CMC TCCC

COMBAT MEDIC/ CORPSMAN

DHA Defense Health Agency JOINT TRAUMA SYSTEM

TACTICAL COMBAT CASUALTY CARE COURSE

MODULE 11: HEMORRHAGIC SHOCK FLUID RESUSCITATION IN TACTICAL FIELD CARE (TFC)

Committee on Tactical Combat Casualty Care (CoTCCC)

TCCC TIER 1
All Service Members

TCCC TIER 2
Combat Lifesaver

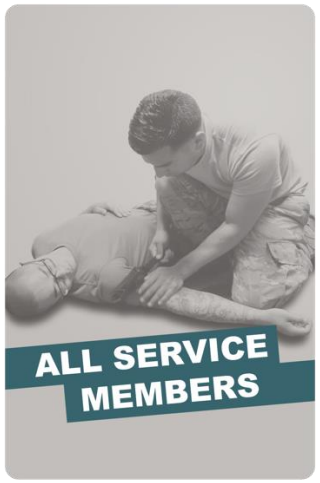
TCCC TIER 3
Combat Medic/Corpsman

TCCC TIER 4
Combat Paramedic/Provider

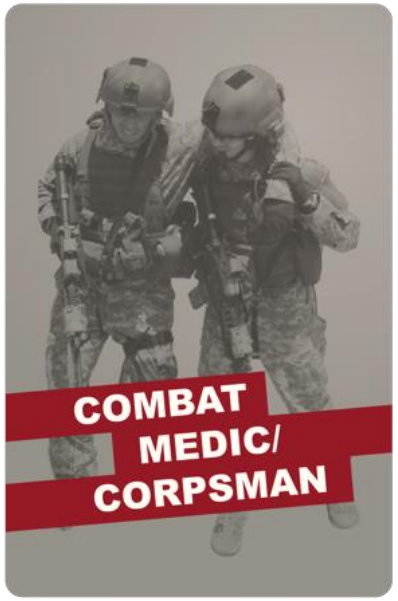
TACTICAL COMBAT CASUALTY CARE (TCCC) ROLE-BASED TRAINING SPECTRUM

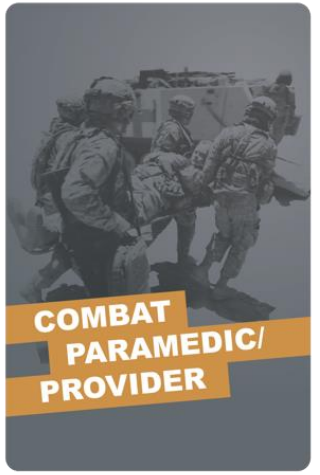
ROLE 1 CARE

NONMEDICAL PERSONNEL



MEDICAL PERSONNEL





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STANDARDIZED JOINT CURRICULUM

1 x TERMINAL LEARNING OBJECTIVES

14 Given a combat or noncombat scenario, perform fluid resuscitation as part of the management of hemorrhagic shock on a trauma casualty during Tactical Field Care in accordance with CoTCCC Guidelines.

- **14.1** Identify progressive strategies, indications, and limitations of fluid resuscitation for hemorrhagic shock in Tactical Field Care.
- **14.2** Identify appropriate fluid resuscitation techniques to prevent or treat hemorrhagic shock in Tactical Field Care.
- **14.3** Identify the importance and advantages of early use of blood products in Tactical Field Care.
- **14.4** Identify the indications, contraindications, and administration methods of low-titer group O whole blood in Tactical Field Care.
- **14.5** Identify the considerations, indications, contraindications, and administration methods of fresh whole blood in Tactical Field Care.
- **14.6** Identify the indications, contraindications, and administration methods of plasma in Tactical Field Care.
- **14.7** Identify the indications, contraindications, and administration methods of packed red blood cells in Tactical Field Care.
- **14.8** Demonstrate administration of blood products to a trauma casualty in Tactical Field Care.
  - a. EldonCard®
  - b. Donor blood product collection
  - c. Administration of blood products
- **14.9** Identify the signs, symptoms, considerations, and treatment strategies of blood transfusion complications.

9 x ENABLING LEARNING OBJECTIVES

\# = **Terminal Learning Objectives** ● = Cognitive ELOs ▨ = Performance ELOs

MARCH PAWS

LIFE-THREATENING

- **M** MASSIVE BLEEDING — #1 Priority
- **A** AIRWAY
- **R** RESPIRATION *(Breathing)*
- **C** CIRCULATION
- **H** HYPOTHERMIA / HEAD INJURIES

AFTER LIFE-THREATENING

- **P** PAIN
- **A** ANTIBIOTICS
- **W** WOUNDS
- **S** SPLINTING

INTRO TO FLUID RESUSCITATION FOR SHOCK

1990s-2000s

Fluid resuscitation based on civilian guidelines
- Crystalloids
- Colloids

2003-2006

TCCC Guidelines include blood products for CASEVAC

2014

Crystalloids, Hextend® and **PLASMA-LYTE A** de-prioritized to be used only if blood products are not available

2018

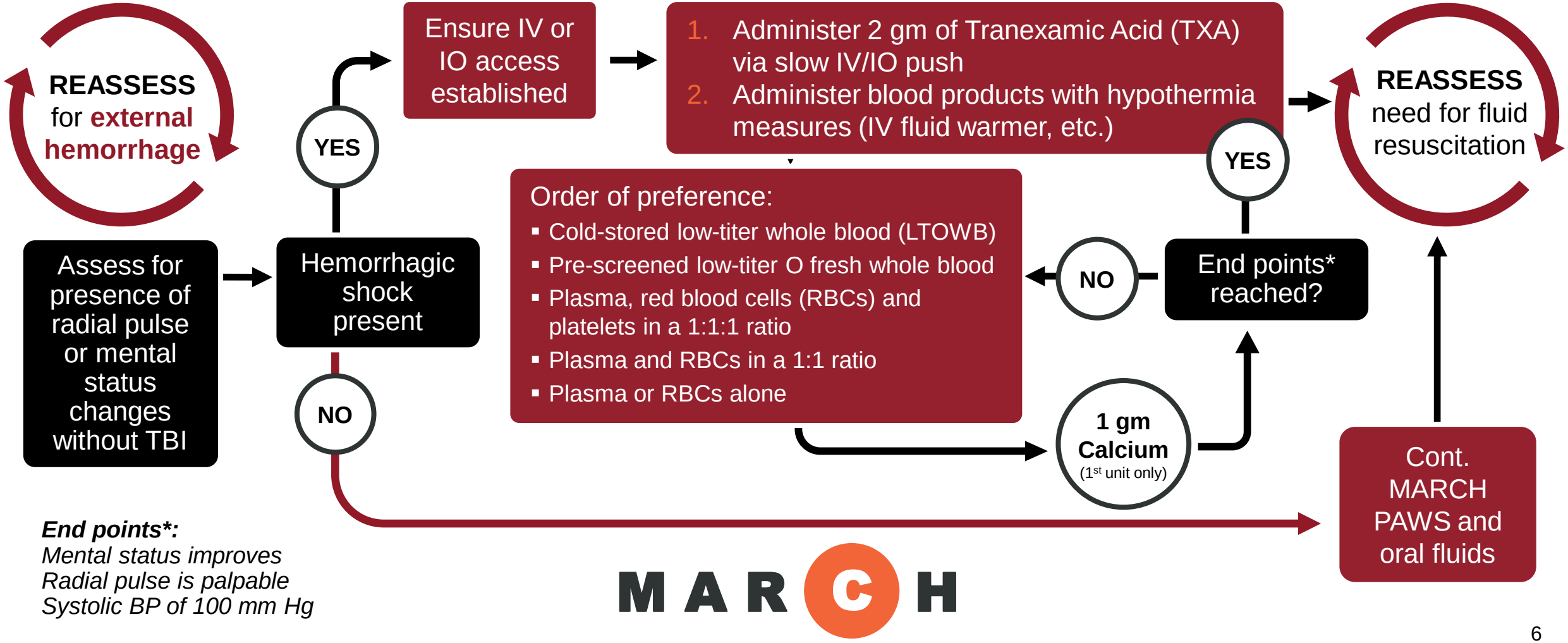
FDA Emergency Use Authorization for freeze-dried plasma in shock

