

Hemorrhage, Massive Transfusions and Coagulopathy

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**Trauma, Acute Care Surgery,
Surgical Critical Care**

Overview

- Initial Assessment
- Airway and ventilator management
- Hemorrhage, massive transfusions and coagulopathy
- Endpoints of resuscitation
- Specific Injuries
 - Chest trauma
 - Abdominal trauma
 - Traumatic Brain Injury
 - Spinal Cord Injury
 - Brain Death and Organ Donation

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Shock

- **Definition**
 - Inadequate delivery of oxygen leading to end-organ dysfunction
- **Importance of red blood cells**
 - **Delivery of Oxygen = Cardiac Output × Oxygen Content.**
 - **Oxygen Content = 1.34 (Hemoglobin × Oxygen Saturation) + Dissolved Oxygen.**

Hemorrhagic Shock

- **Most common cause of hypotension in trauma patients**
- **Tissue trauma worsens hypotension via a immunologic and inflammatory response**
- **Trend markers of end organ perfusion (lactate, base deficit)**

Classes of Hemorrhagic Shock

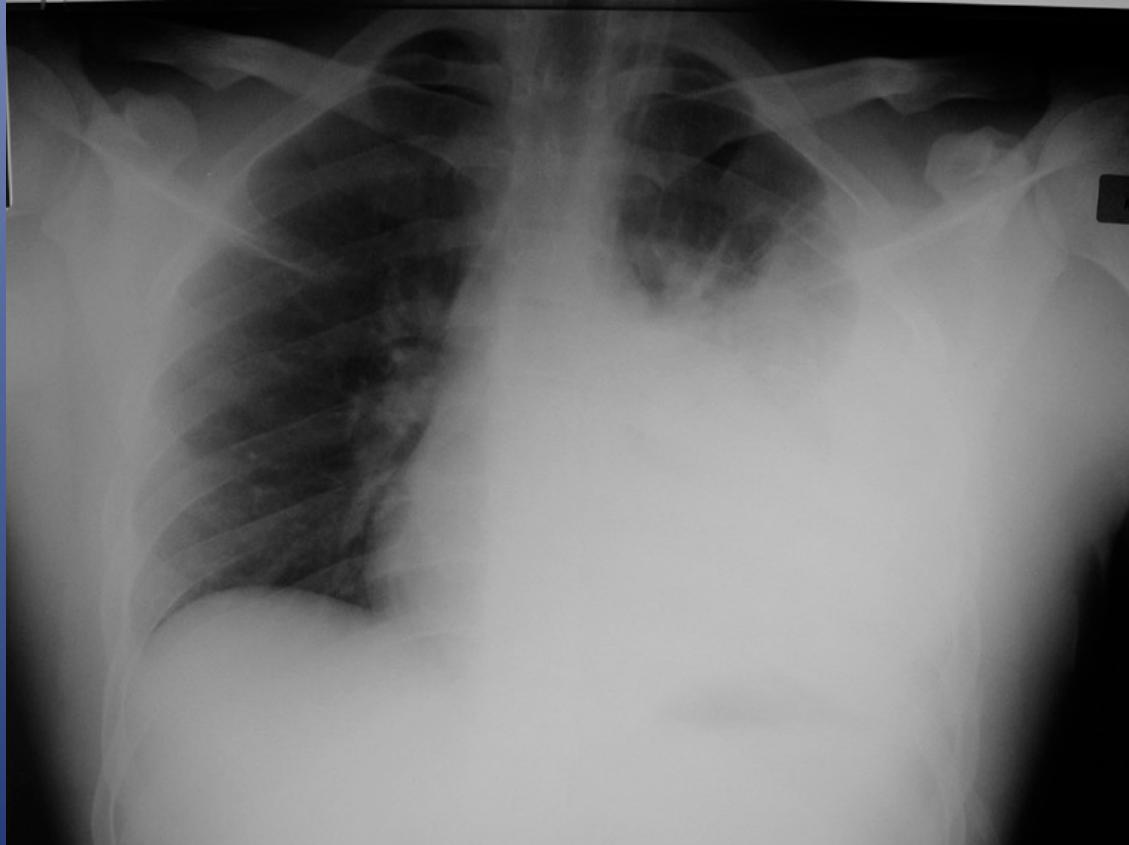
	Volume	% Blood Volume	Heart Rate	Blood Pressure	Urine Output	Mental Status	Breaths per Minute
Class 1	up to 750 mL	up to 15%	No change	No change	No change	No change	No change
Class 2	750-1500 mL	15%-30%	100	Narrowed pulse pressure, mild hypotension	<0.5 mL/kg/h	Anxiety	20-30
Class 3	1500-3000 mL	30%-40%	120	Hypotension	<0.25 mL/kg/h	Confusion	30-40
Class 4	>3000 mL	>40%	>140	Hypotension	Anuria	Obtunded	>40

