IN THE NAME OF GOD

HYPOVOLEMIC AND HEMORRHAGIC SHOCK

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BACKGROUND

* LOW EXTRACELLULAR VOLUME
  ~ OFTEN INVOLVES ↓↓ in SODIUM & WATER

TREATMENT

* ORAL HYDRATION & DIET MAINTENANCE
* IV FLUIDS
* BLOOD TRANSFUSION

SIGNS & SYMPTOMS

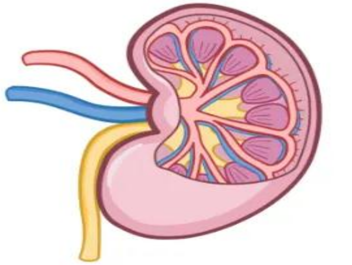
* WEAKNESS
* FATIGUE
* DIZZINESS
* ↑↑ THIRST

CAUSES

* DEHYDRATION
* TRAUMA
* EXCESSIVE FLUID ACCUMULATION between CELLS
* MEDICAL CONDITIONS:
  ~ RENAL DISEASE
  ~ CONGESTIVE HEART FAILURE

DIAGNOSIS

* BLOOD TEST
  ~ CBC
  ~ CHEMISTRY PANELS
* URINE TEST
  ~ ↑↑ BUN, CREATININE, URINE SODIUM CONCENTRATION, URINE pH
* X-RAY or MRI



- Severe hemorrhage after injury carries a mortality rate of 30% to 40% and is responsible for almost 50% of deaths occurring within 24 hours of injury.
- Hemorrhagic shock is an important contributor to postresuscitation organ failure and late mortality

- The principal objectives of fluid and blood resuscitation

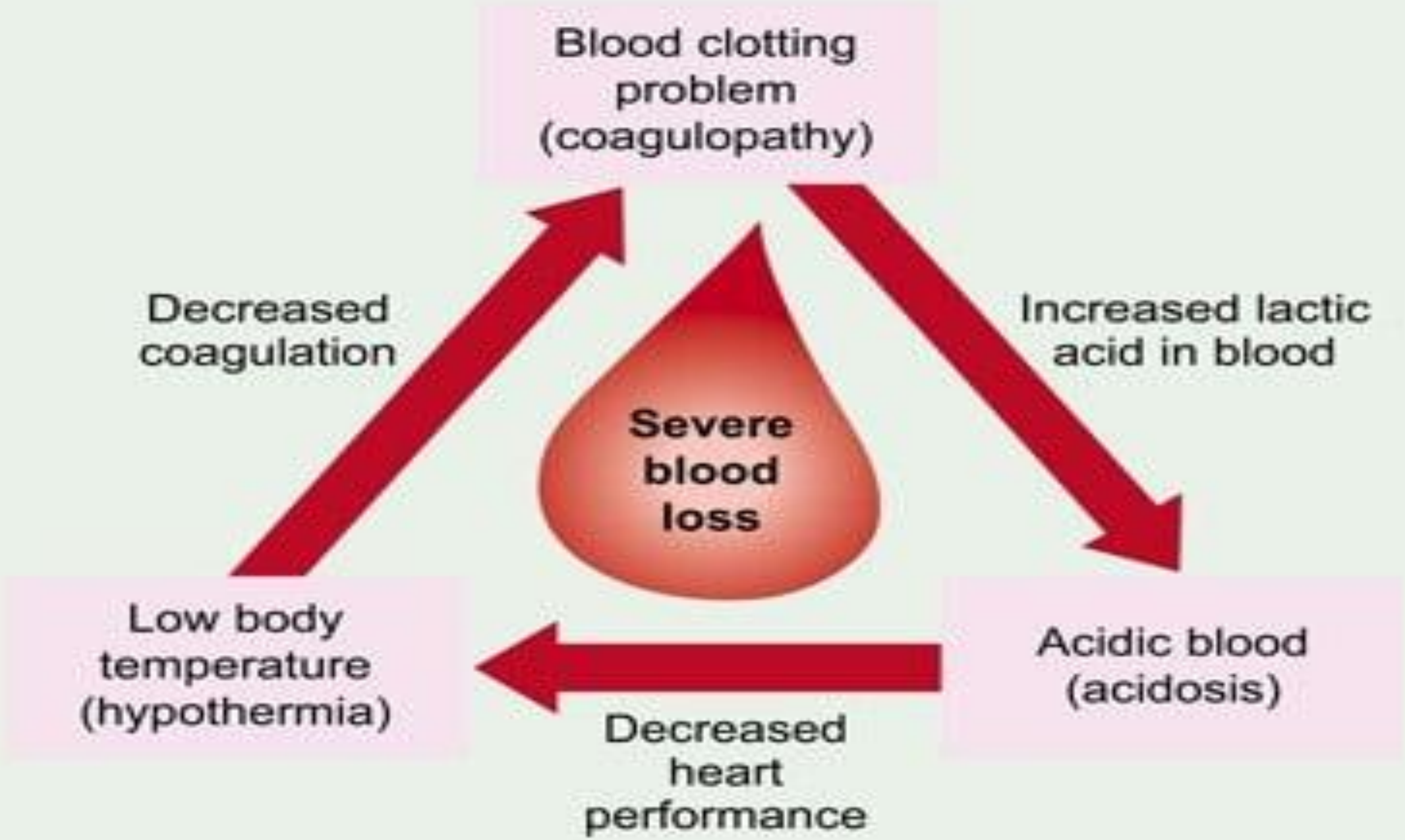
(1) to restore intravascular volume sufficient to maintain oxygen-carrying capacity and tissue perfusion for adequate cellular oxygen delivery

