Blood, Sweat, and Tears: ECHO Massive Transfusion Protocol!

TeleCritical Care Medicine Project ECHO
April 6th, 2022

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Disclosure

The content of this presentation does not relate to any product of a commercial entity; therefore, I don’t have any relationships to report.

Learning Objectives

- Describe the principles of hemorrhagic shock and massive transfusion protocols
- Understand the lethal triad pathophysiology and association with calcium
- Formulate patient-specific treatment regimens for patients during massive transfusion protocol activation

Massive Transfusion Protocol

Patient Case

- Overhead: “Trauma one activation, here now!”
- Flip phone: “MTP activation. L&D RM x////. FIN: //////”
- Pale patient, clenching abdomen: “I fell onto a bench doing the Milk Crate Challenge”

Background

- Hemorrhagic shock accounts for more than 60,000 deaths in the United States and 1.9 million worldwide each year
- Fluid and/or blood replacement AND treat lethal triad
- Massive Transfusion Protocols (MTP) improve survival rates
- Standardization of best practices begins with education and open discussion

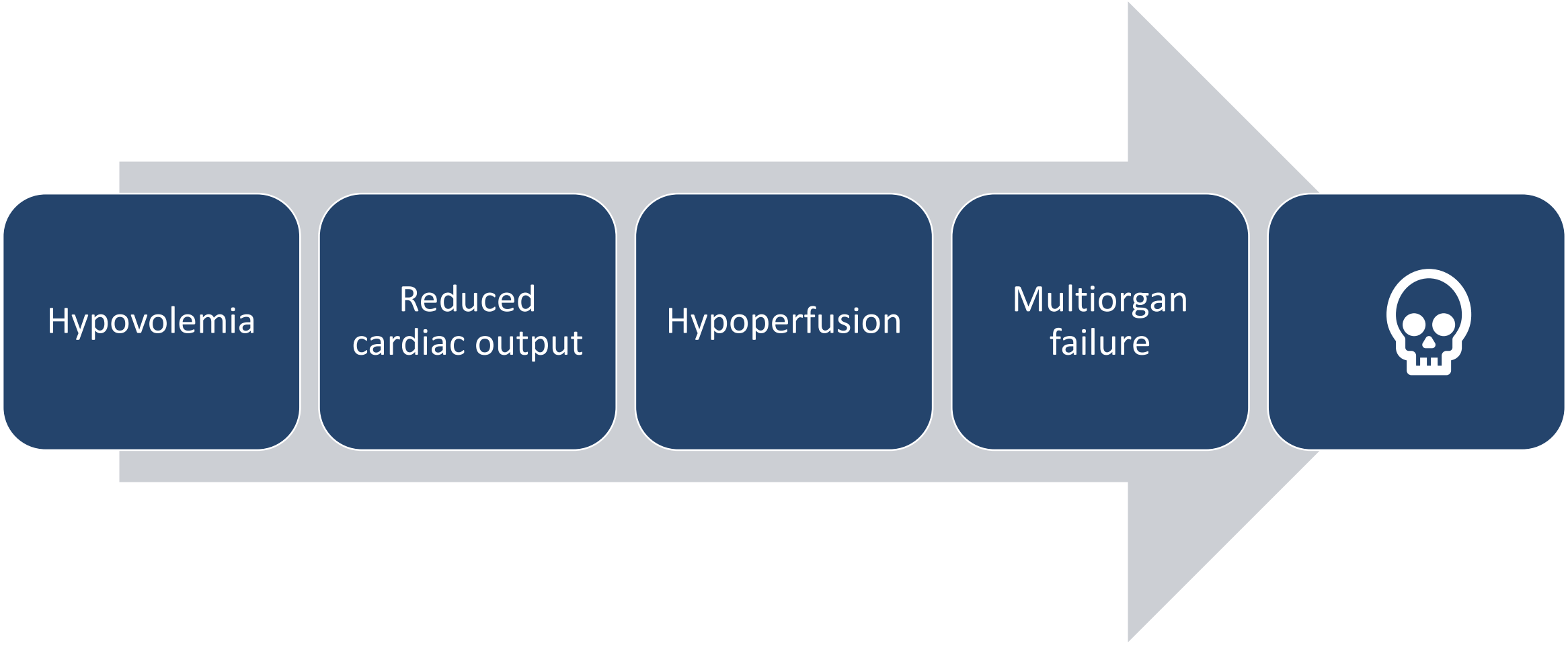
Flint, McQuilten, & Wood. Transfus Med. 2018 Apr;28(2):140-149.
Meneses et al. Am J Emerg Med. 2020 Dec;38(12):2661-2666.
Guerado et al. Eur J Trauma Emerg Surg. 2016 Jun;42(3):283-95

