THE GEORGE WASHINGTON UNIVERSITY

Unconventional Medicine in a Conventional World

Hypocalcemia and the Lethal Triad

SGT Ditzel Ricky M Jr

CCP-C, FP-C, TP-C, SO-ATP

AGENDA

- Case Review
- Definition
- Hypocalcemia
- Physiology
- SOF Initiative
- Evidence
- Protocols
- Synopsis
- Reference List
- Questions

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

Proposal

Hypocalcemia

Acidosis

Coagulopathy

Hypothermia

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.

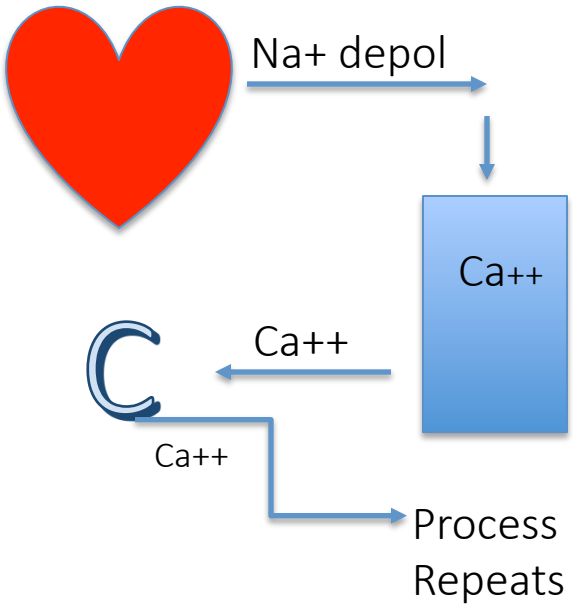
- What could have gone better?