2020

Updated guidelines emphasize cold-stored or fresh whole blood, other fluids not recommended for hemorrhagic shock

MARCH

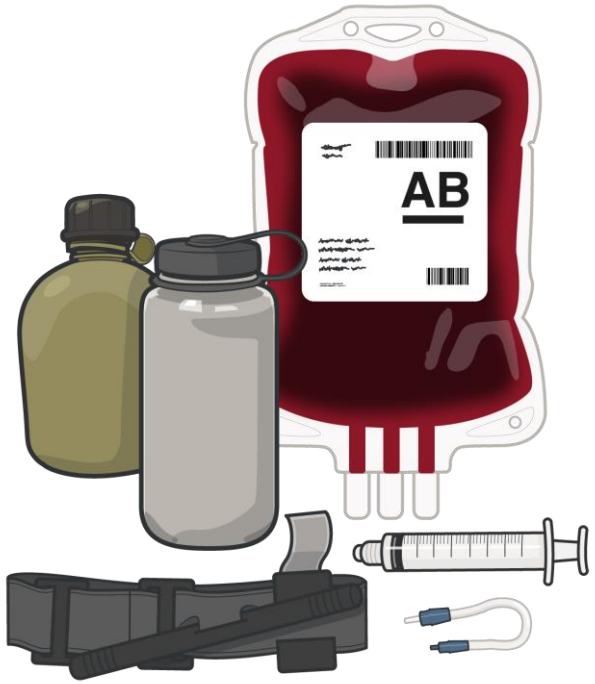
PROGRESSIVE STRATEGIES FOR FLUID RESUSCITATION IN HEMORRHAGIC SHOCK



End points*:
Mental status improves
Radial pulse is palpable
Systolic BP of 100 mm Hg

MARCH

TECHNIQUES FOR PREVENTION AND TREATMENT OF HEMORRHAGIC SHOCK



Oral rehydration, if the casualty can swallow, is appropriate and recommended

- Dehydration is a risk during treatment and evacuation
- Risk of emesis and aspiration is very low

Consider placing saline lock, if tactically feasible

Fluid selection priorities are:

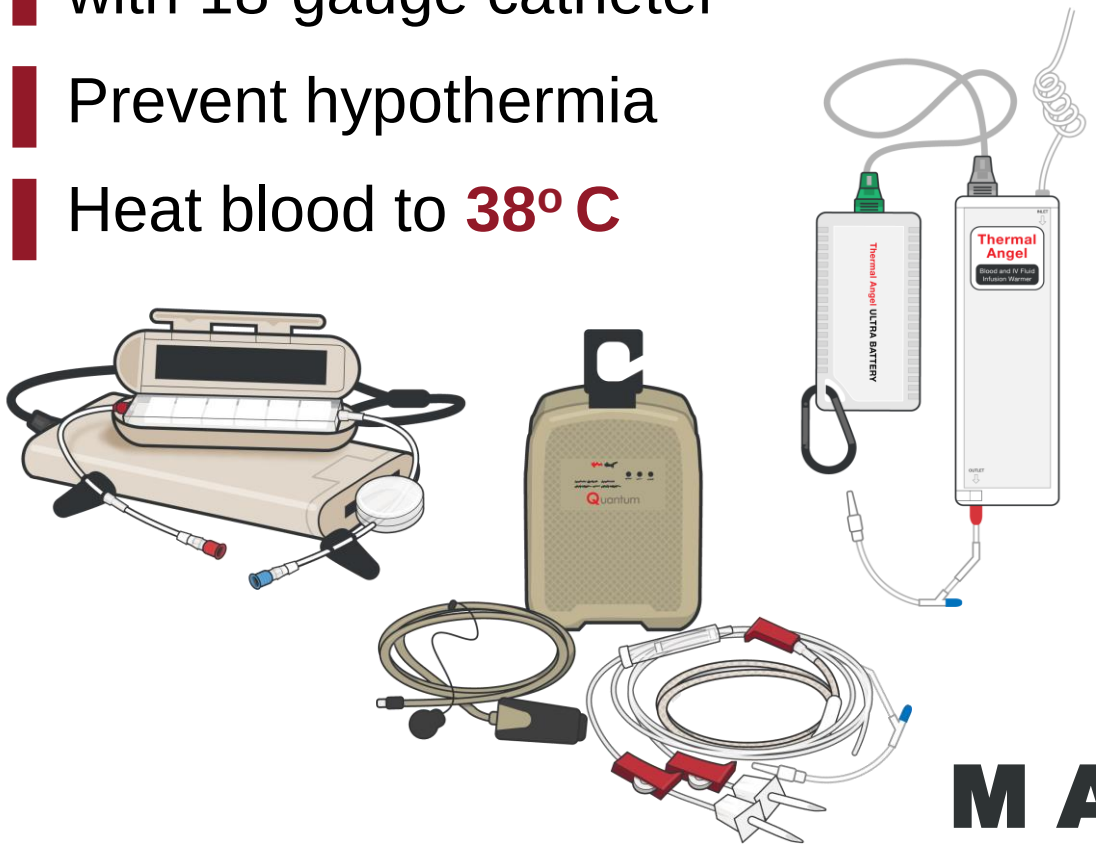
- Cold-stored low-titer O whole blood
- Pre-screened low-titer O fresh whole blood
- Plasma, red blood cells (RBCs) and platelets in a **1:1:1 ratio**
- Plasma and RBCs in a **1:1 ratio**
- Plasma or RBCs alone

⚠ Best prevention of hemorrhagic shock is **control** of all sources of **bleeding**

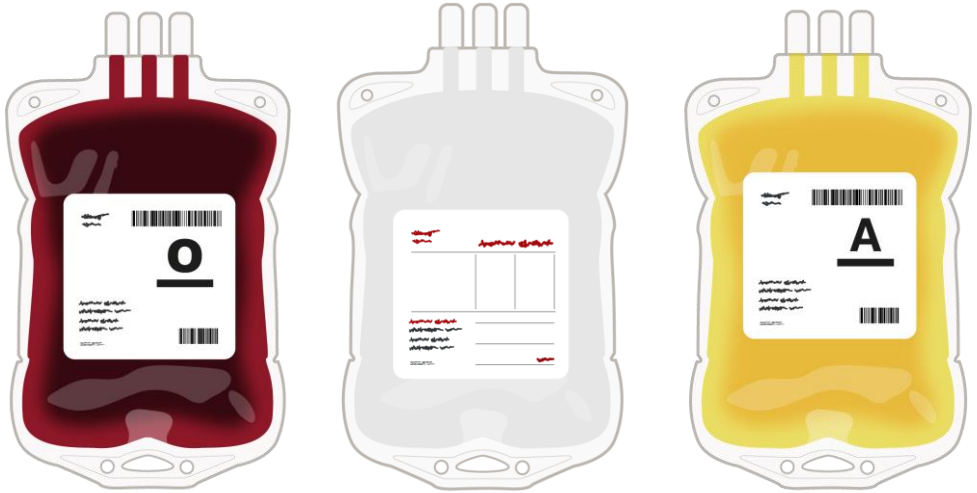
MARCH

APPROPRIATE TECHNIQUES FOR TREATMENT OF HEMORRHAGIC SHOCK

- **Establish IV** or **IO** access with 18-gauge catheter
- Prevent hypothermia
- Heat blood to **38º C**