Source of Hemorrhage

- Scalp
- Extremities
- Chest
- Abdomen
- Pelvis
- Floor

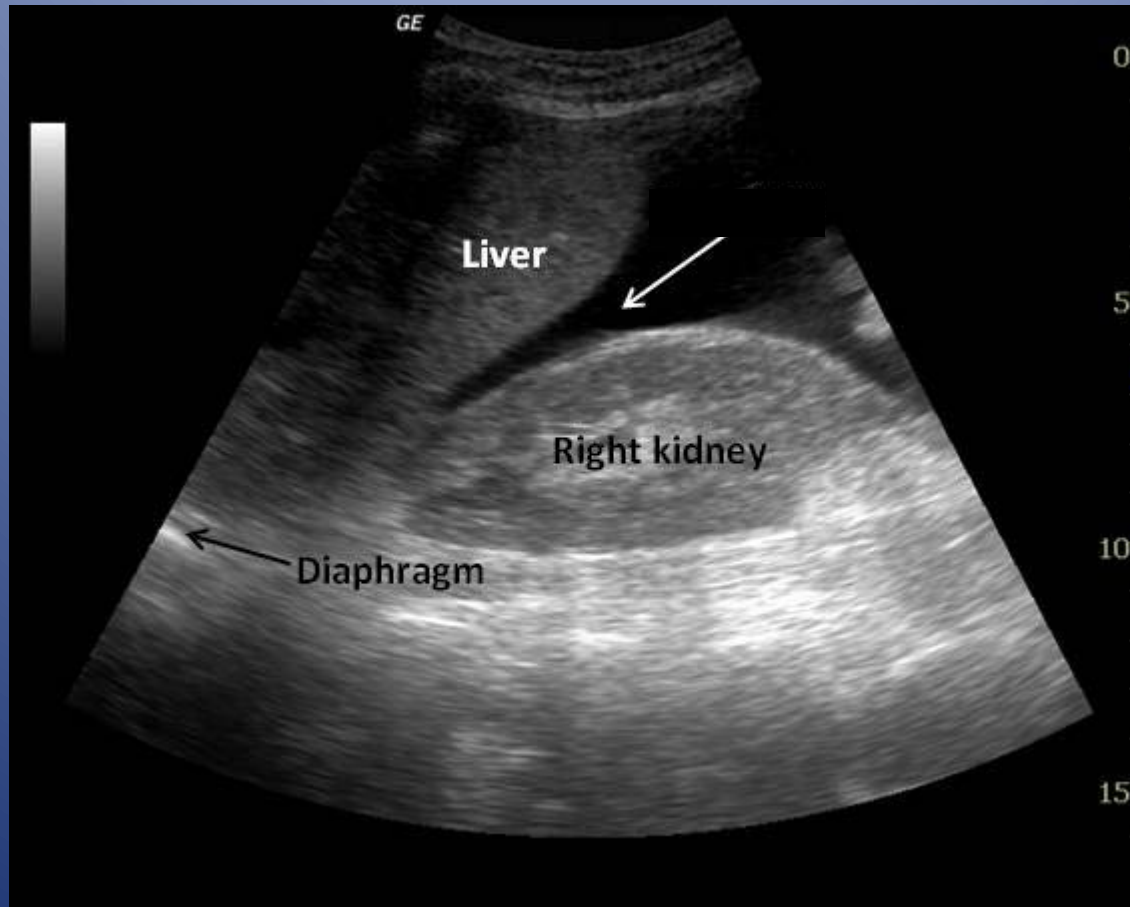
Hospital Primary Survey- Circulation

- Hemorrhage control



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Control of external hemorrhage

- Pressure
- Packing
- Tourniquets
- Crystalloid solutions, blood transfusion

Access

- Two large-bore (14 or 16 gauge) IV
- Goal SBP 80-90 mmHg
- If traumatic brain injury or spinal cord injury is suspected than goal SBP 90 mmHg

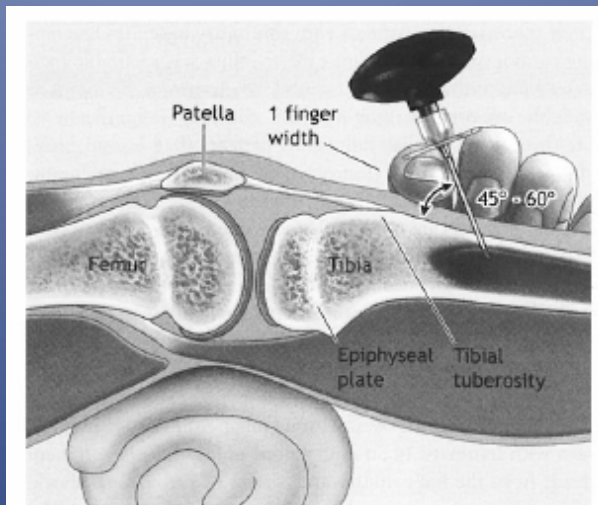


FIGURE 10-2 Demonstration of intraosseous puncture via the proximal tibial route. (Reproduced with permission from American College of Surgeons Committee on Trauma. *Advanced Trauma Life Support for Doctors*. 8th ed. Chicago, IL: American College of Surgeons Committee; 2008: p. 77.)

