WVU Critical Care & Trauma Institute

Correcting Coagulopathy

Intended Audience:

Residents

Correcting Coagulopathy

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Director of Trauma Education

Suggested Readings

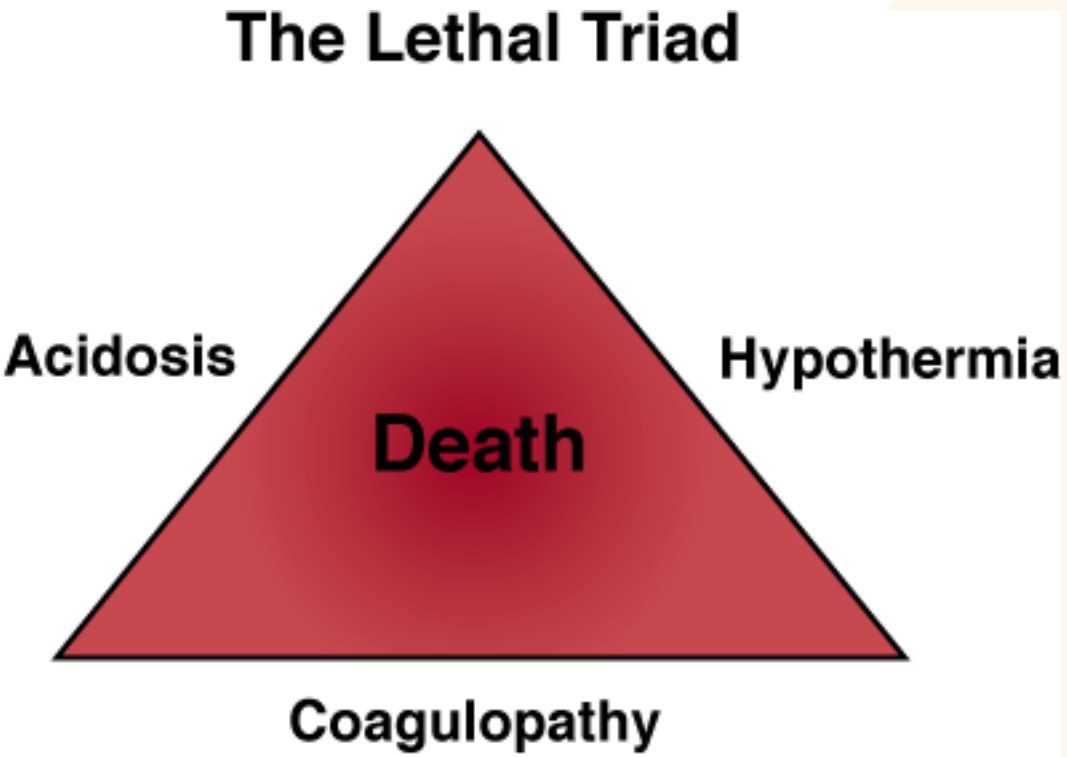
- Damage Control Resuscitation in Trauma
  - H Kaafarani, G Velmahos
  - Scandanavian Journal of Surgery
  - 2014;103:81-88.

Objectives

- Demonstrate understanding of the effects of trauma on coagulation
- Discuss diagnosis and monitoring of coagulation abnormalities in the trauma patient
- Provide rationale for the resuscitation of the bleeding trauma patient

Effect of Trauma on Coagulation

- Hemorrhage
  - Hypovolemia
  - Hypercarbia
  - Hypoxia
  - Acidosis
- Tissue edema
- Volume shifts
- Dilution
- Coagulopathy



Source: Mattox KL, Moore EE, Feliciano DV: *Trauma, 7th Edition:*
www.accesspharmacy.com

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Laboratory Monitoring

- Blood type, screen, cross match
  - ***"Maybe the single most important test!"***
- CBC
  - Hg, Hct, Platelets (number)
- Coagulation panel
  - PT, PTT, INR
- Fibrinogen
- Thromboelastography (TEG)
  - Small aliquot of warmed whole blood

TEG

- R Time: clotting time
  - If prolonged needs FFP
- α angle: clot formation
  - If decreased needs cyroprecipitate +/- platelets
- MA: clot strength
  - If decreased needs platelets
- LY-30: fibrinolysis
  - If elevated needs TXA