(2) to prevent or correct derangements in coagulation

- **Trauma-induced coagulopathy**

- A combination of factors beginning with tissue hypoxia, loss of coagulation factors from hemorrhage followed by hemodilution from crystalloid resuscitation, and then exacerbated by acidosis (evidenced by a base deficit) and hypothermia
- Acidosis does not, by itself, have a significant effect on coagulation until the pH decreases below 7.0

Trauma Triad of Death



CLINICAL FEATURES

- Cause
- Rate
- Volume
- Duration of volume loss or bleeding
- Presence of other acute disorders
- Effects of current medications
- Patient’s baseline physiologic status

- Tachycardia
- Hypotension
- Signs of poor peripheral perfusion (cool, pale, clammy extremities with weak peripheral pulses and prolonged capillary refill)
- Arterial and venous vasoconstriction leads to a narrowing of the pulse pressure
- Cerebral hypoperfusion causes alterations in mental status

- Classification of hemorrhage severity as a percentage of blood volume loss estimated based on systolic blood pressure, heart rate, and Glasgow Coma Scale is **not reliable** and should not be used to guide ED resuscitation

- Hemoperitoneum → increased vagal tone → Bradycardia or lack of tachycardia (about 30% of patients)

- In a **pregnant trauma patient**, compression of the inferior vena cava by the gravid uterus can decrease central venous return and worsen hypotension and tachycardia in the setting of less severe hemorrhage

- Vital signs offer little value unless they are in extreme low ranges
- **Arterial blood pressure** does not adequately reflect cardiac output or regional perfusion
- Clinical evidence of **peripheral hypoperfusion** is useful but is not a quantitative measurement.
- Metabolic information / assessment of mechanisms of injury / appropriate imaging

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The best chance for early recognition of severe hemorrhage and for guiding an appropriate response to treatment

- Lactate
- Base deficit
- Is associated with improvements in survival
- Elevated lactate and base deficit are late findings
- An earlier finding is an increase in oxygen extraction, indicated by a decrease in indicators of oxygen consumption such as mixed or central venous hemoglobin oxygen saturation

TREATMENT

- Resuscitation begins in the prehospital setting and continues in the ED
- The priority for prehospital care is treatment of life-threatening conditions and rapid transport to an appropriate facility

- **Adequate ventilation and oxygenation (including securing an airway if necessary)**
- **Controlling external bleeding (if present)**
- **Protecting the spinal cord (if potentially vulnerable)**

IN THE ED

- Rrestore intravascular volume to reverse or limit systemic and regional hypoperfusion
- Maintain oxygen-carrying capacity
- Limit ongoing blood loss
- Prevent the development of coagulopathy
- Prevent the development of hypothermia by keeping the patient warm and administering warmed IV fluids and blood products

