Anticipated need for rapid, high-volume replacement
- Balanced Component Therapy

2

- 1:1:1 Ratio – PRBC : FFP : Platelets
- Warm all fluids – Prevent hypothermia
- SIDE EFFECTS - Early signs of DIC, citrate toxicity, hypocalcemia

3

Click here to add text

- Prepare for calcium replacement
- (1g Calcium Chloride after every 4 units PRBC)

TRANEXAMIC ACID (TXA)

- A synthetic antifibrinolytic that prevents clot breakdown
- Available in IV / Oral form
- Easy to administer – ideal for pre-hospital/field use
- Mostly each Ampule contains 5 ml soultion equevallent to 500 mg of tranexamic acid.

Dosage Protocol

- 1g IV over 10 minutes
- Followed by 1g IV over 8 hours
- Administer as early as possible, ideally <1 hr of injury
- Proven very effective in severe bleeding , Combat injuries (MATTERs study) & if given with <3 hours of injury (CRASH 2, CRASH 3 trail)
- Caution - Chances of thrombosis , Very fast infusion can cause seizure & hypotension.

Maintaining Oxygen Delivery and Monitoring Perfusion

Oxygen Therapy

Provide supplemental oxygen to improve arterial saturation especially in hypoxic patients.

Vital Sign Monitoring

- Regularly check pulse rate and quality
- Monitor blood pressure for signs of shock
- Assess capillary refill and mental status

Advanced Monitoring

Use portable ultrasound or lactate levels if available to assess perfusion adequacy.

Maintain U:O >0.5m/kg/hr

PHARMACOLOGICAL SUPPORT TO ENHANCE PERFUSION

Vasopressor : Administer drugs like norepinephrine to maintain vascular tone in hypotensive patients.

Inotropes : Support cardiac contractility in cases of depressed cardiac output

Pain Management : Effective analgesia reduces sympathetic stress and improves hemodynamics

Considerations : Use pharmacologic agents judiciously, balancing benefits with limited field resources and side effects.

Vasopressors do not replace fluid or blood

Only use if:

- Ongoing hypotension despite fluids & hemorrhage control
- Neurogenic shock
- Inaccessible or delayed transfusion

Noradrenaline (Norepinephrine) - α1, β1 agonist → ↑ SVR, ↑ MAP , Dose -Initial dose: 8 to 12 mcg/min continuous IV infusion. Maintenance dose: 2 to 4 mcg/min continuous IV infusion

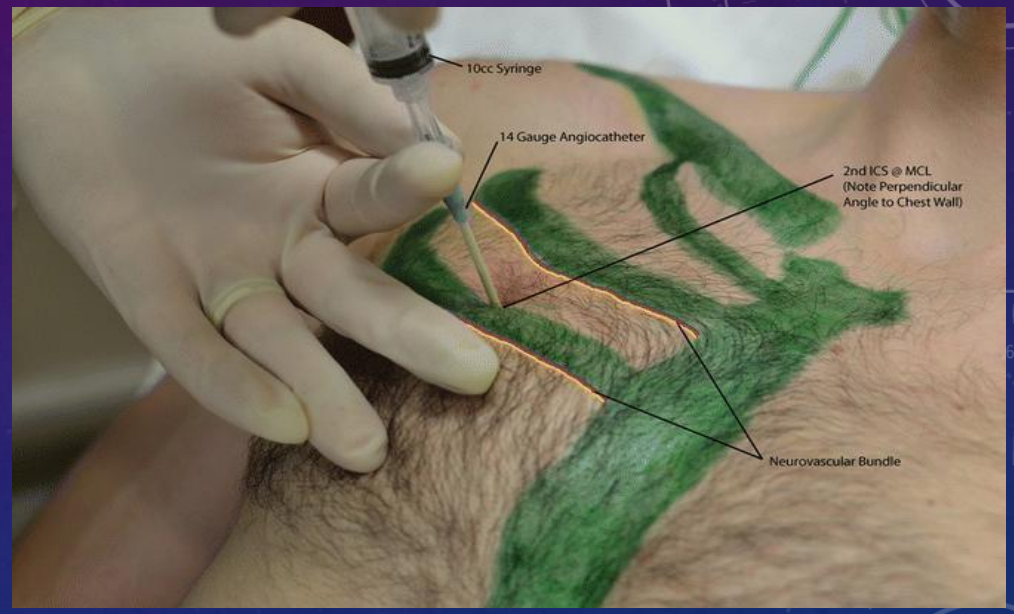
- Dopamine - Effective in bradycardia . Dose -Initial dose: 1 to 5 mcg/kg/min by continuous IV infusion. Titrate to desired response

- Ephidrine - Short-term use in hypotension during anesthesia/field sedation. Small boluses of (3-6 mg) are effective

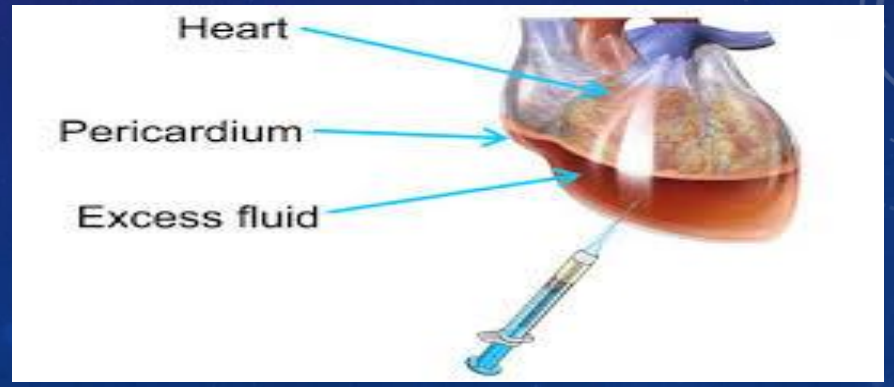
- Its better to Central venous catheter for prolonged infusion of vasopressor .

OTHER CAUSES OF POOR PERFUSION

- Tension Pneumothorax: Immediate needle decompression → chest tube. / 3 sided occlusive dressing



- Cardiac Tamponade: Pericardiocentesis or thoracotomy.



Cardiogenic Shock

- Fluid restriction if pulmonary edema present.
- Inotropes (e.g., Dobutamine) for myocardial dysfunction.

Neurogenic Shock

- Vasopressors (Norepinephrine) to counteract vasodilation.
- Judicious fluids (risk of pulmonary edema due to unopposed vasodilation).

PERFUSION IN TBI

Maintaining SBP at ≥100 mm Hg for patients 50 to 69 years old or at ≥110 mm Hg or above for patients 15 to 49 or >70 years old may be considered to decrease mortality and improve outcomes.

The recommended target CPP value for survival and favorable outcomes is between 60 and 70 mm Hg. Whether 60 or 70 mm Hg is the minimum optimal CPP threshold is unclear and may depend upon the autoregulatory status of the patient.

FIELD CONSIDERATIONS

- Limited resources: prioritize hemorrhage control over IV fluids
- Evacuation readiness: stabilize before transfer
- Team roles: assign airway, circulation, documentation

FUTURE DIRECTIONS

- Autonomous Drones: Blood product delivery.
- Wearable Sensors: Real-time lactate/hemoglobin monitoring.
- Resuscitative Endovascular Balloon (REBOA): Selective aortic occlusion.

SUMMARY & KEY TAKEAWAYS

- Early recognition and control of bleeding saves lives
- Permissive hypotension (except TBI).
- Whole blood is gold standard.
- Use tranexamic acid if available
- Adapt monitoring to resource limitations.

THANK YOU