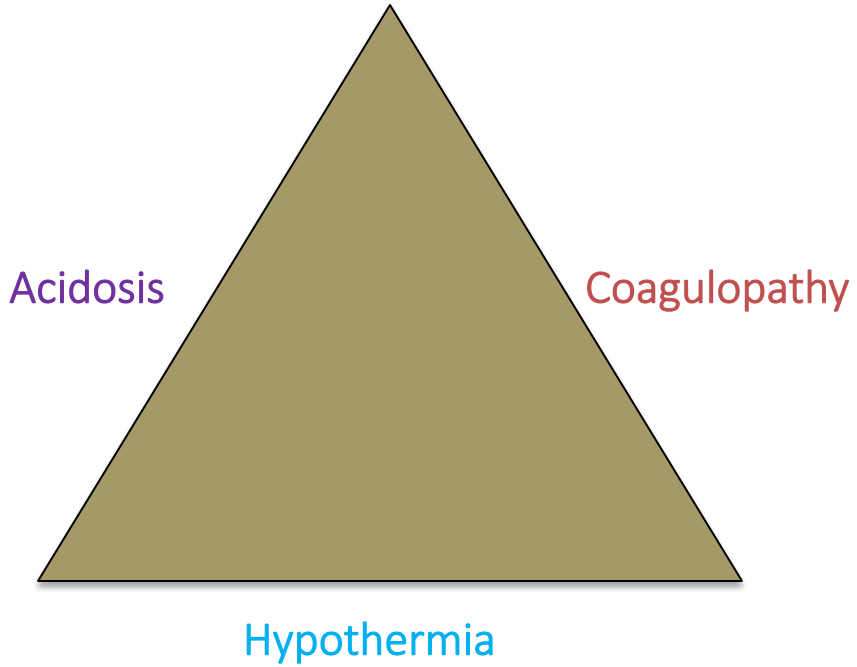
Hypocalcemia-Clinical Presentation

Serum Ionized Calcium <4.5mg/dL

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	

Traumatic Hypocalcemia





$$DO2 = CaO2 \times CO$$

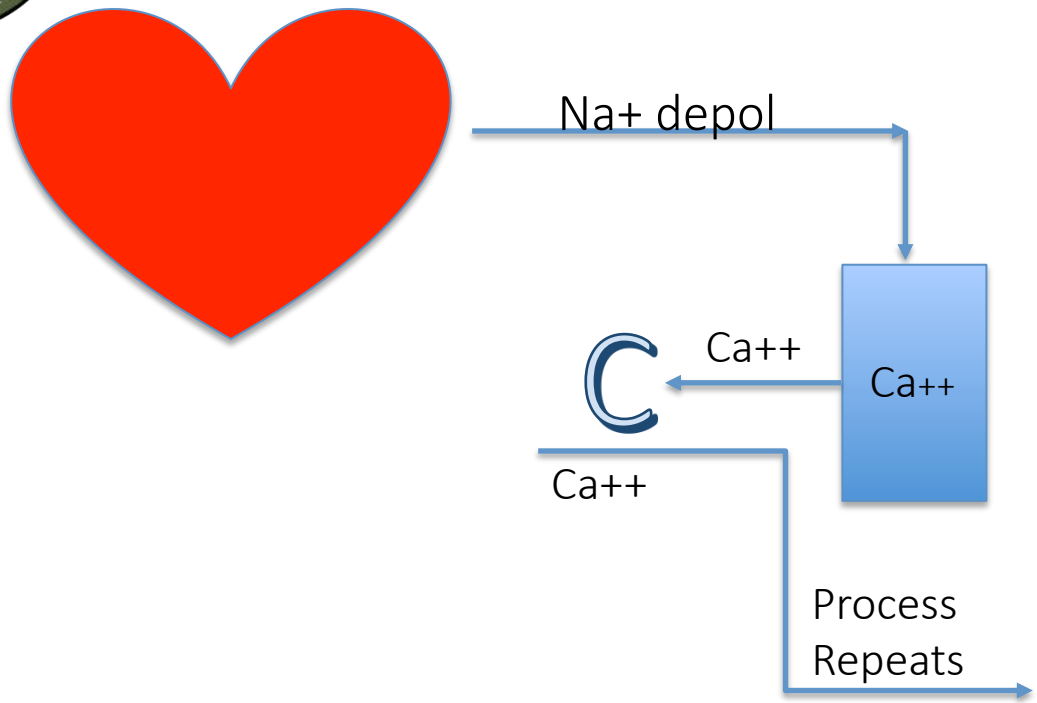
Traumatic Hypocalcemia

$DO_2 = CaO_2 \times HR \times SV$

$(Spo_2 \times 1.34 \times [HGB]) + (0.0003 \times PaO_2)$

CO

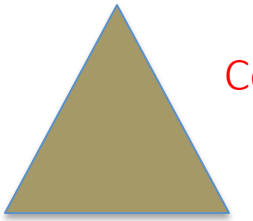
Traumatic Hypocalcemia



Do2=CO x SAO2 x HGB X 1.34