- **Endogenous hypothermia** occurs when heat production from cellular respiration is decreased by hypoperfusion and inadequate tissue oxygen delivery
- Major causes of **Exogenous hypothermia** are exposure and the use of below-body-temperature fluid and blood resuscitation.
- Apply external warming devices early to prevent external heat escape

AIRWAY CONTROL, VENTILATION, AND OXYGENATION

- If spontaneous ventilation is not adequate, intubate and ventilate to achieve an arterial hemoglobin oxygen saturation of ≥94%.
- Identify and treat potential respiratory conditions such as pneumothorax, tension pneumothorax, hemothorax, or upper airway obstruction

VASCULAR ACCESS AND MONITORING

- Establish adequate IV access concurrent with airway management
- Large-bore (14- to 16-gauge in adults) peripheral lines
- Intraosseous lines are suitable for resuscitation when peripheral IV access is problematic

- Institute continuous ECG heart rate monitoring
- Continuous pulse oximetry
- Continuous end-tidal carbon dioxide monitoring
- Monitor arterial blood pressure, mental status, and peripheral perfusion frequently

Bedside FAST and POCUS are useful to identify:

- Intraperitoneal bleeding
- Assess cardiac function
- Volume status
- Aassist in central venous cannulation

HEMOSTATIC-HYPOTENSIVE RESUSCITATION

- (1) infusion of large volumes of either normal saline or lactated Ringer's solution can cause increased neutrophil activation
- (2) lactated Ringer's solution can increase cytokine release and may increase lactic acidosis when given in large volumes
- (3) normal saline can exacerbate intracellular potassium depletion and cause hyperchloremic acidosis

- Crystalloid solutions are isotonic but hypo-oncotic, because they lack the large protein molecules present in the plasma

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Low oncotic pressure results in substantial shifts of crystalloid to the extravascular space

TABLE 13-2 Theoretical Volemic Effect of 1 L of Fluid Administration on Fluid Compartments

	Intracellular (mL)	Interstitial (mL)	Plasma (mL)
5% dextrose in water	660	255	85
Normal saline or Ringer's lactate	–100	825	275
7.5% saline	–2950	2960	990
5% albumin	0	500	500
Whole blood	0	0	1000

- This was the physiologic basis for the 3:1 ratio for crystalloid to blood

- Loss of 1 L of blood (about 15% to 20% of total circulating blood volume) would require about 3 L of isotonic crystalloid to restore normovolemia, assuming no ongoing blood loss

- Solutions containing lactate or acetate are considered balanced crystalloids because they are buffered and have a lower chloride concentration compared to normal saline.
- Balanced crystalloids yield better clinical outcomes compared to normal saline in both critically ill and non–critically ill patients from all causes,
- Ringer’s lactate is compatible with current red blood cell preservatives

COLLOIDS

- Clinical trials of colloid resuscitation for traumatic shock have not demonstrated a clear survival benefit or reduction in morbidity

- The one advantage of colloids is that achievement of hemodynamic goals requires less volume to be infused

If ongoing hemorrhage is expected or operative repair is going to be delayed

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severely restricting the use of crystalloids and instead beginning the early use of blood products in blunt trauma victims

PACKED RED BLOOD CELLS

- If hemorrhage is definitively controlled, do not transfuse if the hemoglobin concentration is >7 grams/dL (>70 grams/L) for those without cardiopulmonary, cerebral, or peripheral vascular disease
- For those with comorbidities such as coronary artery or cerebrovascular disease, clinical judgment should be used for achieving and maintaining minimum hemoglobin levels, with the general principle that there is no benefit to transfusion when the hemoglobin concentration is >10 grams/dL (>100 grams/L).