Common Causes of Hemorrhagic Shock

Cause
Antithrombotic therapy
Coagulopathies
Gastrointestinal bleeding
Obstetric/gynecologic
Pulmonary
Ruptured aneurysm
Retroperitoneal bleeding
Trauma

Abuzeid et al. Curr Opin Crit Care. 2019 Dec;25(6):661-667
Guerado et al. Eur J Trauma Emerg Surg. 2016 Jun;42(3):283-95

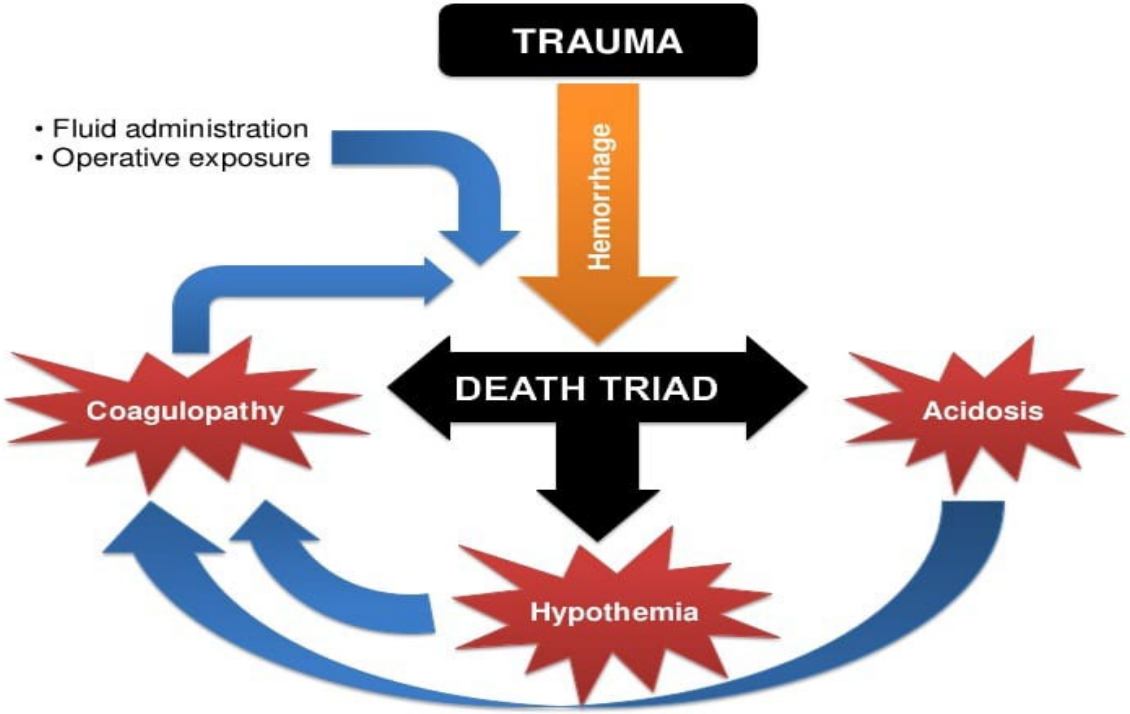
Pathophysiology



Meneses et al. Am J Emerg Med. 2020 Dec;38(12):2661-2666.
Rosen P, Marx J. Rosen's Emergency Medicine: Concepts and Clinical Practice. 8th ed. Philadelphia, PA: Elsevier/Saunders, 2014.

Lethal Triad

- Coagulopathy
  - Exacerbated with hemodilution
- Acidosis
  - Reduction of coagulation factor activity
- Hypothermia
  - Inhibits thromboxane A2
  - Impaired oxygen delivery



Ditzel et al. J Trauma Acute Care Surg. 2020 Mar;88(3):434-439.
Gerecht R. JEMS. 2014 Apr;39(4):56-60.

