

## Hypocalcemia in Hemorrhage

### General Overview

- a. As patient's lose blood, they bleed out calcium as well
- b. Calcium is crucial for the clotting cascade to be effective
- c. Calcium now included in the lethal triad → diamond
  - a. Hypothermia
  - b. Acidosis
  - c. Coagulopathy
  - d. Hypocalcemia

### Blood Products

- a. Citrate in blood products destroy calcium in packaging
- b. Massive transfusions can lead to worsening hypocalcemia
- c. Fluids obviously will kill the patient and you guessed it, drop calcium lower
- d. Liver: Metabolizes 3g of citrate in 5 mins
  - a. Blood products are given much faster
  - b. Can lead to liver dysfunction
- e. Blood: Contains 3g of citrate per unit

### Protocol

- a. For a patient given 1unit/min in resuscitation
- b. 1g chloride during 1st unit of blood
- c. Unsure of exact ratio
  - a. 1g per 2 units
  - b. 1g per 4 units
- d. Pull an iCal and let that help guide you
- e. One of the medics has protocols to give 1g calcium & 1g TXA in the ambulance

### Random Points

- a. The lethal diamond is a revolving wheel, all adding on to the other
- b. Chloride: 1g
- c. Gluconate: 3g
- d. Hydrogen is an antagonist to calcium
- e. Loss of calcium leads to an inability to vasoconstrict
- f. Hyperkalemia is a common response to trauma, which eats up more calcium
- g. This is not made for patient's getting slower transfusion
  - a. Made for MTP only
  - b. Go off of iCal for slower transfusions

## Calcium Supplementation During Massive Transfusion

### Clinical Application

- ▶ Check  $\text{Ca}^{2+}$  often
- ▶ Consider 2g  $\text{CaCl}_2$  (or equivalent) for every 2-4 units of blood products

### Pathophysiology



Metabolizes 3 g citrate in ~5 mins



1 unit pRBCs = 3 g citrate



Citrate chelates  $\text{Ca}^{2+}$  ⇒ Hypocalcemia

### Risk of Citrate Accumulation

Liver dysfunction

>1 unit pRBCs every 5 mins

### Giancarelli, et al.

- ▶ 156 trauma patients receiving massive transfusion
- ▶ 97%  $\text{iCa}^{2+} < 1.12 \text{ mmol/L}$   
71%  $\text{iCa}^{2+} < 0.9 \text{ mmol/L}$
- ▶ ↑ blood products ⇒ ↓  $\text{iCa}^{2+}$
- ▶ >10 units of blood product best predictor of  $\text{iCa}^{2+} < 0.9$
- ▶ Mortality: <0.9 49% vs >0.9 24%

iCa=ionized calcium

#### References & additional readings:

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## LETHAL DIAMOND- THE ROLE OF $\text{Ca}^{2+}$

### Hypothermia

- Causes decrease in liver metabolism of citrate.
- Citrate not metabolized in the liver binds to  $\text{Ca}^{2+}$  leading to less  $\text{Ca}^{2+}$  available in the blood.

### Acidosis

- Low  $\text{Ca}^{2+}$  levels associated with lower Ph.
- Lower Ph prolongs clot formation.



### Coagulopathy

- $\text{Ca}^{2+}$  in the plasma is a necessary co-factor for clotting.

### Hypocalcemia

- $\text{Ca}^{2+}$  levels drop due to blood loss.
- Transfusion further exacerbates.