



Hypocalcemia and the Lethal Triad
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ACKNOWLEDGEMENT/DISCLOSURES


- Thank you to the Special Operations Medical Association.
- Thank you to the Lethal Diamond Working Group.
- Thank you to the Medics, Nurses, Physicians Assistants, and Doctors who continue to help with the cause to include the PFC working group and the JTS.
- Special thank you to LTC Ted Redman.
- I have no financial disclosures.

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AGENDA

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- Case Review
- Hypocalcemia
- Physiology
- Evidence
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- Synopsis
- Reference List
- Questions

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Definition


Calcium(Ca⁺⁺) is a major cation for multiple physiologic functions of the body. *** WHAT DOES Ca⁺⁺ do?***

Ca⁺⁺ is measured in two forms:


- Total Serum:8.2-10.5mg/dL
- Serum Ionized: 4.5-5.2mg/dL
 - 1.3-1.5mmol/L



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LETHAL DIAMOND – the Role of Ca²⁺



Hypothermia

- Causes decreased liver metabolism of citrate
- Citrate not metabolized in the liver binds Ca²⁺ leading to less available in the blood

Coagulopathy

- Ca²⁺ in the plasma is a necessary co-factor in the clotting cascade

Acidosis


- Low Ca²⁺ levels associated with lower pH
- Lower blood pH prolongs clot formation time

Hypocalcemia

- Ca²⁺ drops due to blood loss
- Transfusion exacerbates further

*Normal Blood Ca²⁺ in an healthy adult 4.64 to 5.28 mg/dL or 1.20-1.40 mmol/L

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Case Review

- Location: Cooper University Hospital, Camden NJ
- Approximately 1600 EST A 21 y/o Asian female is brought to the ED via ground transport.
- G: PT is A&Ox1, supine, cool, pale and clammy, with bimanual vaginal pressure from the Resident OBGYN.
- O: PT has a spiral tear from her vagina to her uterus.
- Tx: Methergine, hemabate, mass transfusion, and Pitocin.
- Outcome: Surgical reconstruction of vaginal cavity and uterus, PT positively diagnosed with disseminated intravascular coagulopathy(DIC). Extubated 4 days post op.

• What could have gone better?

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Hypocalcemia-Clinical Presentation

Serum Ionized Calcium <1.3mmol/L

Acute Signs/Symptoms	Chronic Signs/Symptoms
Trousseau's Sign	Dementia
Chvostek's Sign	Dry Skin
Perioral Paresthesia	Abnormal dentition
Fatigue	Parkinsonism
Prolonged QT interval	Extrapyramidal Signs
Seizures	

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Traumatic Hypocalcemia

DO2= CaO2 x CO

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Traumatic Hypocalcemia

DO2= CaO2 x HR x SV

(Spo2 x 1.34 x [HGB])+(0.0003 x PaO2)

CO

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Traumatic Hypocalcemia

Do2=CO x SAO2 x HGB X 1.34

Roberto et al., 1988

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Traumatic Hypocalcemia

100Kg M	Class I	Class II	Class III	Class IV
Blood Loss(mL)	Up to 750	750-1500	1500-2000	>2000
Blood Loss(dL)	Up to 7.5	7.5-15	15-20	>20
Ca++ Loss (mg)	0-75	75-150	150-200	>200

▲ Coagulopathy

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Traumatic Hypocalcemia

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Traumatic Hypocalcemia

- Citrate is metabolized in the liver
- Citrate in blood bags insignificant in a healthy liver
- Hemorrhage leads to hypothermia and decreased iC++

Hypothermia + Liver = Decreased Citrate Metabolism

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Physiology-Platelette Plug

So what happens when there is an insult to the endothelium?

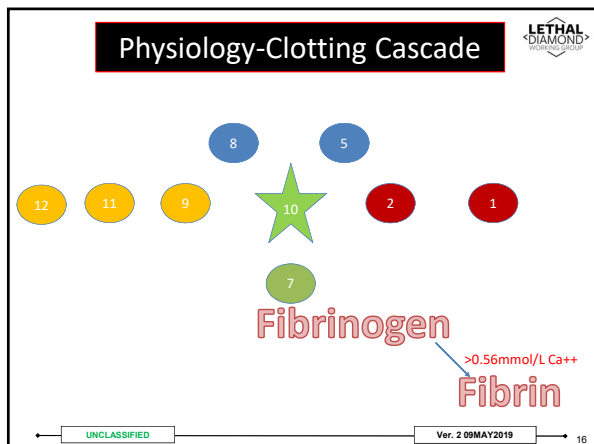
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Physiology-Platelette Plug

What was the role of calcium in this process?