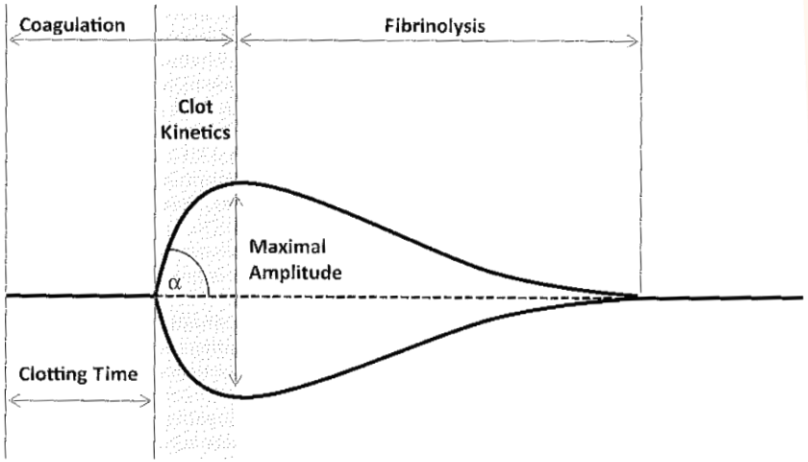


Figure 7-1. Thromboelastography (TEG) Measurement.

Hemorrhage Control

- Hemorrhage is #1 cause of preventable death in trauma
- Early control of hemorrhage
  - Tourniquets
  - Wound packing
- Rapid transport to trauma center
  - Care at level 1 trauma center improves survival
- Minimal fluid resuscitation before surgical hemorrhage control
  - “Hypotensive resuscitation” or permissive hypotension
    - SBP 90
  - Don’t pop the clot