Gather **blood products** for transfusion:



Cold-stored whole blood

Fresh blood collected in the field

Plasma, RBCs, platelets

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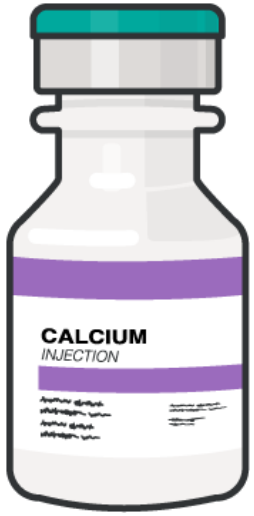
APPROPRIATE TECHNIQUES FOR TREATMENT OF HEMORRHAGIC SHOCK (CONT.)



RISK OF HYPOCALCEMIA from citrate binding to endogenous calcium

- Replace with **1 gm Ca++**

REASSESS after every transfusion of a unit of blood products

End points for **fluid resuscitation**:

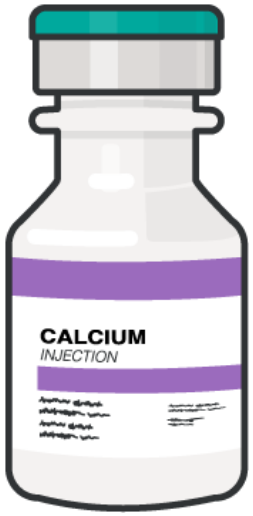
- A palpable radial pulse
- Improved mental status
- Systolic BP of 100 mm Hg

More is **not necessarily** better

- Potential for clot disruption from higher pressures
- Blood products are a valuable resource to conserve, when possible

MARCH

CALCIUM ADMINISTRATION



DOSAGE(S):

- Calcium **1 gm** IV daily

ROUTE(S):

- *Calcium is available in IV or IO form*

INDICATIONS:

- For use after blood product transfusions

CONTRAINDICATIONS:

- Ventricular fibrillation
- Hypercalcemia
- Hypophosphatemia
- Renal calculi

Use cautiously in:

- Digitalized patients
- Patients with sarcoidosis
- Renal or cardiac disease
- Respiratory acidosis
- Respiratory failure potential

CALCIUM
ADMINISTRATION cont.

POTENTIAL SIDE EFFECTS:

Tingling sensations, headache, irritability, weakness, syncope with rapid IV injection, mild decrease in blood pressure, vasodilation, bradycardia, arrhythmias, rebound hyperacidity, nausea polyuria, renal calculi, hypercalcemia, and local reactions

DRUG INTERACTIONS:

Decreased bioavailability with atenolol, fluoroquinolones and tetracyclines, calcium channel blockers decrease calcium effectiveness, cardiac glycosides increase digitalis toxicity, thiazide diuretics cause a risk of hypercalcemia

ONSET/PEAK/DURATION:

Immediate/immediate/1-2 hr

TACTICAL CONSIDERATIONS:

Administer one gram of calcium as either 30 ml of 10% calcium gluconate or 10 ml of 10% calcium chloride; immediately after the first transfused blood product. Monitor calcium chloride infusion closely as severe necrosis and skin sloughing can occur if peripheral IV extravasates.

IMPORTANCE AND ADVANTAGES OF EARLY USE OF BLOOD PRODUCTS

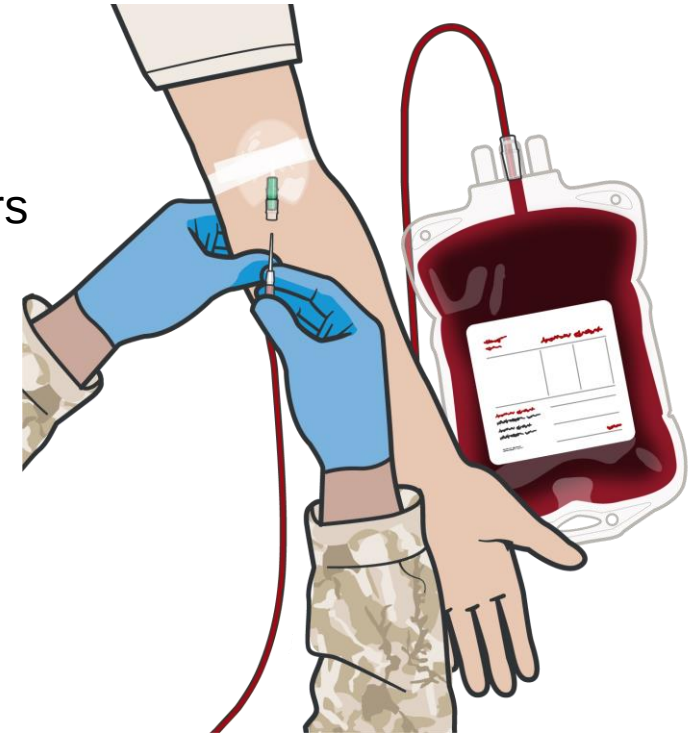
502 U.S. military combat casualties in Afghanistan (2012-2015):
*Time to initial blood product transfusion associated with **reduced** 24-hour and 30-day **mortality***

Ensure processes to move **cold-stored LTOWB**

- Electric-powered coolers at distribution sites
- Battery-operated containers for field use

Prepare alternate to **cold-stored LTOWB**

- Prescreen unit members for potential donors



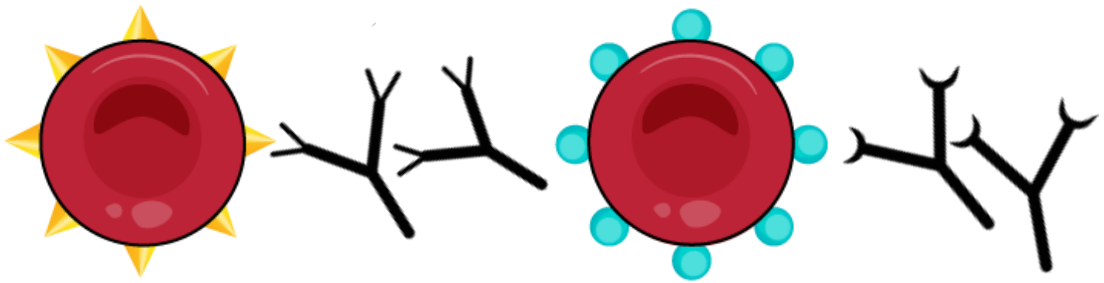
MARCH

INDICATIONS AND ADVANTAGES OF USING LOW-TITER GROUP O WHOLE BLOOD

The preferred fluid for hemorrhagic shock resuscitation is **cold-stored low-titer O whole blood (LTOWB)**

Low-titer type O whole blood

- Titers refer to **anti-A/anti-B** in plasma
- WWII experience was mild reactions with titers **>512**
- Current threshold for low titer **<256**