Significance of Massive Transfusion Protocol

- Common MTP definitions
  - Transfusion of > 10 packed red blood cells (PRBC) units
  - Transfusion of > 20 units of PRBC units in 24 hours
  - Transfusion > 4 PRBC in 1 hour with anticipation of continued blood product support need
  - Replacement of > 50% total body volume by blood products within three hours

Ditzel et al. J Trauma Acute Care Surg. 2020 Mar;88(3):434-439
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Better Outcomes with Massive Transfusion Protocol

- MTP activation impact
  - Reduced mortality and morbidity
  - Reduction in blood product requirements
  - Reduction in health-care costs
- Use your resources!
  - Save institutional-specific MTP documents onto an approved e-device
  - Quick electronic references
  - Phone/text/direct message help

O'Keeffe et al. Archives of Surgery. 2008;143:686-690
Riskin et al. Jour Am Col Surg. 2009;209:198-205.
Holcomb et al. Ann Surg. 2008;248:447-458.

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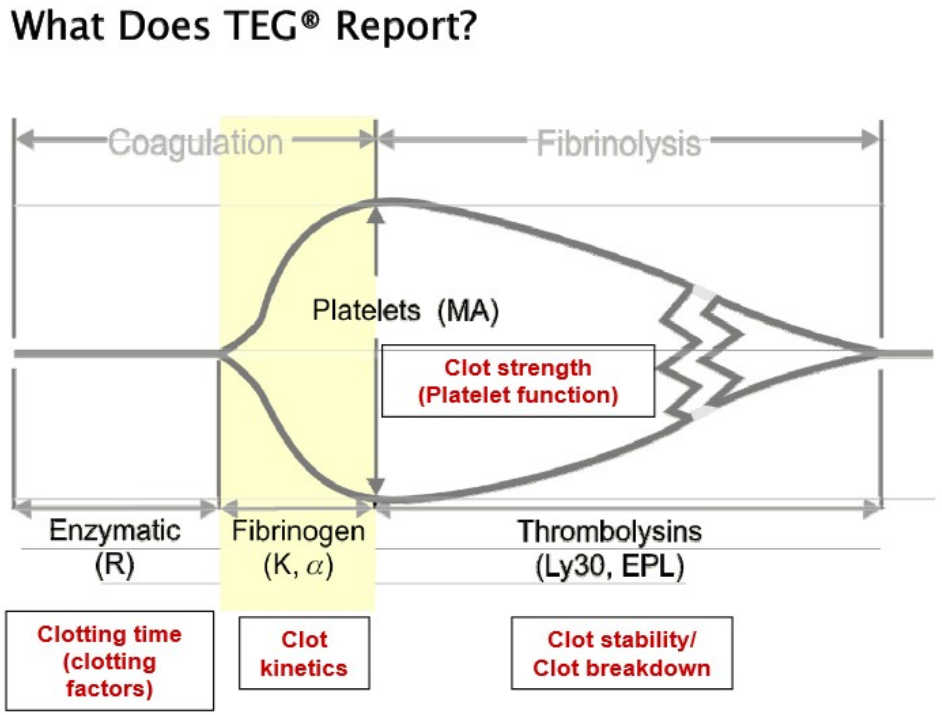
Massive Transfusion Protocol Activation

- Pre-arrival and assemble team with identification of roles
- Procurement and delivery of blood products
  - Dedicated runner
  - Access to transfusion service / blood bank
  - Prioritization of access for blood products
  - Reserve cooler
- Pertinent laboratory measures
  - CBC, type/screen, **TEG**, etc.
- Endpoints of transfusion