- When possible, typed and cross-matched blood is preferable
- If time and the patient’s clinical status do not permit full cross-matching, type-specific blood is the next option, followed by low titer O-negative blood

PLASMA

- A unit of FFP has a volume of 200 to 250 mL
- Contains all the coagulation factors present in fresh blood
- Kept frozen, FFP can be stored for up to a year after the unit was collected
- It takes between 15 and 20 minutes to thaw a unit of FFP in a 37°C water bath, which can limit availability in a massive transfusion situation

- **When transfusing FFP**:
  - ABO compatibility is required
  - Because there are no red cells in FFP, Rh compatibility is less important
  - Universal donor FFP is typically AB+ and does not require cross-matching for emergency use

PLATELETS

- Can be stored for up to only 5 days
- Six units of pooled random-donor platelet concentrate in an adult will increase platelet count up to 50,000/mm3 (50 × 109/L)

MASSIVE TRANSFUSION PROTOCOLS

- Requirement for >10 units of PRBCs within the first 24 hours of injury
- An estimated 10% of military trauma patients and 3% to 5% of civilian trauma patients receive massive transfusion
- Massive transfusion is not a substitute for definitive surgical hemostasis but enhances the ability to achieve surgical hemostasis and to limit complications

- The Assessment of Blood Consumption score uses four values on patient arrival:

- Penetrating mechanism of injury
- Positive FAST examination
- Blood pressure <90 mm Hg
- Pulse rate >120 beats/min

The presence of two or more variables has a sensitivity for massive transfusion of 76% to 90%, with a specificity of 67% to 87

Massive Transfusion Protocol (MTP) – ADULT

Appropriate initial interventions:

- Intravenous access – 2 large bore IVs and Central Venous Cath
- Labs: T&S, CBC, Plts, INR, PT, PTT, Fibrinogen, Electrolytes. BUN/Creatinine, ionized calcium
- Continual monitoring: VS, U/O, Acid-base status
- Aggressive re-warming
- Prevent/Reverse acidosis
- Correct hypocalcemia: CaGluconate or CaCl
- Target goal ionized calcium 1.2–1.3
- If use CaCl 1 gm, give slowly IV
- Repeat lab testing to evaluate coagulopathy
- Stop crystalloid - avoid dilutional coagulopathy

Other considerations:

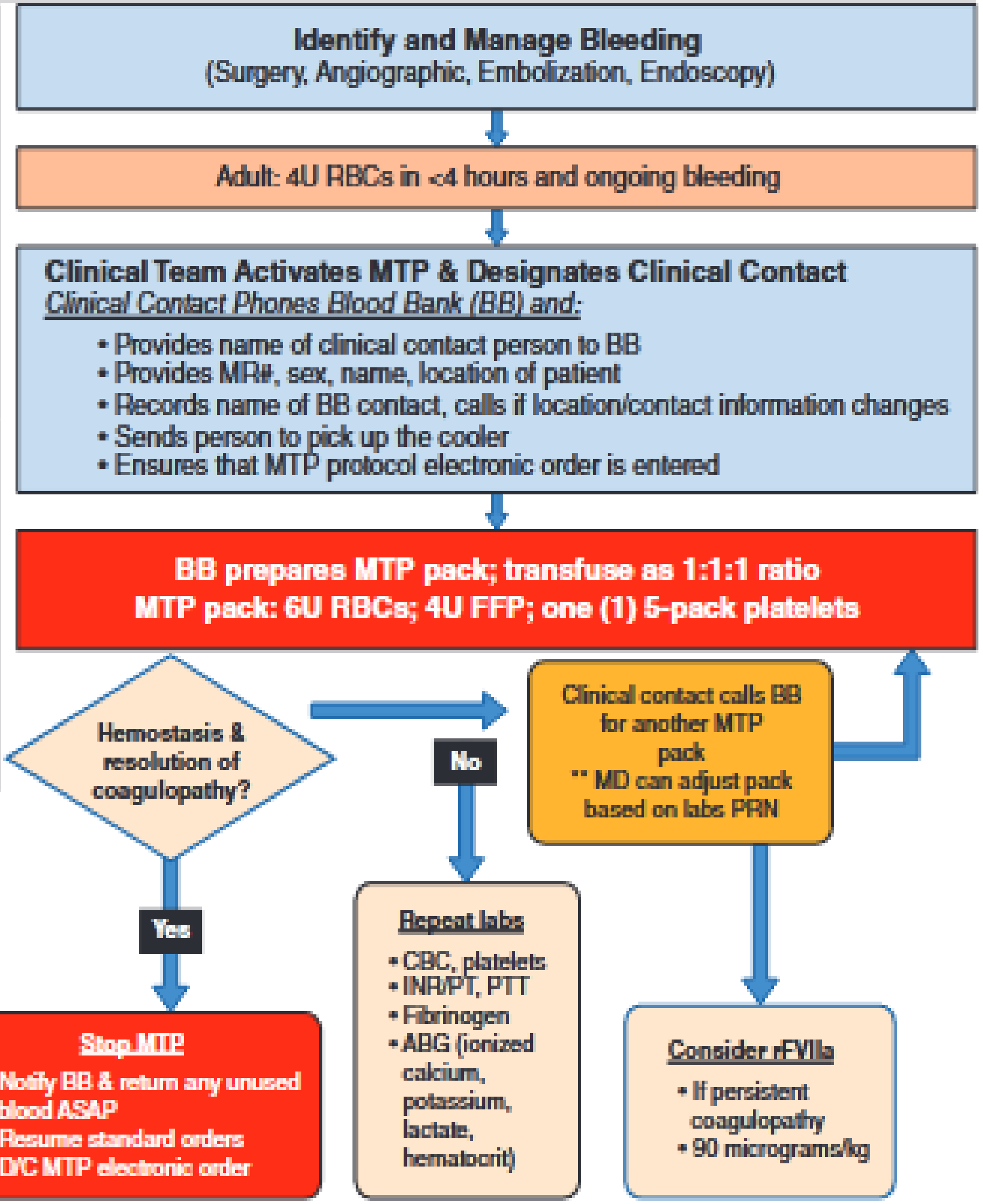
- Cell salvage: Anes Tech via front desk
- Heparin reversal: Protamine 1 mg IV/100 U heparin
- Warfarin reversal: Vitamin K 10 mg IV: consider prothromin CC
- Chronic Renal Failure or VW Disease: DDAVP 0.3 microgram/kg IV x 1 dose
- Consider antifibrinolytics:
  - Tranexamic acid 10 mg/kg IV
  - Amicar 5 gm IV bolus then 1 gm/hr IV infusion