Advantages of **cold-stored LTOWB:**

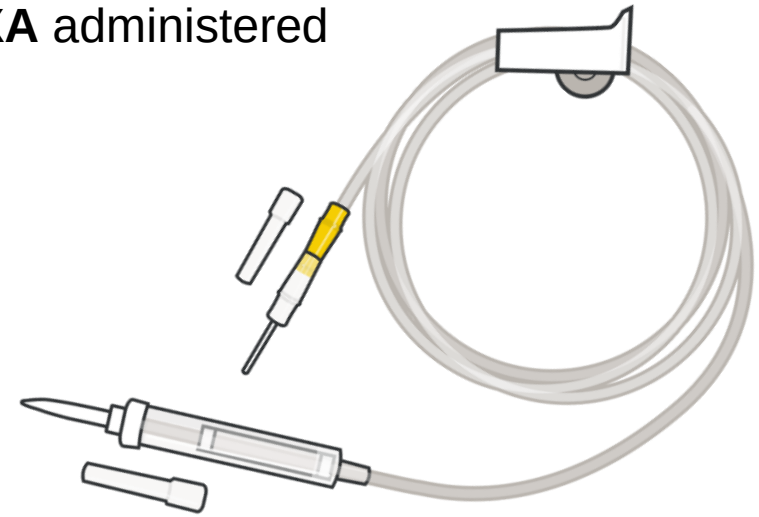
- Tested for diseases (FDA requirement)
- Titers and leukocyte reduction
- Ready for immediate transfusion
- Whole blood better than three-component replacement in at least one study

MARCH

METHODS OF TRANSFUSING LOW-TITER GROUP O WHOLE BLOOD

Prior to fluid resuscitation ensure:

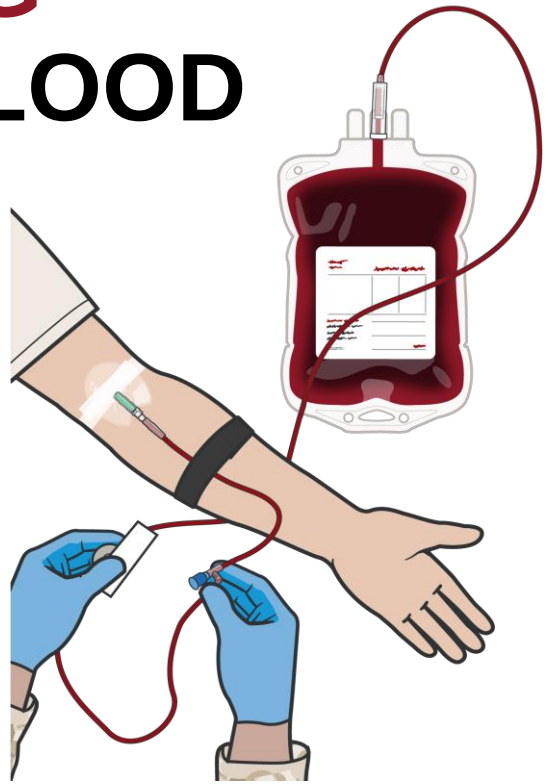
- **External Hemorrhage** is controlled
- **IV** or **IO** line with fluid is in place and functioning properly
- **TXA** administered



<5 MIN

Begin transfusion within **5 min** of starting the process

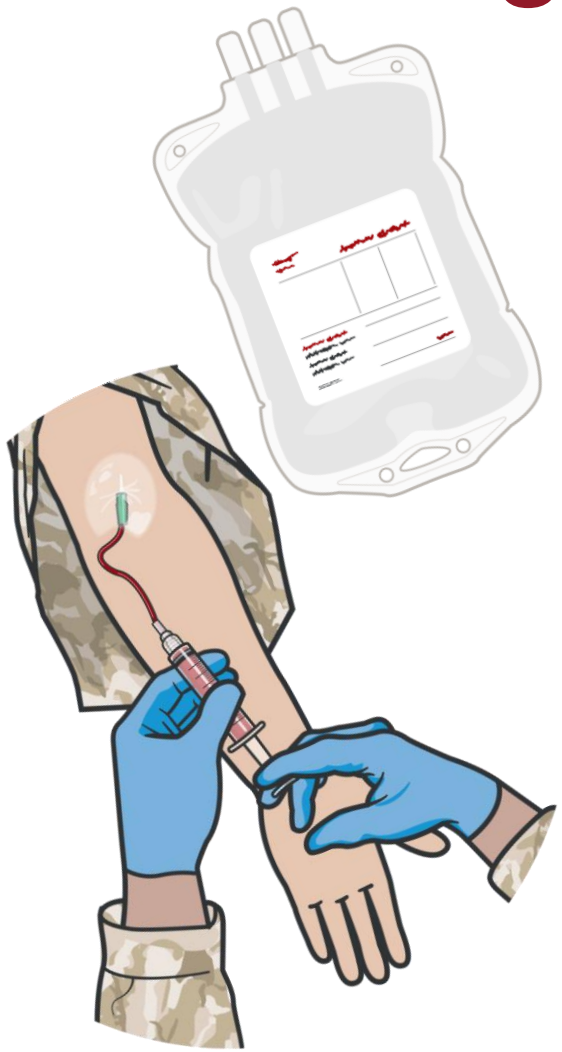
- Administer **1 gm of calcium** after the first unit
- Assess for and treat blood transfusion reactions:
  - **Anaphylactic reaction** *(hives, itching, stridor/shortness of breath, and/or hypotension*
  - **Acute hemolytic reaction** *(arm pain, chest pain, back pain, nausea, disseminated intravascular coagulation, and/or fever)*



⚠ Blood filters remove small clots that develop during collection and storage

MARCH

INDICATIONS AND METHODS OF USING FRESH WHOLE BLOOD



If cold-stored **LTOWB** is not available, utilize **Pre-screened low titer O fresh whole blood**

Ideally, fresh whole blood donors are pre-screened

- Known low titers
- No transmissible diseases
- Could be group-specific (A-A, B-B), although up to 4% inaccuracy

POSSIBLE ADVANTAGES

- Availability even when cold chain is not in place (or cold stores exhausted)
- Degree of hypothermia during transfusion may be less than cold-stored LTOWB

POTENTIAL ISSUES

- Time to collect blood may delay transfusion
- Unit members unavailable while donating

MARCH

INDICATIONS AND METHODS OF USING RED BLOOD CELLS

In the absence of whole blood, either cold-stored or fresh, packed **red blood cells (RBCs)**, **platelets** and **plasma** in a **1:1:1 ratio** should be used

1 part **RBCs** : 1 part **platelets** : 1 part **plasma**

If three component therapy isn't available, then:
Plasma and RBCs in a 1:1 ratio
if unavailable then:
Plasma or RBC's alone

Separate blood components have **different active shelf-lives**

Platelets
5 days room temp, 15 days refrigerated

Plasma
40 days frozen, 5 days thawed

RBCs
35-42 days refrigerated, depending on preservative

MARCH

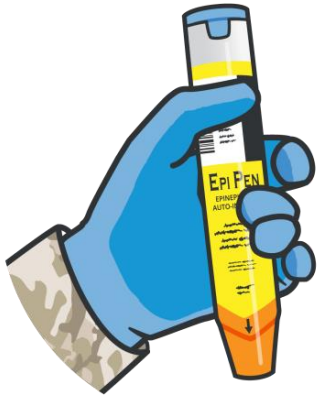
TRANSFUSION COMPLICATION IDENTIFICATION AND MANAGEMENT STRATEGIES

Monitor all transfusions for complication and adverse reactions:

Anaphylaxis – life-threatening allergic reaction
Stridor/SOB
Hypotension
Early signs – hives, itching

STOP TRANSFUSION

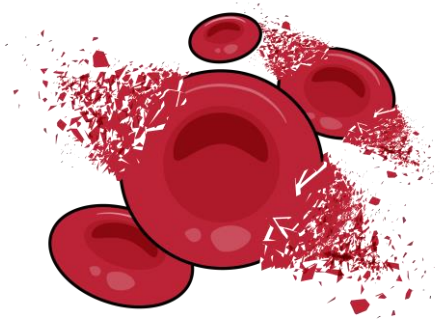
- Initiate NS or LR infusion
- 0.3 mg of 1:1000 epinephrine IM
- 25 mg of diphenhydramine IM or slow IV push
- If available, consider 10-40 mg methylprednisolone slow IV push



Acute hemolysis – rupture of RBCs
Flank, chest, arm or back pain
Fever
Disseminated intravascular coagulation
Early sign – nausea

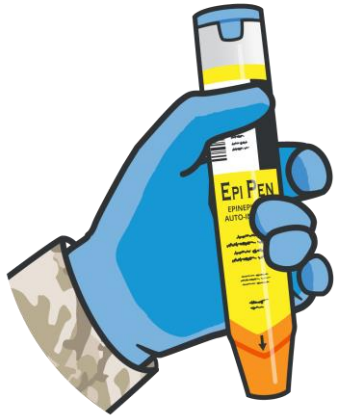
STOP TRANSFUSION

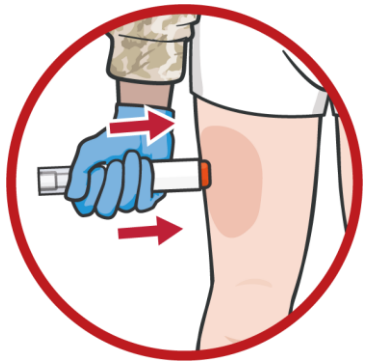
- Initiate NS or LR infusion
- 25 mg of diphenhydramine IM or slow IV push



MARCH

EPINEPHRINE ADMINISTRATION





DOSAGE(S):

- 0.3 mg (1:1000 solution), repeated every 5 to 10 minutes as necessary

ROUTE(S):

- *IM or subcutaneous*

INDICATIONS:

- Emergency treatment of anaphylaxis or allergic reactions.

CONTRAINDICATIONS:

- None

POTENTIAL SIDE EFFECTS:

- Anxiety, restlessness, tremor, weakness, dizziness, sweating, palpitations, pallor, nausea and vomiting, headache, disorientation, and tachycardia

MARCH

EPINEPHRINE ADMINISTRATION cont.

DRUG INTERACTIONS:

- Antihypertensives reduce the pressor effects of epinephrine, thyroid hormones, antihistamines and some anti-arrhythmic medications increase its arrhythmogenic effects

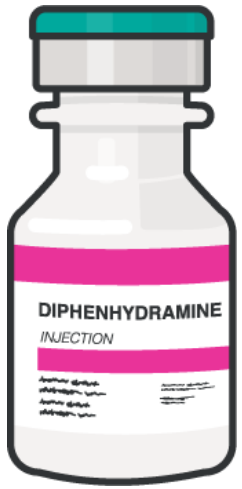
ONSET/PEAK/DURATION:

- 15-30 sec (IM<subcutaneous)/ 20 sec to 4 min/5-10 min

TACTICAL CONSIDERATIONS:

- Standard EpiPens® deliver the recommended 0.3 mg IM dose
- Casualties in hemorrhagic shock have poor tissue perfusion to their extremities reducing the delivery of epinephrine; use large muscle groups closest to the torso (in order of preference: thigh > deltoid > gluteal).

DIPHENHYDRAMINE ADMINISTRATION



DOSAGE(S):

- 25 mg initial dose, may consider 50 mg based on clinical situation; repeat q 4-6 hr prn; max daily dose 300 mg

ROUTE(S):

- *IM, IO & IV*

INDICATIONS:

- Emergency treatment of anaphylaxis or allergic reactions

CONTRAINDICATIONS:

- Documented hypersensitivity to diphenhydramine, breastfeeding mothers, use in pregnancy if clearly needed

POTENTIAL SIDE EFFECTS:

- Sedation/somnolence/sleepiness, drowsiness, unsteadiness, dizziness, headache, rare extrapyramidal effects, tremor, or convulsions

DIPHENHYDRAMINE
ADMINISTRATION cont.

DRUG INTERACTIONS:

- Accentuates effects of other medications that cause drowsiness or decreased level of consciousness (sedatives, hypnotics)

ONSET/PEAK/DURATION:

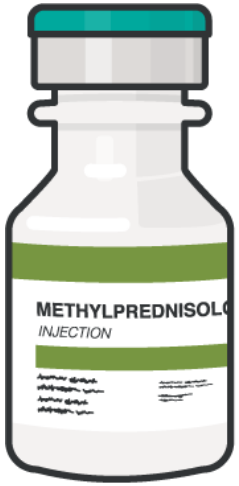
- 10 sec-20 min (IV<IO<IM)/ 15 min-2 hr/2-6 hr

TACTICAL CONSIDERATIONS:

- There is no evidence to support H1-antihistamines alone in emergency management of anaphylaxis – diphenhydramine should only be used as an adjunct to epinephrine during anaphylaxis management; the slower onset and longer duration may help sustain effects of successful treatment.
- Useful for minor reactions that are not life-threatening
- Casualty weapons, communications, and sensitive equipment should be secured.

MARCH

METHYLPREDNISOLONE ADMINISTRATION



DOSAGE(S):

- 10-40 mg

ROUTE(S):

- *Slow IV or IO push (over one minute)*

INDICATIONS:

- Blood product transfusion anaphylactic reaction

CONTRAINDICATIONS:

- Systemic fungal infections and known hypersensitivity (prior allergic reaction); potential benefits may warrant use in pregnant women despite potential risks if the alternative is worse

POTENTIAL SIDE EFFECTS:

- Sodium retention, fluid retention, potassium depletion, hyperglycemia, increased liver function tests, muscle weakness, impaired sweating, pancreatitis, esophagitis, urticaria or allergic reactions

MARCH

METHYLPREDNISOLONE ADMINISTRATION cont.

DRUG INTERACTIONS:

- Accentuates effects of other medications that cause drowsiness or decreased level of consciousness (sedatives, hypnotics)