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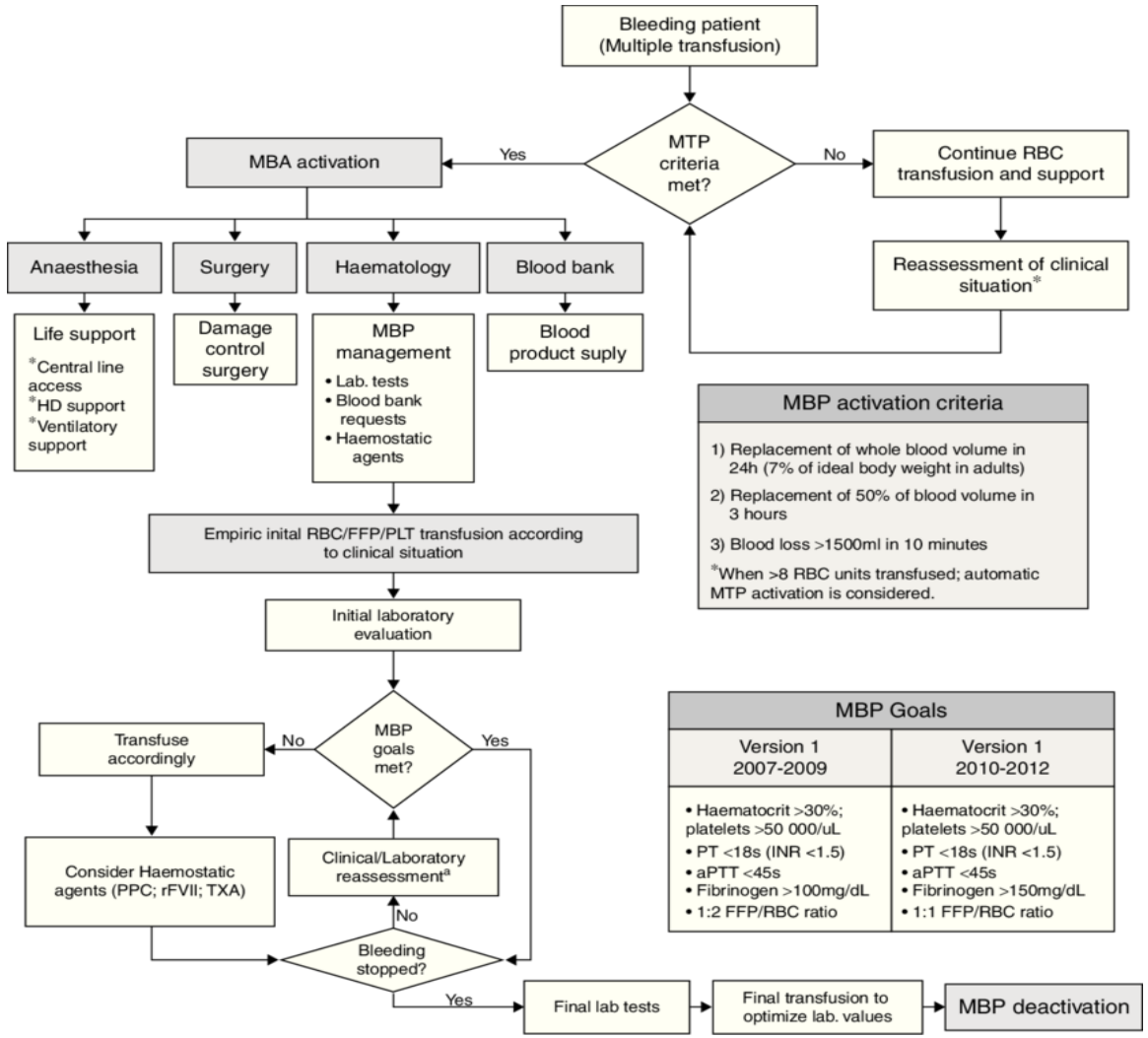
Massive Transfusion Protocol Administration

MTP	
Pack 1 – Whole blood (4 units)	
Pack A	Pack B
1 unit PLT 3 units PRBC 2 units FFP	3 units PRBC 2 units FFP 2 5-packs cryoprecipitate (obstetrics)

PLT = platelets
PRBC = packed red blood cells
FFP = fresh frozen plasma



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Massive Transfusion Protocol Pharmacologic Interventions