Massive Transfusion

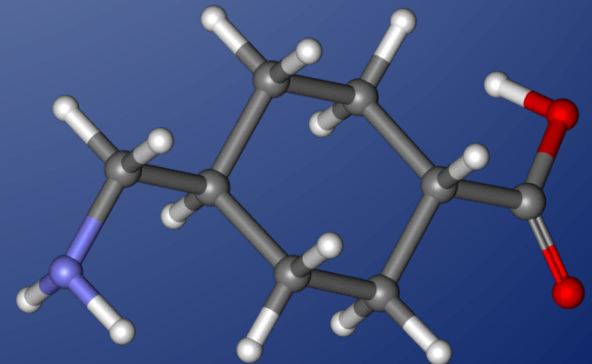
- 10 units of PRBCs within 24 hours
- 6 unit of PRBCs within 4 hours
- Whole blood lost so preferable to transfuse whole blood...
- Whole blood not widely available in civilian setting
- Component resuscitation
 - 1:1:1
 - PRBC:FFP:Plt (6 pack)
 - 6 PRBC:6FFP:1Plt

Damage Control Resuscitation

- Improved hemostasis
- Improved survival with 1:1:1 ratio
- Even with a massive transfusion protocol achieving a 1:1:1 ratio in the first 6 hours patients may still be coagulopathic