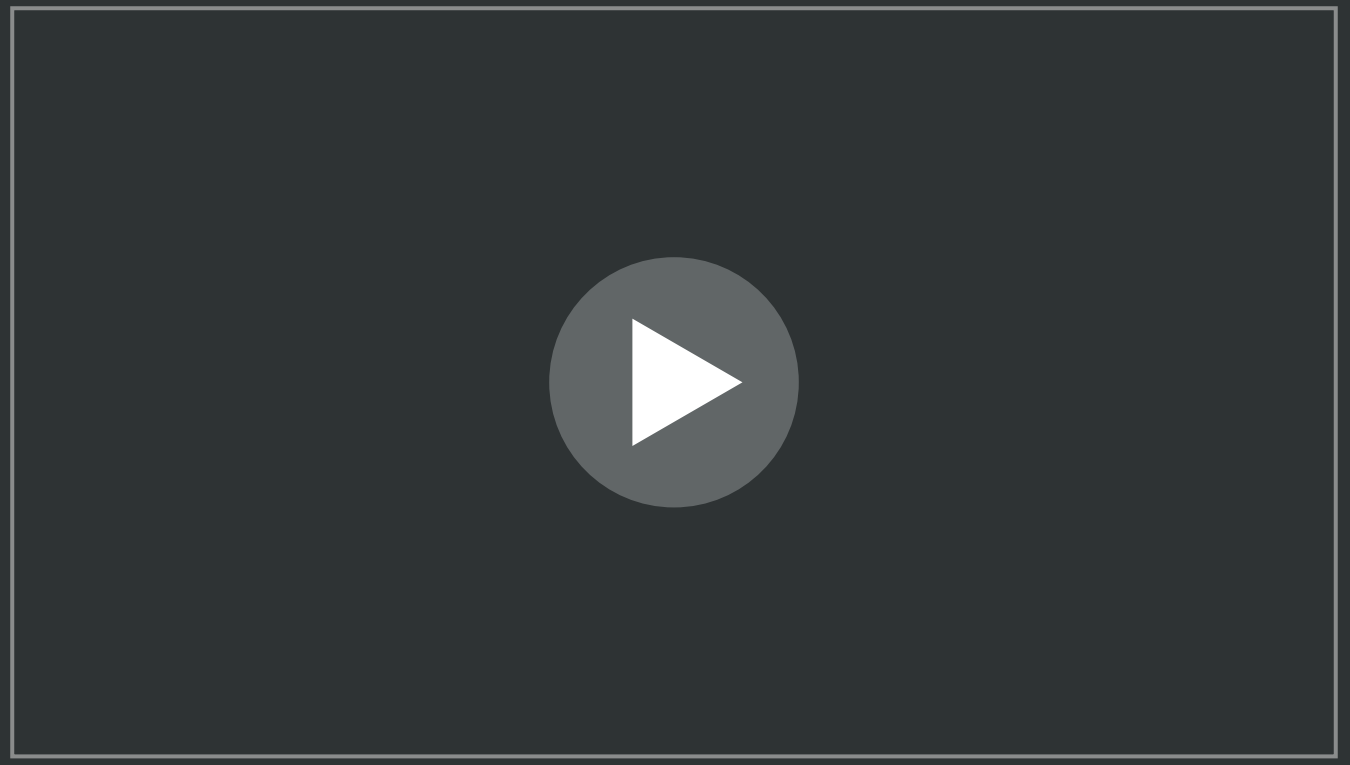
ONSET/PEAK/DURATION:

- Immediate/1-2 min/1 hr

TACTICAL CONSIDERATIONS:

- Administer 10-40 mg IV or IO, after first administering epinephrine and diphenhydramine, when treating an anaphylactic reaction from a blood product transfusion.

ADMINISTRATION OF BLOOD PRODUCTS IN TACTICAL FIELD CARE



Video can be found on deployedmedicine.com

INDICATIONS AND METHODS OF USING PLASMA

Freeze-dried plasma (FDP)

- Developed in 1930s
- Used in WWII and Korea
- Stopped because of disease transmission
- Continued by other nations
- Rekindled interested by US military due to problems with access to whole blood at battlefront
- Approved for use in hemorrhagic shock in recent years

PLASMA

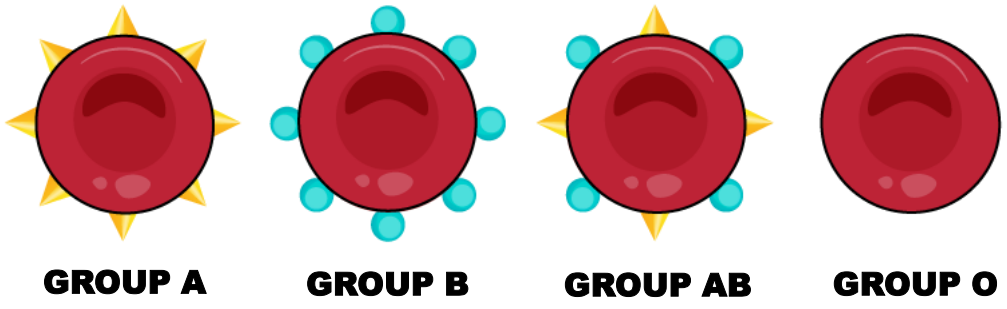
- Provides fibrinogen and hemostatic factors
- Although best with other blood products, can be used alone
- **FDP** stored without refrigeration and carried by Combat Medics
- **FDP** reconstituted in vials must be administered through vented tubing, but with collapsible bags standard blood tubing can be used

MARCH

BLOOD TYPING

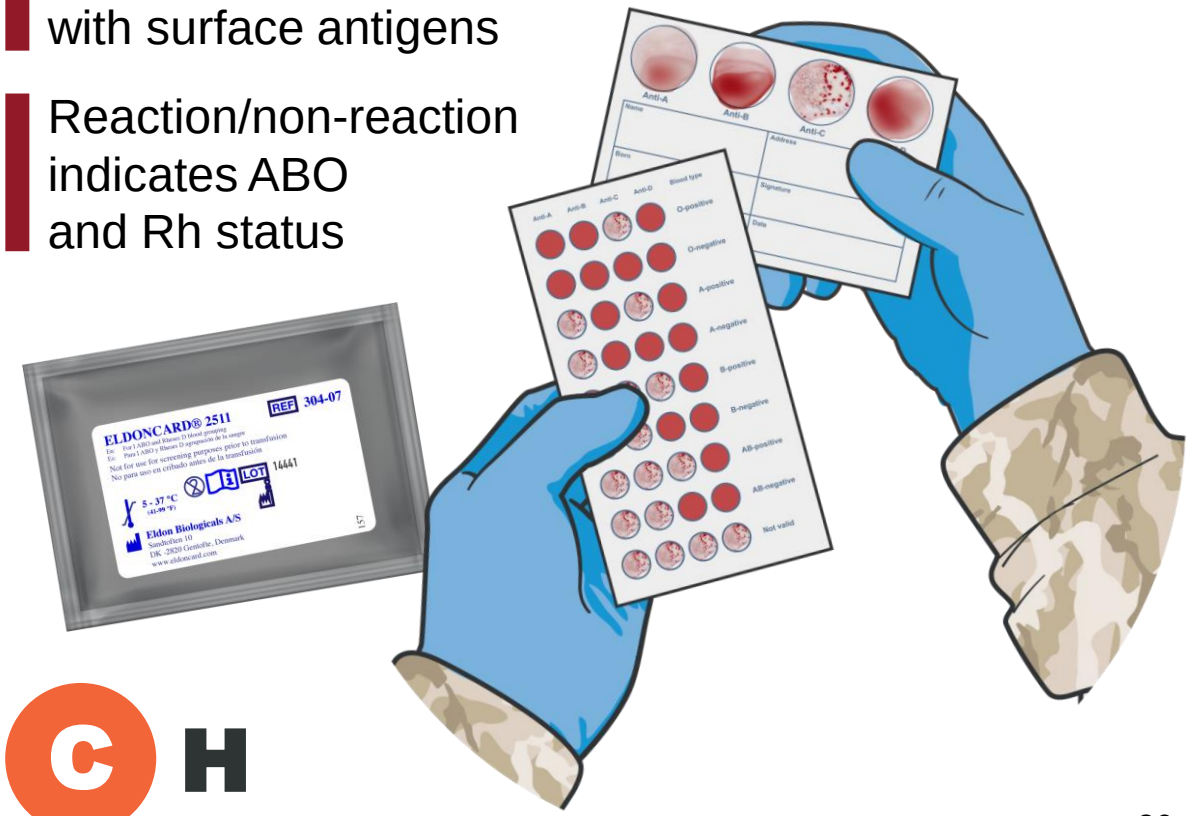
Surface markers (antigens) determine blood groups/types