Pharmacologic Interventions

- Supportive care
- Calcium supplementation
- Vasopressors
- Hemostatic agents

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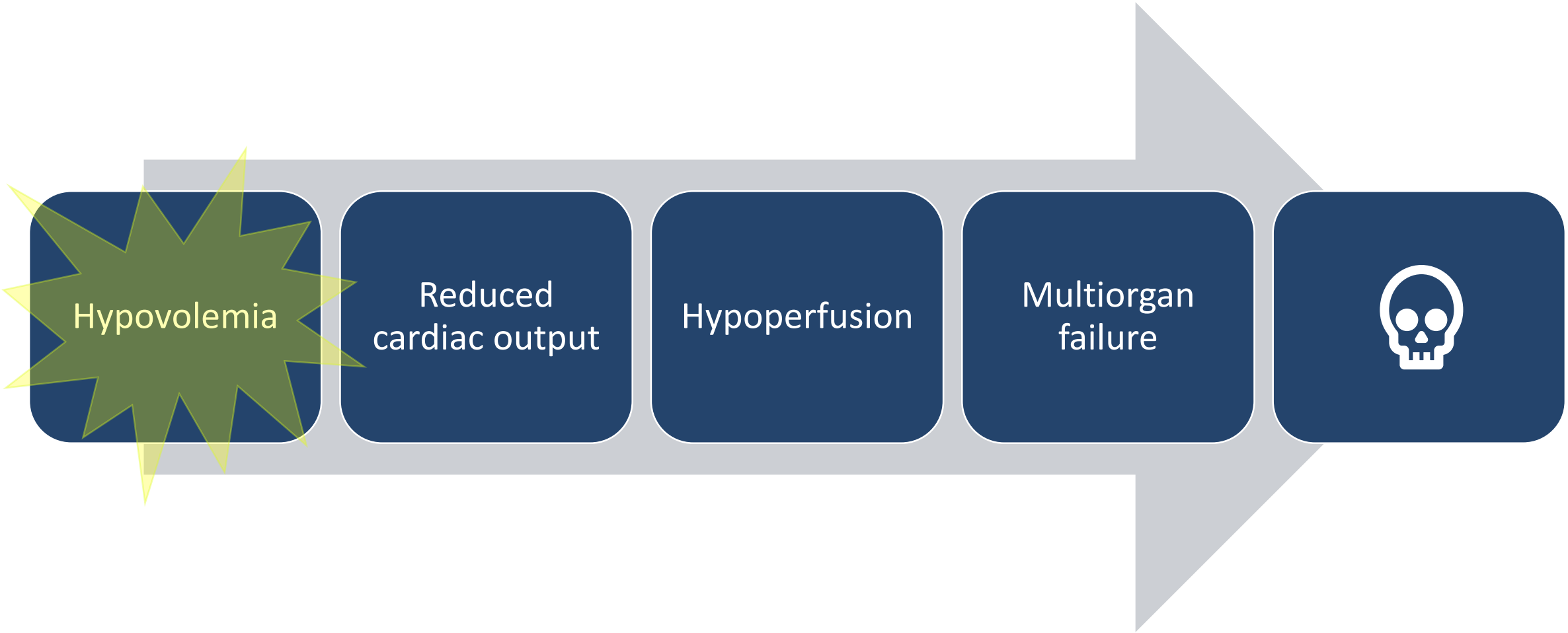
Supportive Care



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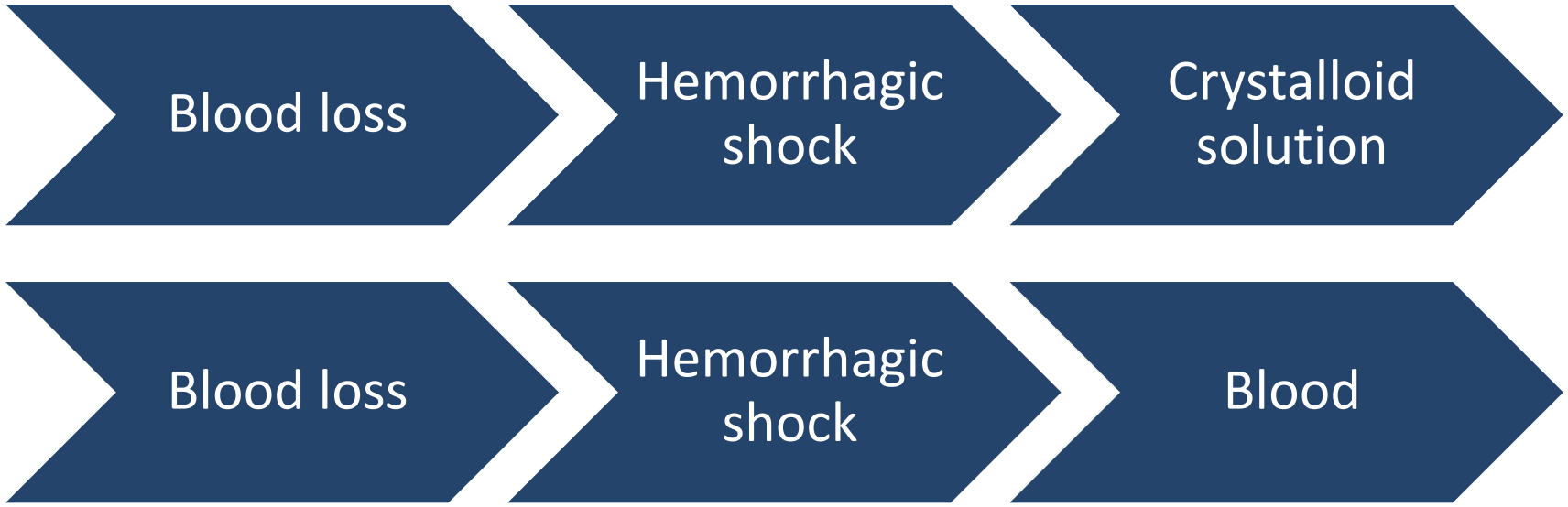