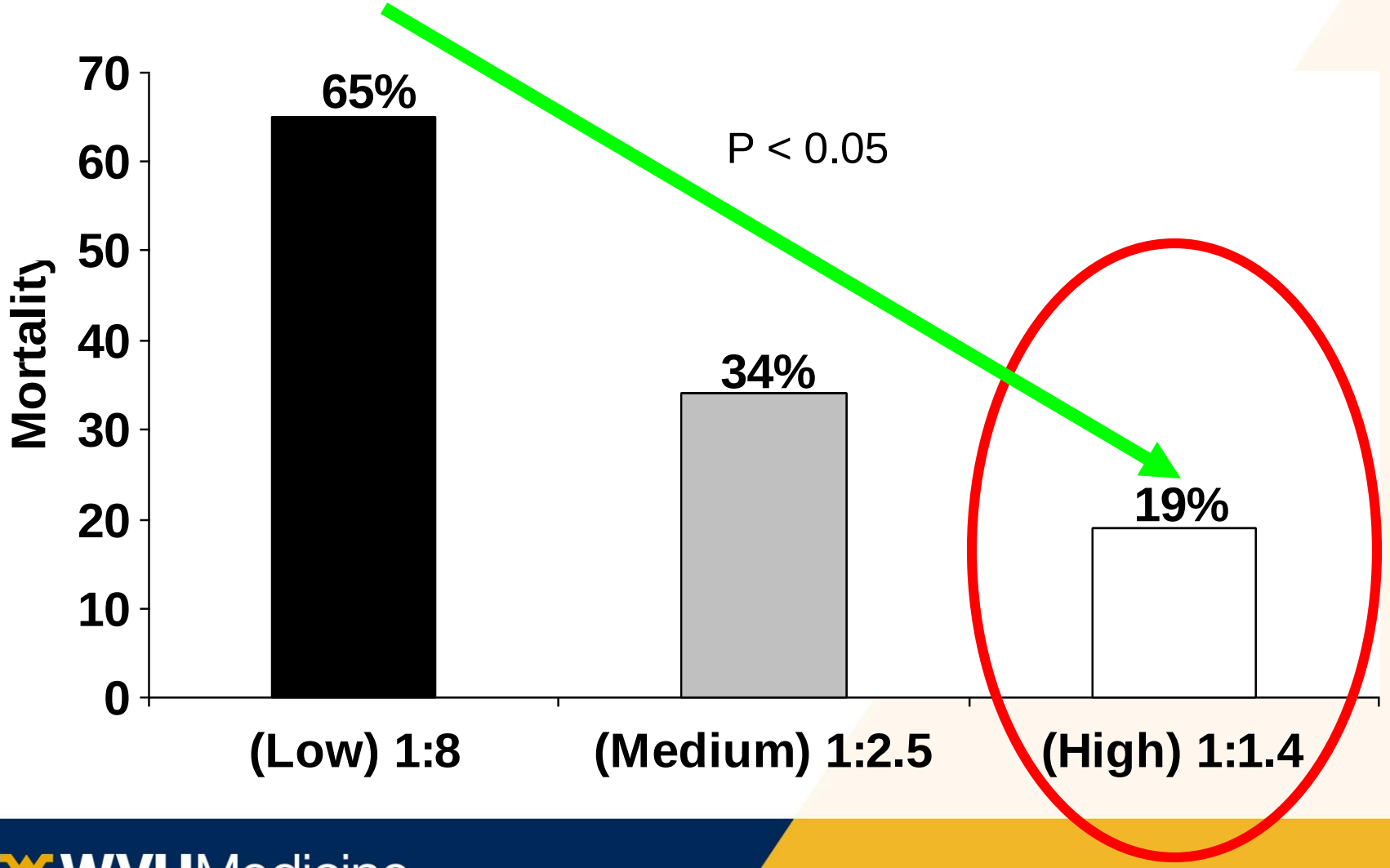
Transfusion Management

- Packed Red Blood Cells (PRBCs)
  - 225 to 300 mL per unit
  - Raise Hg by 1g/dL
  - Screened: ABO, Rh (15-60 minutes for type specific)
  - Emergency: Type O -> (Rh- females; Rh+ males)
- Plasma
  - Fresh or thawed
  - 200 to 250 mL (coagulation proteins, fibrinogen)
  - ABO
  - Emergency: Type AB-

Transfusion Management

- Platelets
  - Single donor, apheresis; pooled donor ”six pack”
  - Increase PLT count 30,000 to 50,000
- Transfusion ratios for “Hemostatic Resuscitation”
  - 1:1:1 (PRBC:PLASMA:PLT)
  - Improved survival
- Fresh Whole Blood
  - Not readily available
  - Improved survival, especially military data

Mortality by Plasma : RBC Ratio



Procoagulant Agents

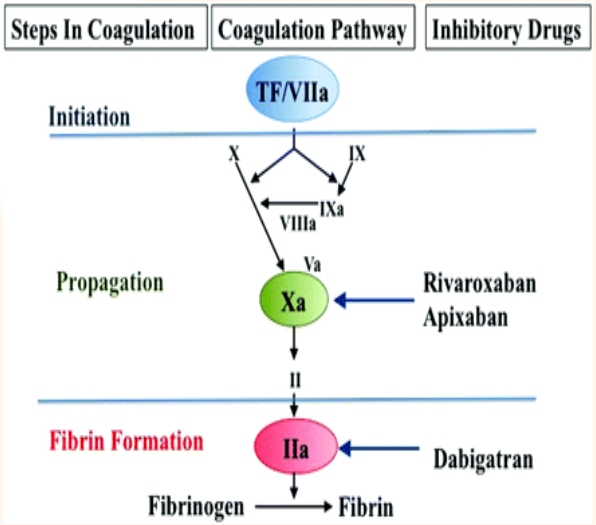
- Tanexamic Acid (TXA)
  - Antifibrinolytic
  - Reduces mortality from hemorrhage in trauma
  - Often given with massive transfusion
- Prothrombin Complex Concentrate (PCC)
  - 3 Factor II, IX, X and 4 Factor (additional VII)
  - Rapidly reverse warfarin induced coagulopathy
  - Less volume than FFP
  - Has some activity in reversal of novel oral anticoagulants
- Recombinant Factor VIIa
  - Expensive
  - Decreases hemorrhage, no mortality benefit

Antiplatelets

- Aspirin; Plavix
  - Normal PLT number
  - Correct with PLT transfusion in setting of severe bleeding +/- VERIFYNOW
  - Desmopressin
    - Uremic bleeding
    - Induces endothelial release of vWf
    - ASA reversal

Pre-injury Anticoagulation

- Common
  - Warfarin: inhibits Vit K dep Factors (II, VII, IX, X)
  - Reversible in setting of severe bleeding
    - FFP and Vit K
    - PCC and Vit K
  - Direct Oral Anticoagulants
    - Direct Thrombin Inhibitor
      - Dabigatrin -> Idarucizumab
    - Anti-Xa
      - Rivaroxaban, Apixaban
      - PCC, Andexanet Alfa



Indications for Transfusion

- Transfusion in the bleeding patient is generally dictated not by lab value alone.
  - Active large volume bleeding
  - Signs of hemorrhagic shock
- Restrictive transfusion strategies (>7g/dL) are effective in the hemodynamically normal patient.
- Bleeding trauma patient, active coronary ischemia: Hg < 10g/dL is useful trigger.