- A & B antigens determine ABO status
- Rh antigen also a major marker
- Minor markers require more advanced lab resources, but not tactically important



EldonCard®

- Antigen-impregnated surface
- Donor/casualty blood reacts with surface antigens
- Reaction/non-reaction indicates ABO and Rh status



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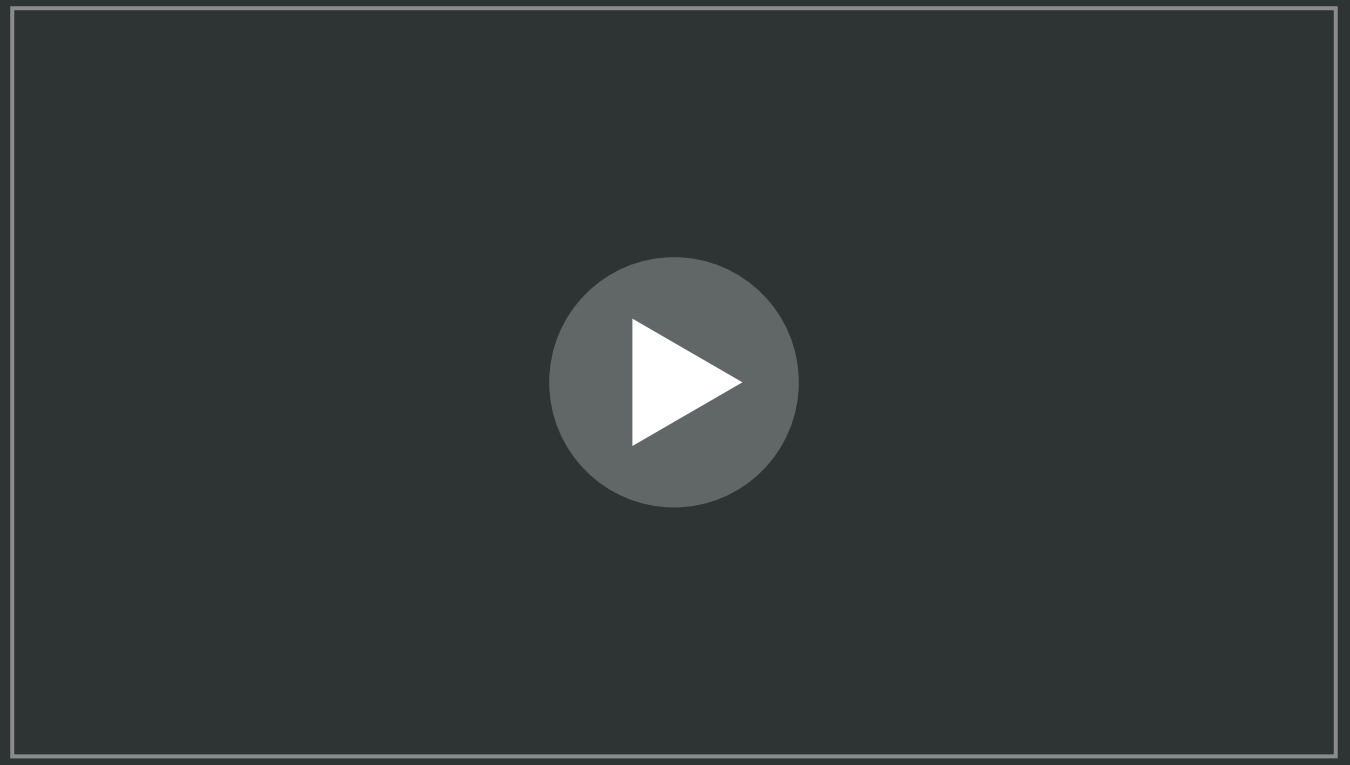
ELDONCARD TECHNIQUES IN TACTICAL FIELD CARE

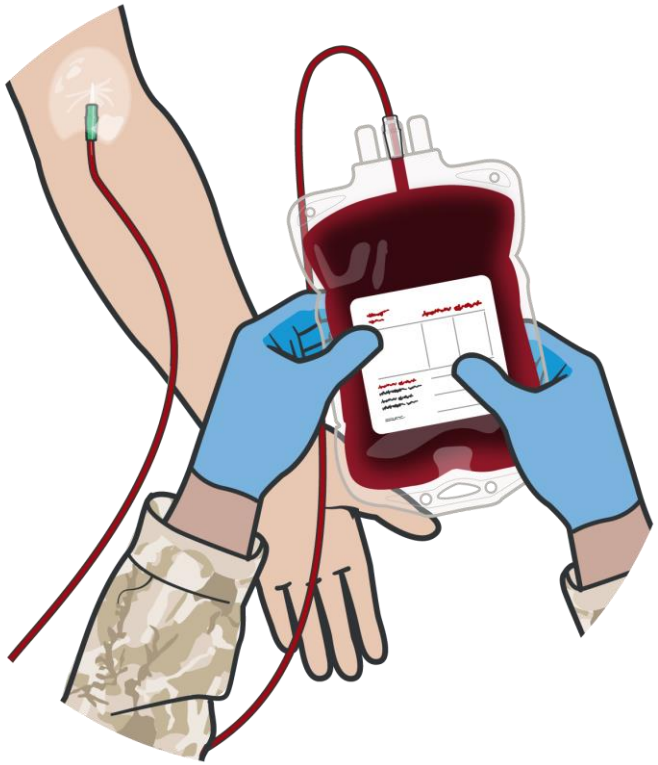


Video can be found on deployedmedicine.com

BLOOD COLLECTION

Considerations in collecting blood

- Collection bags have needle attached (16-gauge)
- Lower collection bag below level of the heart
- Gently shake or agitate bag to mix citrate anticoagulants
- Don’t overfill the bag
- Clamp and then tie off the collection tubing when bag is full