- Permissive hypotension (SBP > 65 mmHg)
- Hemodilution with over fluid resuscitation
- Minimize crystalloid fluids (< 2L)
- Blood is the primary replacement “fluid”

Cannon J. N Engl J Med 2018;378:370-379.
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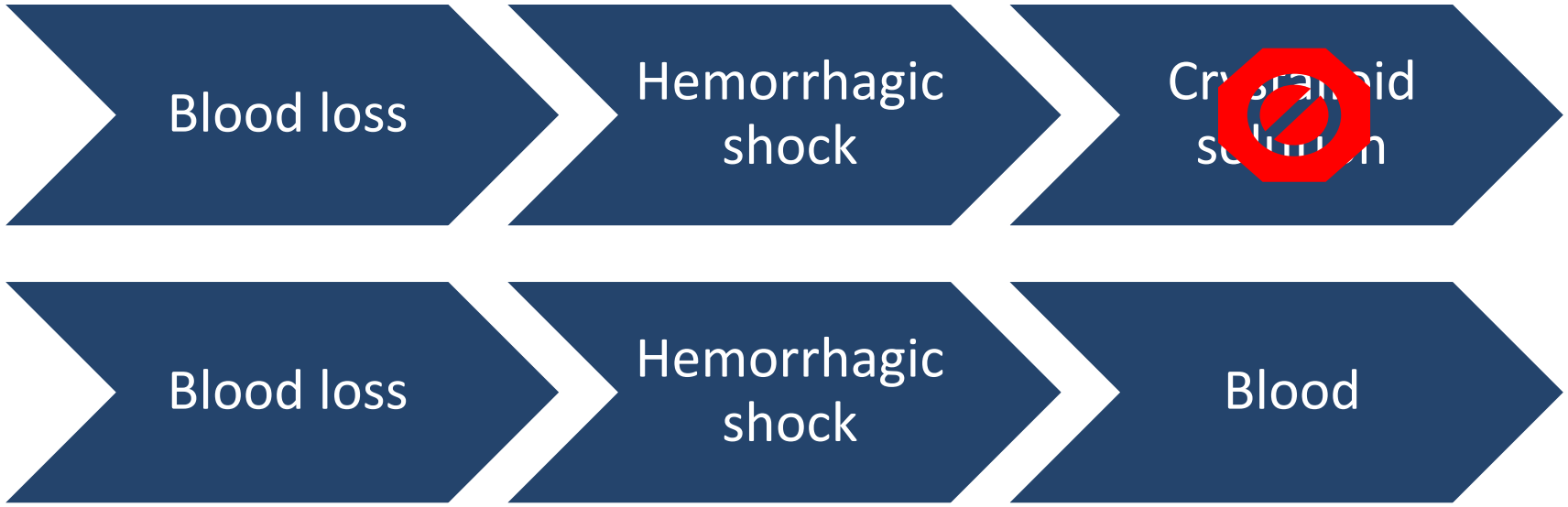

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Blood Products

- Give blood as soon as possible
- Type and cross-matched PRBC are best
- Use emergency-release blood, if indicated
- Resuscitation with FFP, PLT, and PRBC
- 1:1:1 unit ratio