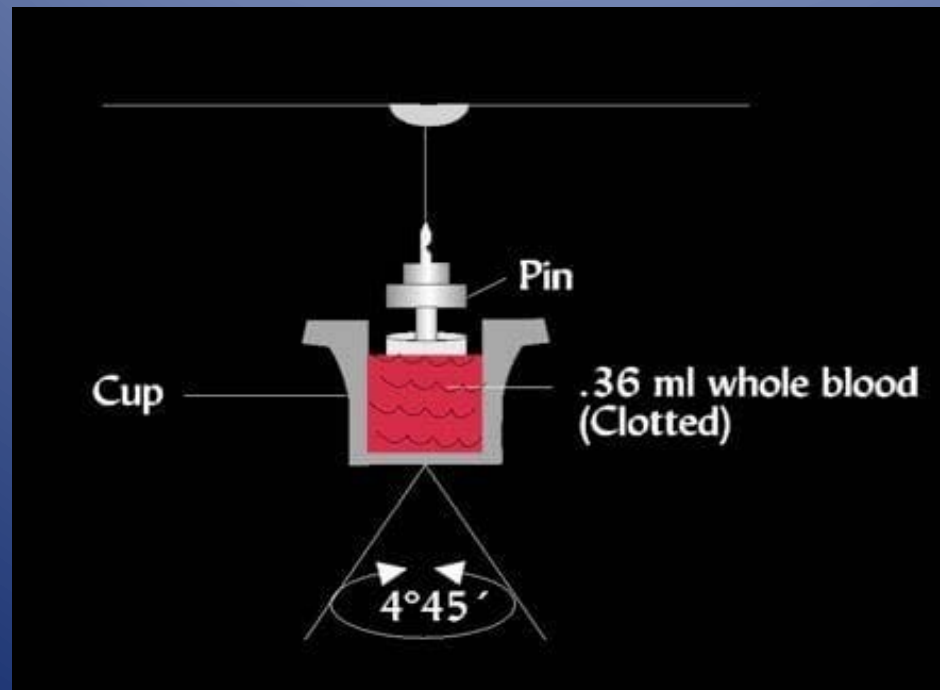
Tranexamic acid

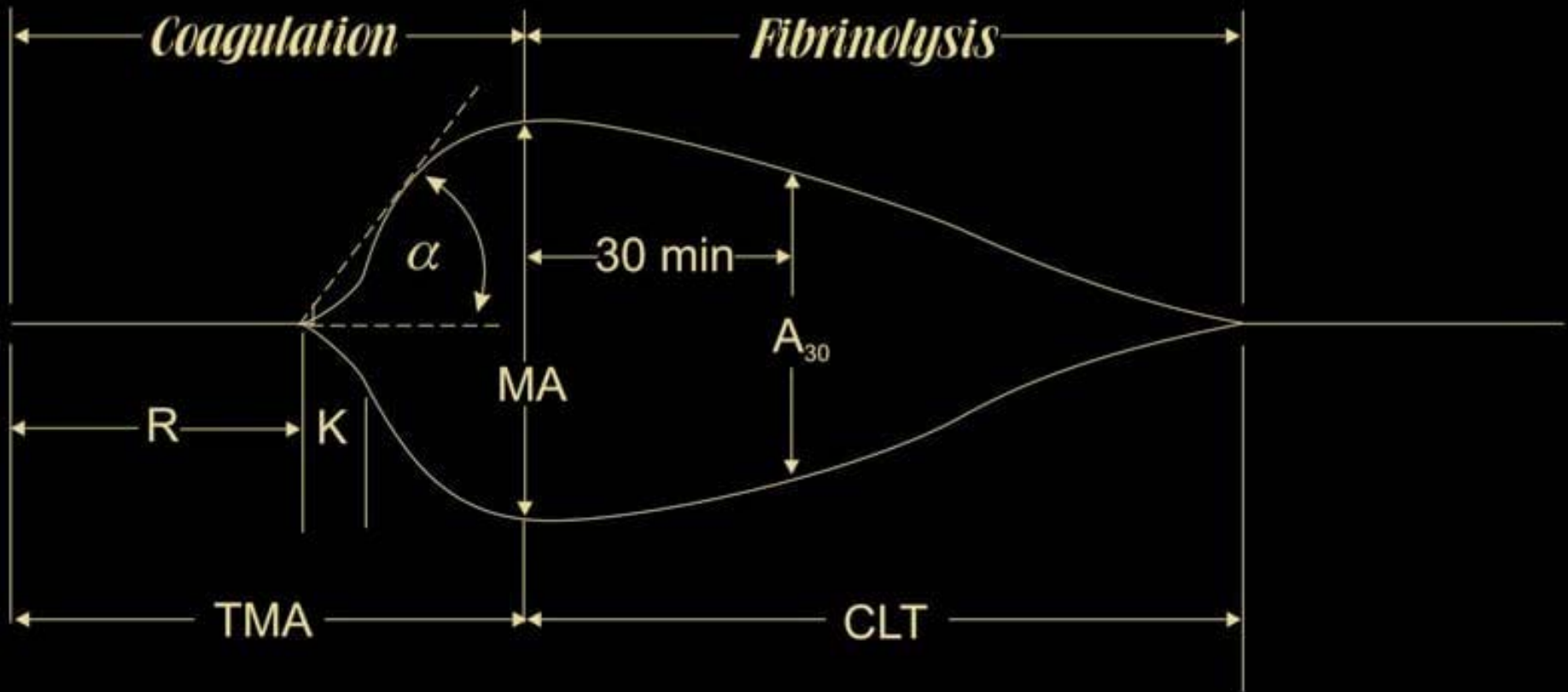
- Antifibrinolytic
- Reduces conversion of plasminogen to plasmin thus preventing fibrin degradation
- Administration in first 3 hours of injury may reduce death in bleeding trauma patients (CRASH-2 trial)



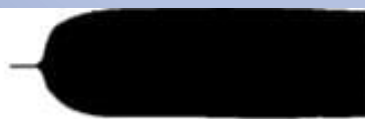
Thromboelastogram (TEG)

- Measures global viscoelastic properties of whole blood clot formation
- Shows interaction of platelets with coagulation cascade





- **R: time to initial fibrin formation (clotting factors-FFP)**
- **K: time to certain level of clot strength (fibrinogen-cryo)**
- **Alpha: speed of fibrin build up and cross-linking (fibrinogen-cryo)**
- **MA: ultimate strength of fibrin clot (platelets-plt, DDAVP)**
LY30: fibrinolysis (TXA)



Normal

R;K;MA;Angle = Normal



Anticoagulants/hemophilia

Factor Deficiency

R;K = Prolonged;

MA;Angle = Decreased



Platelet Blockers

Thrombocytopenia/

Thrombocytopathy

R ~ Normal; K = Prolonged;

MA = Decreased



Fibrinolysis (UK, SK, or t-PA)

Presence of t-PA

R ~ Normal;

MA = Continuous decrease

LY30 > 7.5%; WBCL130 < 97.5%;

Ly60 > 15.0%; WBCL160 < 85%



Hypercoagulation

R;K = Decreased;

MA;Angle = Increased



D.I.C

Stage 1

Hypercoagulable state with
secondary fibrinolysis



Stage 2

Hypocoagulable state



Coagulopathy of Trauma

- Early hypocoagulable state later followed by development of a hypercoagulable state
- Triggered by:
 - Dilution
 - Hypothermia
 - Acidemia
 - Consumption
 - Hyperfibrinolysis

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Questions? Please ask