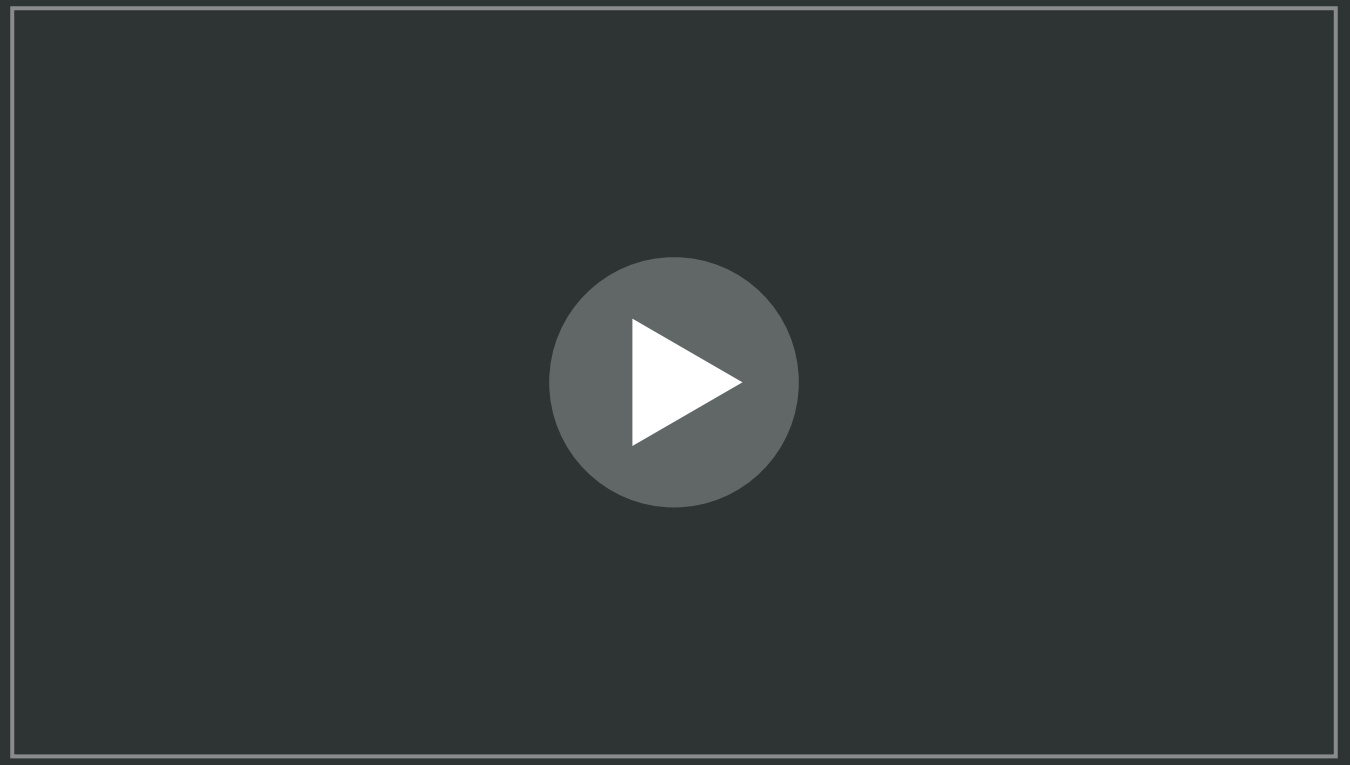
Methods to determine bag is full

- 6.5-inch beaded cable tie
- 6.5-inch zip tie
- Fold and clamp bottom 1-1½ inches of the bag
- Parachute 550 cord cut at 10 inches wrapped around center

⚠ Donors experience mild decline in oxygen-carrying capacity, but no decrease in performance or cognitive function

MARCH

BLOOD DONOR COLLECTION IN TACTICAL FIELD CARE



Video can be found on deployedmedicine.com

SKILL STATION

Fluid Resuscitation in Hemorrhagic Shock

- Blood-typing using an EldonCard
- Collecting blood from a donor
- Administering freeze-dried plasma
- Transfusing blood products to a casualty

SUMMARY

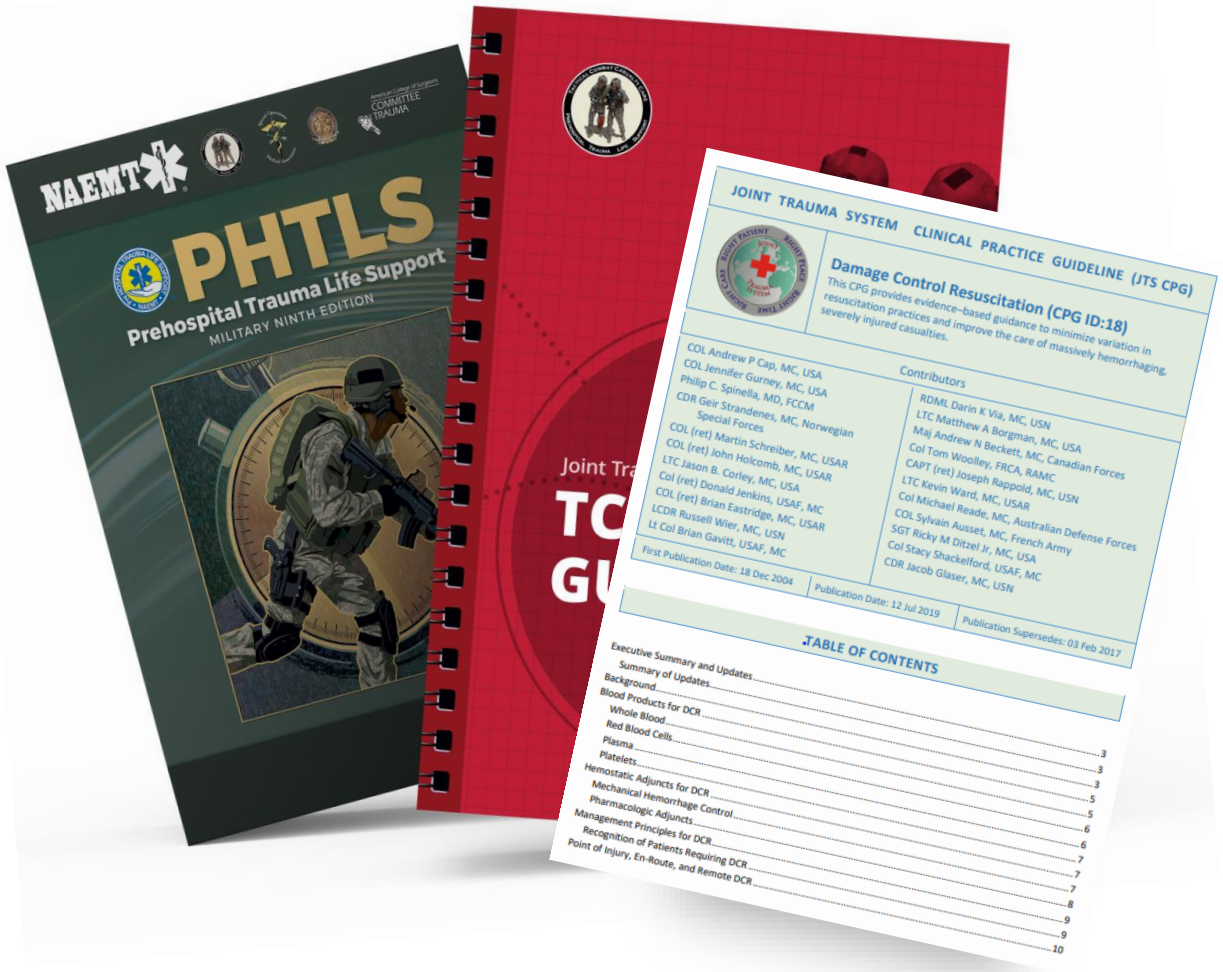
- Early resuscitation with cold-stored low-titer type O whole blood
- Progressive strategies for fluid resuscitation
- Importance of early administration of blood products
- Indications and techniques for blood product administration
- Identification and management of blood transfusion complications
- Blood-type determination with EldonCards
- Donor blood collection techniques
- Blood administration skills training
- Blood typing and blood collection skills training

CHECK ON LEARNING

- What signs of hemorrhagic shock are indications that fluid resuscitation is needed?
- What is the preferred product for hemorrhagic fluid resuscitation?
- When should calcium be administered during fluid resuscitation?
- When should fluid resuscitation be discontinued?
- What is an advantage of freeze-dried plasma?

ANY QUESTIONS?

REFERENCES



TCCC: Guidelines

by JTS/CoTCCC

These guidelines, updated regularly, are the result of decisions made by CoTCCC in exploring evidence-based research on best practices.

PHTLS: Military Edition, Chapter 25

by NAEMT

Prehospital Trauma Life Support, Military Ninth Edition

Damage Control Resuscitation CPG

Joint Trauma System

Damage Control Resuscitation (CPG ID:18), Joint Trauma System Website