Massive Transfusion

- Common definition: >/= 10 units PRBCs in 24 hours
- Subset: critically injured in whom even brief interruption in transfusion may be lethal
  - > 20 – 30 u PRBc and corresponding FFP/PLT in 1st 6 to 8 hours
- Assessment of Blood Consumption (ABC)
  - Scoring tool (penetrating mechanism, HR > 120, SBP< 90, +FAST)
  - Predict need for massive transfusion

Massive Transfusion Protocols

- Likelihood of MT based on individual triggers
- 2 or more of the following 85% predictive:

INR > 1.5	SBP < 90 mmHg
Hg < 11g/dL	BD >/= 6
dFAST +	HR >/= 120 bpm

- MTP
  - Improve survival; use less blood products
  - Lower complication rate; less sepsis

Defining when to initiate massive transfusion: A validation study of individual massive transfusion triggers in PROMMTT patients

Rachael A. Callcut, MD, MSPH, Bryan A. Cotton, MD, Peter Muskat, MD, Erin E. Fox, PhD, Charles E. Wade, PhD, John B. Holcomb, MD, Martin A. Schreiber, MD, Mohammad H. Rahbar, PhD, Mitchell J. Cohen, MD, M. Margaret Knudson, MD, Karen J. Brasel, MD, MPH, Eileen M. Bulger, MD, Deborah J. del Junco, PhD, John G. Myers, MD, Louis H. Alarcon, MD, Bryce R.H. Robinson, MD, *on behalf of* the PROMMTT Study Group, *San Francisco, California*

Transfusion Goals

- Overall hemodynamic status of the patient
- Correct acidosis, hypothermia
- Correct coagulopathy
- Monitor
  - Hg, PLT
  - INR
  - Fibrinogen
  - TEG

Risks of Transfusion

- Storage Lesion
  - Average age 13 – 37 days for PRBC
  - Metabolic and structural changes to RBC
    - Increase K concentration
    - Decrease pH
    - Decrease O2 carrying capacity
    - Pro inflammatory changes
- Infectious disease risks
  - HIV/HCV: 1:2,000,000
  - HBV: 1:205,000

Complications of Transfusion

- Acute
  - Acute hemolytic transfusion reactions
  - Febrile nonhemolytic transfusion reactions
  - TRALI
  - TACO
  - Allergic reactions
  - Bacterial sepsis
  - Hypocalcemia
  - Hypokalemia, hyperkalemia
  - Acidosis
  - Hypothermia
  - Dilutional coagulopathy
  - Dilutional thrombocytopenia
- Delayed
  - Delayed hemolytic transfusion reactions
  - TRIM
  - Microchimerism
  - Transfusion-transmitted diseases
  - Posttransfusion graft-vs-host disease
  - Posttransfusion purpura

Case #1

- A 32 year old man SP MVC presents to ED via ambulance. GCS 7; HR 135; BP 70/40
  - Femur fx splinted
  - CXR with right hemo-pneumothorax, CT placed
  - FAST positive
  - PXR normal
- What labs should be sent?
- Evaluation of labs…

Case #2

- A 32 year old man SP MVC presents to ED via ambulance. GCS 7; HR 135; BP 70/40

- Discuss resuscitation strategy

Case #3

- 79 year old woman fell down 3 steps. Presents to ED via EMS, obtunded and vomiting.
  - GCS 6; HR 70; BP 180/90
  - CXR, PXR, FAST no evidence of trauma
  - PMH: AFIB, CAD; MEDS: Apixaban, ASA, Metoprolol
- Discuss reversal strategies for pre-injury antiplatelets and anticoagulation

Case #4

- 43 year old ICU patient POD 10 s/p esophagectomy. Hg 6.8
  - 2 units PRBC ordered
  - 5 minutes after transfusion begun develops respiratory distress
- Differential Dx.
- Steps in management?

Question #1

- 27 year old male sp GSW abdomen presents to ED via EMS.
  - GCS 14; HR 134; BP 80/40; T 35.9 C
  - CXR normal, FAST positive, PXR with bullet
  - Peritonitis, single GSW RUQ
  - 2 units PRBC Type O + given, no improvement in BP

1. Is this patient likely to need Massive Transfusion? Yes or No
2. Which of the following predict the need for massive transfusion?
   a. SBP<90 despite resuscitation
   b. HR >/= 120
   c. Positive FAST
   d. INR < 1.5
   e. All of the above

Question #2

- 89 year old man sp fall from standing presents to SICU after trauma workup in the ED. GCS 13. Vital signs normal. Isolated right SDH on CT scan. PMH significant for CHF, prior CVA and AFIB on warfarin. INR 2.8

- What is the optimal way to reverse pre-injury warfarin use in this patient?
  a. Transfuse 4 units FFP, vitamin K and repeat INR
  b. PCC and vitamin K
  c. Vitamin K alone
  d. Monitor INR and allow time to correct
  e. TXA

Correcting Coagulopathy

- Questions?

- Thank you for your time.