Additional help

- Anesthesia: Page

General Guidelines for Lab-based Blood Component Replacement in Adults:

Product	Threshold	Dose
RBCs	No threshold	MD discretion
FFP	INR >1.5	4 units FFP
Platelets	<100,000	One 5-pack Plts
Cryoprecipitate	Fibrinogen <100	Two 5-packs cryoprecipitate



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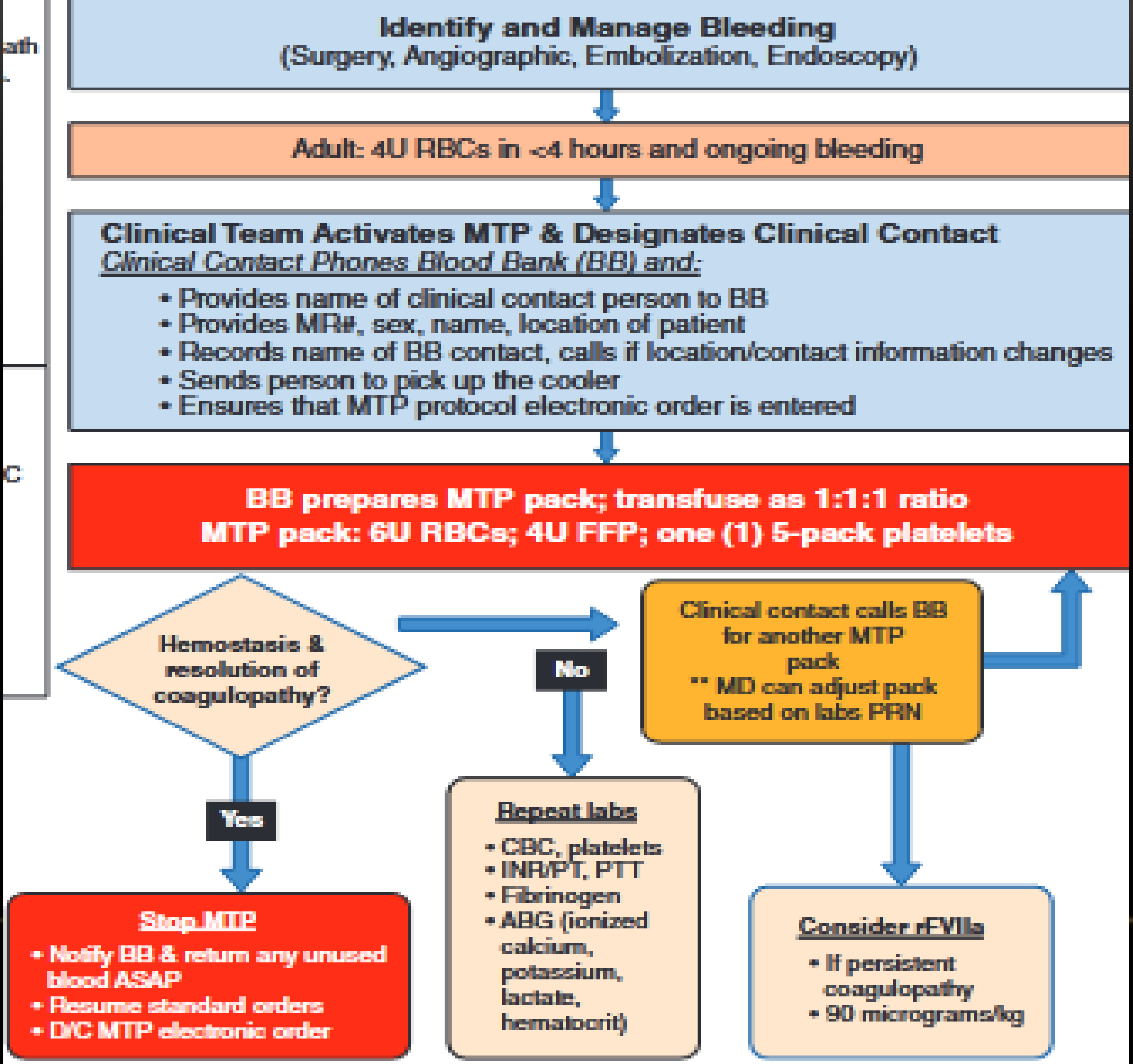
Identify and Manage Bleeding
(Surgery, Angiographic, Embolization, Endoscopy)
Adult: 4U RBCs in <4 hours and ongoing bleeding
Clinical Team Activates MTP & Designates Clinical Contact
Clinical Contact Phones Blood Bank (BB) and:
• Provides name of clinical contact person to BB
• Provides MR#, sex, name, location of patient
• Records name of BB contact, calls if location/contact information changes
• Sends person to pick up the cooler
• Ensures that MTP protocol electronic order is entered
BB prepares MTP pack; transfuse as 1:1:1 ratio
MTP pack: 6U RBCs; 4U FFP; one (1) 5-pack platelets
Hemostasis & resolution of coagulopathy?
No
Clinical contact calls BB for another MTP pack
** MD can adjust pack based on labs PRN
Yes
Stop MTP
• Notify BB & return any unused blood ASAP
• Resume standard orders
• D/C MTP electronic order
Repeat labs
• CBC, platelets
• INR/PT, PTT
• Fibrinogen
• ABG (ionized calcium, potassium, lactate, hematocrit)
Consider rFVIIa
• If persistent coagulopathy
• 90 micrograms/kg

TRANEXAMIC ACID

- Antifibrinolytic
- advocated early in the resuscitation of major trauma victims suggesting improved survival
- Military and civilian studies reduces overall mortality

CALCIUM

- PRBCs and FFP contain citrate that can complex calcium,producing life-threatening hypocalcemia
- Most massive transfusion protocols include the administration of calcium and/or monitoring of ionized calcium
- Calcium chloride is preferred over calcium gluconate
- A well-perfused liver is required to liberate more free calcium from calcium gluconate

VISCOELASTIC HEMOSTATIC ASSAYS

- Conventional coagulation testing such as the prothrombin time and activated partial thromboplastin time does not account for the cellular components of the clot such as red cells and platelets
- Newer viscoelastic hemostatic assays, namely thromboelastography and rotational thromboelastometry, measure the physical and dynamic characteristics of clotting

- Can be used to guide massive transfusion protocols better than traditional prothrombin time and activated partial thromboplastin time assays

- Improve survival and reduce total blood product use

THANK YOU