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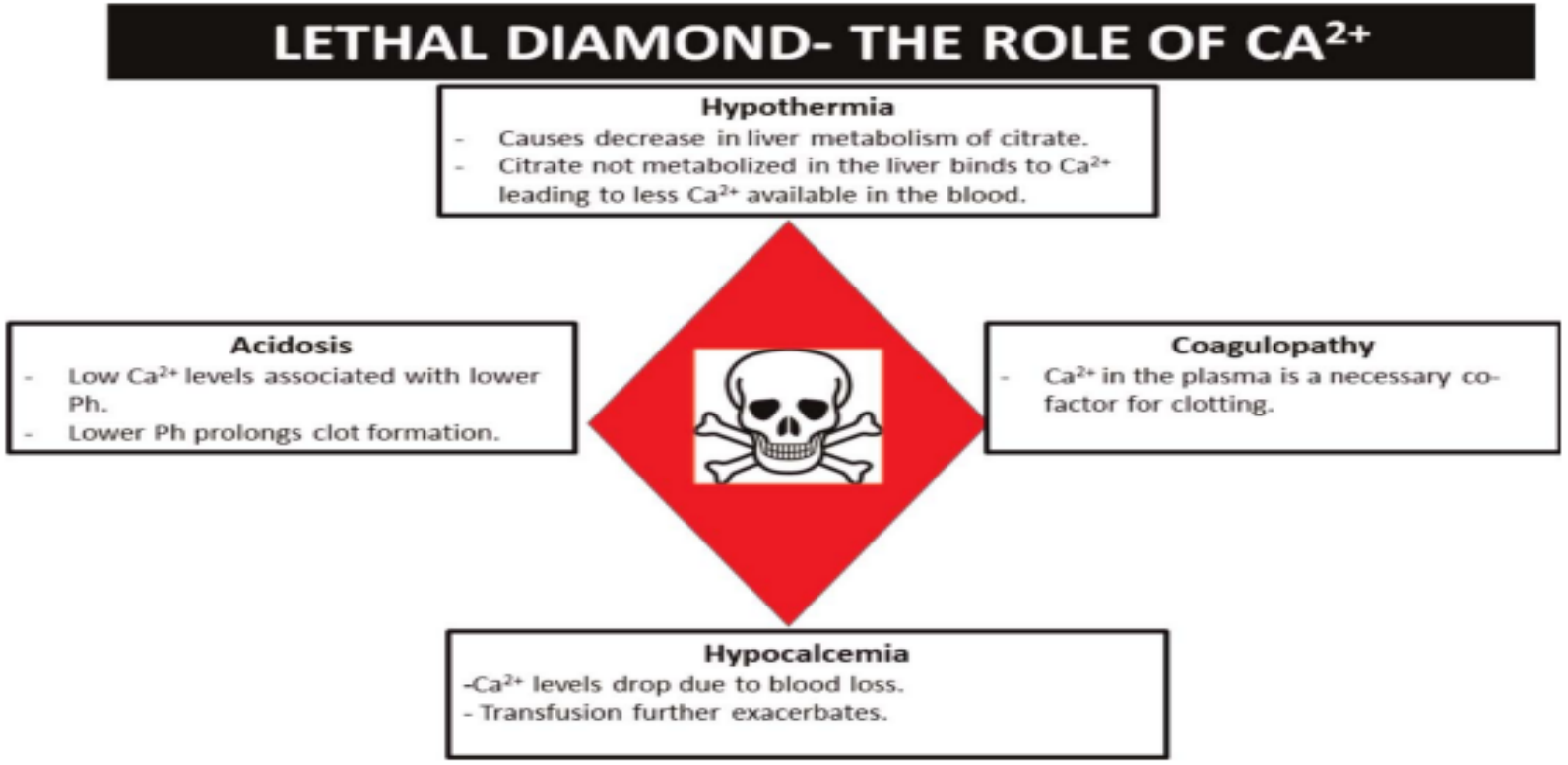
Lethal ~~Triad~~ Diamond?

- Calcium replacement is essential in maximizing other treatment modalities within the lethal triad



Sims et al. JAMA Surg. 2019 Nov 1;154(11)994-1003
Wray et al. Am J Emerg Med. 2021 Mar;41:104-109.

