





TRAUMA RESUSCITATION


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- **First Principles....ATLS/EMST**
 - **A- Airway and C-spine**
 - **B- Breathing**
 - **C- Circulation and Access**
 - **D- Neurological deficit**
 - **E- adequate exposure/inspection and normothermia**

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- In a patient presenting with hemorrhagic shock the management consist of immediate resuscitation and simultaneous institution of measures to remove the source of bleeding

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- In the beginning...
 - Early experience in wartime trauma necessitated immediate resuscitation with IVF prior to attempts at definitive surgical management
 - WWII- blood and plasma products
 - Vietnam- initial observation of deleterious overzealous use of fluid resuscitation (Da Nang Lung-ARDS/TRALI)

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- ATLS/EMST originally transferred military protocols of resuscitation to civilian contexts
 - Shock in setting of trauma can be
 - 1. hemorrhagic/hypovolemic
 - 2. cardiogenic/obstructive
 - 3. neurogenic
 - Shock classification defined in 4 categories as per ATLS

ity, the normal adult blood volume is approximately 7% of body weight. For example, a 70-kg male has a circulating blood volume of approximately 5 L. The blood volume of obese adults is estimated based on their ideal body weight, because calculation based on

and resuscitation of injured patients who are at risk for hemorrhagic shock. These factors include:

- Patient's age
- Severity of injury, with special attention to


■ TABLE 3.1 Estimated Blood Loss¹ Based on Patient's Initial Presentation


	CLASS I	CLASS II	CLASS III	CLASS IV
Blood loss (mL)	Up to 750	750–1500	1500–2000	>2000
Blood loss (% blood volume)	Up to 15%	15%–30%	30%–40%	>40%
Pulse rate (BPM)	<100	100–120	120–140	>140
Systolic b pressure	Normal	Normal	Decreased	Decreased
Pulse pressure (mm Hg)	Normal or increased	Decreased	Decreased	Decreased
Respiratory rate	14–20	20–30	30–40	>35
Urine output (mL/hr)	>30	20–30	5–15	Negligible
CNS/mental status	Slightly anxious	Mildly anxious	Anxious, confused	Confused, lethargic
Initial fluid replacement	Crystalloid	Crystalloid	Crystalloid and blood	Crystalloid and blood


¹For a 70-kg man.


- Following immediate IV access, IV fluids are administered
- Initial 2L bolus crystalloid solution
- Response is assessed:
 - Responders
 - Transient responders
 - Non-responders


The last 2 categories require immediate surgical intervention


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- Disclaimer...
 - The debate/opinions on fluid resuscitation are complex and constantly undergoing reassessment and evaluation
 - Many debates are decades old eg. Crystolloids vs. Colloids

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- Quick reminder
 - Crystolloids are water-based fluids with elemental electrolyte constituents
 - Come in many varieties
 - Are ‘physiological’
 - Can be hypotonic/isotonic/hypertonic
 - Remember physiology of fluid compartments of distribution

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- Colloids
 - Water with additional semi-synthetic macromolecules eg. Gelofusine
 - Human plasma-derived constituents eg. Albumin
 - Have greater plasma oncotic properties due to their inability to cross semi-permeable barrier of endothelium
 - Remain in intravascular compartment longer


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- Lethal triad of trauma
 - 1. coagulopathy
 - 2. hypothermia
 - 3. acidosis
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- Spiral of doom


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- Trauma-induced coagulopathy
 - Physiological and biochemical interaction in damaged tissues that initiates local and systemic interactions that interfere with the coagulation cascade (esp. activation of fibrinolysis pathways)
 - Exacerbated by the dilutional effect of over aggressive fluid resuscitation and depletion of clotting factors/platelets


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- Over-aggressive fluid resuscitation and (relative) hypertension can exacerbate active bleeding and/or prevent active clotting stabilization


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- **Damage Control Resuscitation**


- European Guidelines...
- 1. Use of tourniquets to prevent extremity exsanguination is recommended
- 2. normoventilation with small tidal volumes and moderate PEEP including in the setting of TBI (without herniation)
- 3. the use of HCT as a single marker of blood loss is not useful

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- 4. serum lactate and base excess are better markers of the extent of bleeding/shock and the response to therapy
 - 5. routine monitoring of PT/APTT/fibrinogen/platelet count/viscoelastic calculations to assess specific characteristics of coagulopathy

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- 6. Permissible Hypotension: in the absence of TBI SBP should be kept between 80-90 mmHg (MAP greater than 80 in TBI)
 - 7. Fluid resuscitation should commence immediately for hypotensive bleeding patients
 - Crystalloids should be the initial choice
 - Avoid Ringer's lactate or any hypotonic fluids

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- Crystalloids vs. colloids: there is really no demonstrated benefit
 - Hypertonic solutions can be used judiciously with hypotensive patients with blunt abdominal trauma and TBI
 - Hypertonic solutions eg. 7.5% N/S can be used in hemodynamically unstable penetrating abdominal or thoracic injuries


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- 8. vasopressors can be used if there is no response to fluid resuscitation (norepinephrine)
 - 9. early application of measures to reduce heat loss (warm blankets, warmed fluids, warm operating room, remove wet clothing)

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- 10. Target Hb 70-90
 - 11. Damage control Surgery-resuscitation and correction of coagulopathy and acid-base balance in ICU-definitive surgical repair
 - 12. Damage control surgery entails stopping hemorrhage and preventing further contamination