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graph TD; PLA2 --> AA[Arachidonic Acid]; AA --> LOX; AA --> COX; COX --> TXa2; CA[CA++] --> AA;
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EVIDENCE

"Ionized calcium levels in major trauma patients who received blood en-route to a military medical treatment facility"

Who: UK MERT provided a retrospective study.
What: Compare the evidence of hypocalcemia in patients receiving blood transfusions.
When: Jan 2010-Dec 2014
How: 297 SM requiring blood transfusion were divided into a treatment group and non treatment group.
Results: Non-treatment group(166) 70% were hypocalcemic compared to the treatment group 28.3% were hypocalcemic.
Suggestions: 1 unit drops iCa++ to ~1.12mmo/L
 2 units drops iCa++ to <1.0mmo/L
 5 units drops iCa++ to <.8mmo/L

Kyle et al., 2017

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EVIDENCE

"Concentration-dependent effect of hypocalcemia on mortality of patients with critical bleeding requiring massive transfusion: a cohort study"

Who: Western Australia University
What: Compare the sensitivity of concentrations to mortality.
When: January 2011
How: 352 patients requiring mass blood transfusions from traumatic hemorrhage.
Results: Hypocalcemia was the **most critical** variable in determining mortality than fibrinogen, or acidosis levels. Determined that there is a **linear** concentration dependent relationship to mortality.

Ho et al., 2016

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WOUND GROUP

EVIDENCE-A Common Denominator

Research

Conclusions

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Proposal

Hypothermia

- Causes decreased liver metabolism of citrate
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Hypocalcemia

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*Normal Blood Ca²⁺ in an healthy adult 4.64 to 5.28 mg/dL or 1.20-1.40 mmol/L

Source: [Wolcott, Stewart, & Wilson. Contribution of blood transfusion to coagulopathy in hemorrhagic shock. Crit Care Med. 2004;32\(12\):2153-2158. doi:10.1097/CCM.0b013e3180100000](#)

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Current Protocol-DCR

Transfusion Criteria

- **Two or more distal amputations, or**
- **One proximal amputation, or**
- **Non-Compressible hemorrhage with signs of shock (SBP <100mmHg, and/or HR >100bpm).**
- **Controlled hemorrhage with signs of shock.**
- **Traumatic arrest within 5 minutes of loss of vital signs.**

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Current Protocols	
TMEPS Mild Toxicity- Slow or stop transfusion until symptoms subside. Ensure proper mixture and concentration of citrate. Severe Toxicity- Give 0.45 mEq elemental calcium or approximately 1ml of a 10% Calcium Gluconate(100mg/ml) for each 100mL citrated blood infused. Infuse over 10-20min for each 1 to 2gm of calcium gluconate. Diluted prior to administration (D5w or NS 100-250mL)	JTS CPG DCR May 2018- Calcium (consider one 10 ml ampule of 10% calcium chloride, or 30 ml of 10% calcium gluconate) should be given to patients in shock after approximately 4 units of citrated blood products transfused. Ideally, ionized calcium should be monitored.

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Proposed Protocol-DCR	
Best	
<ol style="list-style-type: none">1. Obtain IV/IO access x22. Flush IV/IO w/ 1G TXA.3. Start infusion of LTOWB/FDP/pRBC/LP through one line w/ fluid warmer attached.4. Administer 10mls CaCL or 30mls CaGlu SIVP.5. Flush Site.	

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Proposed Protocol-DCR	
No blood/products	
<ol style="list-style-type: none">1. Obtain IV/IO access x22. Flush site with 1G TXA.3. Administer 10mls CaCL or 30mls CaGlu SIVP.	

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Synopsis

LETHAL DIAMOND
WOUND REPAIR GROUP

- Ionized calcium is a critical electrolyte for multiple physiologic functions throughout the body.
- Hypocalcemia is directly related to the patients outcome.
- Early treatment of hypocalcemia independent from citrate toxicity can decrease mortality rates.
- Identification and treatment should take place in the platinum minutes.
- Further research is needed to be conducted in this field to determine the perfect treatment plan.

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Synopsis

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Questions?

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