Hypocalcemia and Calcium Supplementation

- More than half of trauma patients present with hypocalcemia (iCal < 1.12 mmol/L) before any blood products
- 97% of MTP patients experience hypocalcemia with 71% having severe hypocalcemia (iCal < 0.90 mmol/L)
- Higher mortality and increased blood requirements
- Overcorrection (iCal > 1.25 mmol/L) associated with increase mortality

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Vasopressors

- Advanced Trauma Life Support (ATLS) does not recommend use of vasopressors
- Priority management include hemorrhage control WITH volume resuscitation
- Increased mortality with early use of vasopressors
- May be needed to prevent circulatory arrest
- Norepinephrine and vasopressin preferred

Gupta et al. J Anaesthesiol Clin Pharmacol. 2017 Jan-Mar;33(1):3-8.
Sims et al. JAMA Surg. 2019 Nov 1;154(11)994-1003

Effect of Low-Dose Supplementation of Arginine Vasopressin on Need for Blood Product Transfusions in Patients With Trauma and Hemorrhagic Shock: A Randomized Clinical Trial

Population	Intervention	Comparison	Outcome
Single center trial May 2013 – 2017 Trauma patients (18-65 years old) who received at least 6 units of any blood product within < 12 hours (n=49) vs standard of care (n=51) Primary: total volume of blood product transfused at 48 hours	Arginine vasopressin (AVP) 4 units IV bolus, then titrate drip (≤ 1.8 units/hr) for 48 hours to maintain MAP > 65 mmHg	Placebo	Primary: significantly less blood products requirements in AVP group (*median reduction of 1L*) Secondary: no difference in crystalloid/vasopressor requirements, mortality, and total complications

Sims et al. JAMA Surg. 2019 Nov 1;154(11)994-1003

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Hemostatic Agents

Hemostatic Agent	Mechanism	Indication
Tranexamic acid	Displaces plasminogen from fibrin → inhibition of fibrinolysis	TBI, postpartum hemorrhage
KCentra (4F-PCC)	Factor II, VII, IX, X, and Protein C/S	Warfarin/DOAC reversal
Vitamin K (phytonadione)	Promotes synthesis of Factor II, VII, IX, X	Warfarin reversal, coagulopathy from liver disease
Andexxa (andexanet alfa)	Binds and sequesters factor Xa inhibitors	Life-threatening bleeding from factor Xa inhibitors
Protamine	Binds to heparin and forms a salt	Reversal of unfractionated heparin and low molecular weight heparin
Desmopressin	Increases plasma levels of von Willebrand factor, factor VIII	Hemophilia A, von Willebrand disease, uremic bleeding, antiplatelet reversal

Tranexamic acid. Lexi-Drugs. Lexicomp. Wolters Kluwer Health, Inc. Riverwoods, IL.
Prothrombin complex concentrate, 4-factor, unactivated. Lexi-Drugs. Lexicomp. Wolters Kluwer Health, Inc. Riverwoods, IL.
Vitamin K. Lexi-Drugs. Lexicomp. Wolters Kluwer Health, Inc. Riverwoods, IL.
Andexanet alfa. Lexi-Drugs. Lexicomp. Wolters Kluwer Health, Inc. Riverwoods, IL.
Protamine sulfate. Lexi-Drugs. Lexicomp. Wolters Kluwer Health, Inc. Riverwoods, IL.
Desmopressin. Lexi-Drugs. Lexicomp. Wolters Kluwer Health, Inc. Riverwoods, IL.

Conclusion

- Early identification and activation of MTP improves patient-centered outcomes
- Prevention of “Lethal Triad” progression during MTP
- Avoid excessive crystalloids, prioritize blood
- Consider alternative treatments in setting of national blood shortage
- Primary goal is hemorrhage control

Patient Case

- 45M, 75kg
- Multiple gunshot wounds
- Received 2L Lactated Ringers enroute
- IV access established
- SBP 80s, alert, oriented
- “Hang fluids!”

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What fluid should be prioritized in hemorrhagic shock?

A. Sodium chloride 0.9%
B. Lactated Ringers
C. Blood products
D. Albumin

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Patient Case

- 19W, 68kg
- Autoped traumatic arrest with ROSC
- Initial iCal 1.02 mmol/L (10 minutes prior to MTP)
- MTP activated, Pack 1 initiated
- Refractory shock with maximal fluid resuscitation

What pharmacologic options may be considered? *(Select all that apply)*

A. Tranexamic acid

B. Calcium salts

C. Vasopressors

D. Corticosteroids

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