- 13. Laparotomy should involve packing, direct pressure control, local hemostatic measures, and cross-clamping of the abdominal aorta in severe cases

14. Early use of tranexamic acid

- pre-hospital use and further dose within 3hrs of injury
- Lysine analogue that competitively inhibits plasminogen

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- CRASH-2 trial has demonstrated a significant survival benefit to those that receive pre-hospital and early administration
 - Less requirement for large transfusion
 - Harm if administered beyond 3hrs

- 15. Blood product administration should be in the ratio 1:1:1 (a minimum PRBC:FFP ratio of 2:1) WFB is superior but not widely available outside the military
- 16. If thromboelastometric evidence of functional fibrinogen deficit then cryoprecipitate should be administered

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- Monitoring Coagulation
 - PT (extrinsic pathway)
 - APTT (intrinsic pathway)
 - D-Dimer
 - Fibrinogen
 - Fibrin-split degradation products
 - Thromboelastogram (TEG)

Clotting → Kinetics → Strength → Lysis

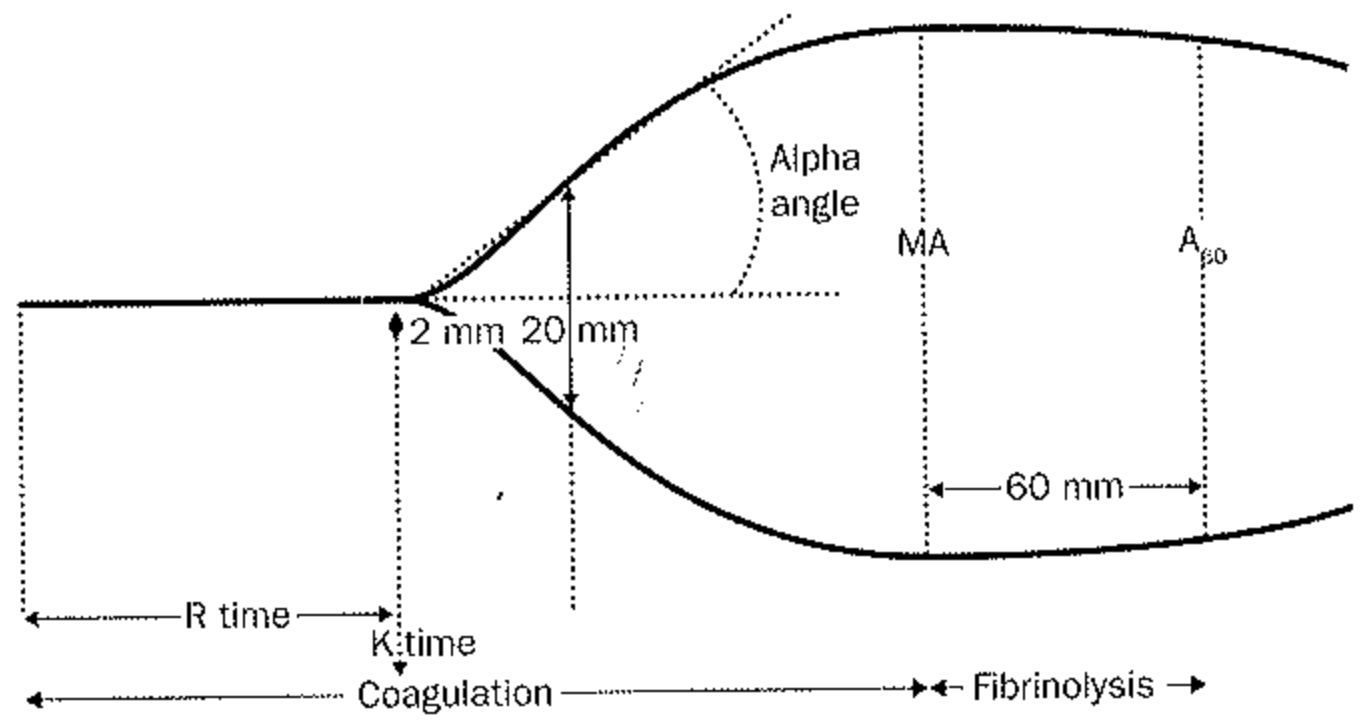





Table 3.2 Administration of medication based on thromboelastography

	Primary action	Secondary action
Reaction time prolonged	FFP	rFVIIa
Kinetic time prolonged	Cryoprecipitate	rFVIIa
Alpha angle $<65^\circ$	Cryoprecipitate/platelets	FFP/rFVIIa
Maximum amplitude <50 mm	Platelets	Desmopressin
Lysis at 30 minutes $>7.5\%$	Tranexamic acid	

FFP, fresh frozen plasma; rFVIIa, recombinant activated factor VIIa

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- New Oral Anticoagulant Therapy
 - Indicated in non-valvular AF as stroke prevention
 - Post-orthopedic surgery
 - Dapigatran direct thrombin inhibitor
 - Rivaroxiban Factor Xa inhibitor
 - More patients are on these and other antiplatelet and anticoagulant therapy

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- Dabigatran can be measured with thrombin clotting time and dabigatran assays, can be reversed only by dialysis
 - Rivaroxiban can measured with APTT and rivaroxiban assays, can partially be reversed with blood products and prothrombinex
 - Warfarin can be measured with PT/INR, reversed with prothrombin, vitamin K, and FFp

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- Clopidogrel, functional platelet dysfunction can be partially managed with platelet infusion
 - Aspirin, can partially be managed with desmopressin

References (Carlos' list)

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