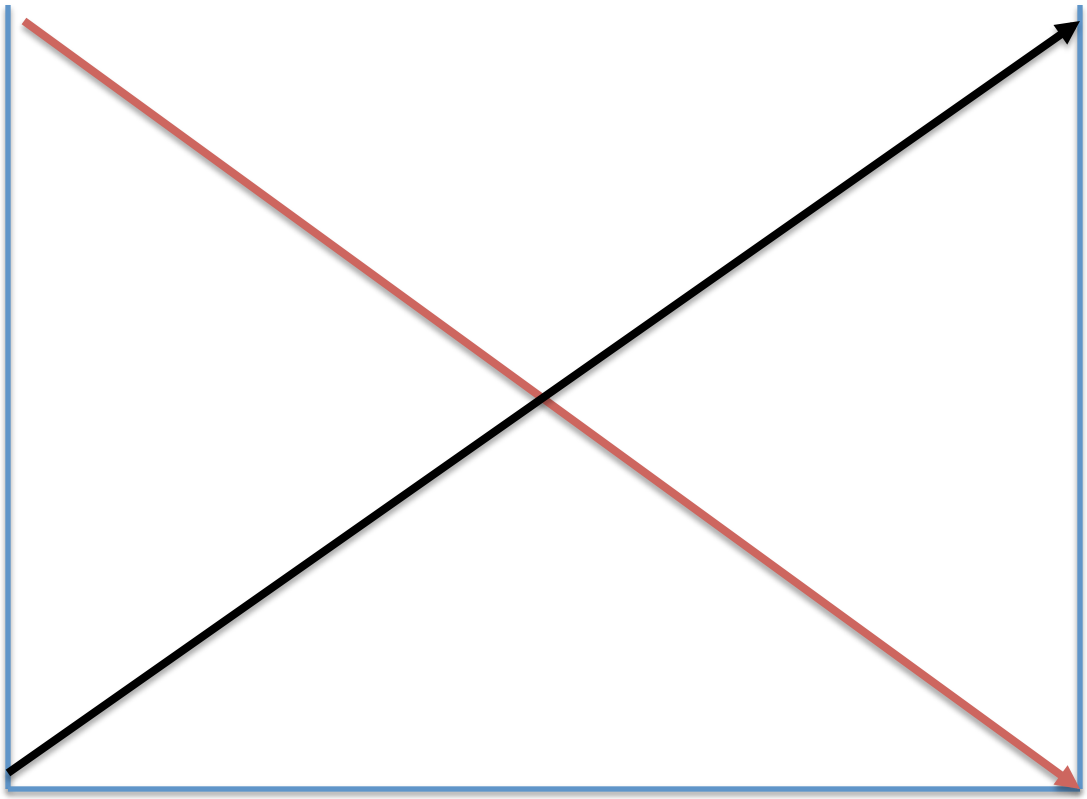
Traumatic Hypocalcemia

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

Traumatic Hypocalcemia



Protein Bound

7 7.1 7.2 7.3 7.4 7.5 7.6 7.7

Ca++ mg/dL

Free Ionized Ca++ mmo/L

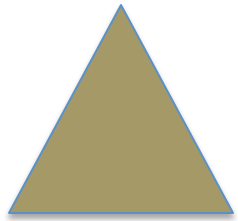
Acidosis

K. Ho 2016

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



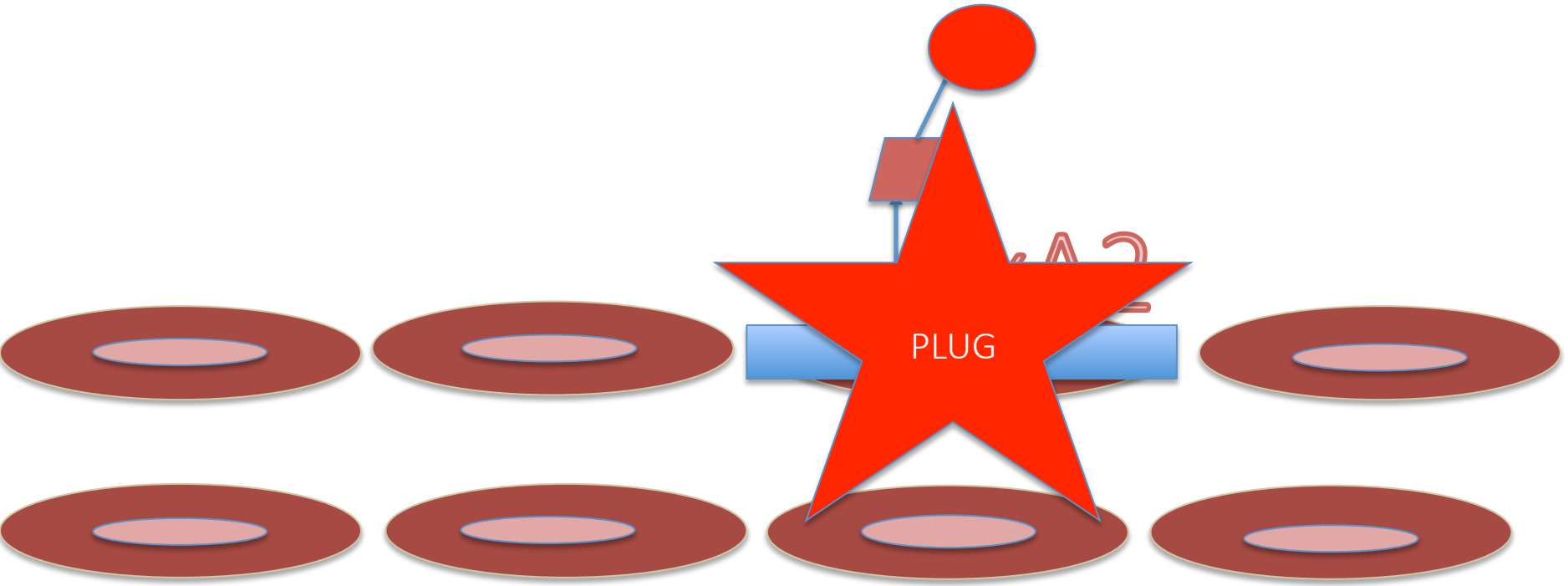
Traumatic Hypocalcemia

"You can't punk physiology"

Anonymous

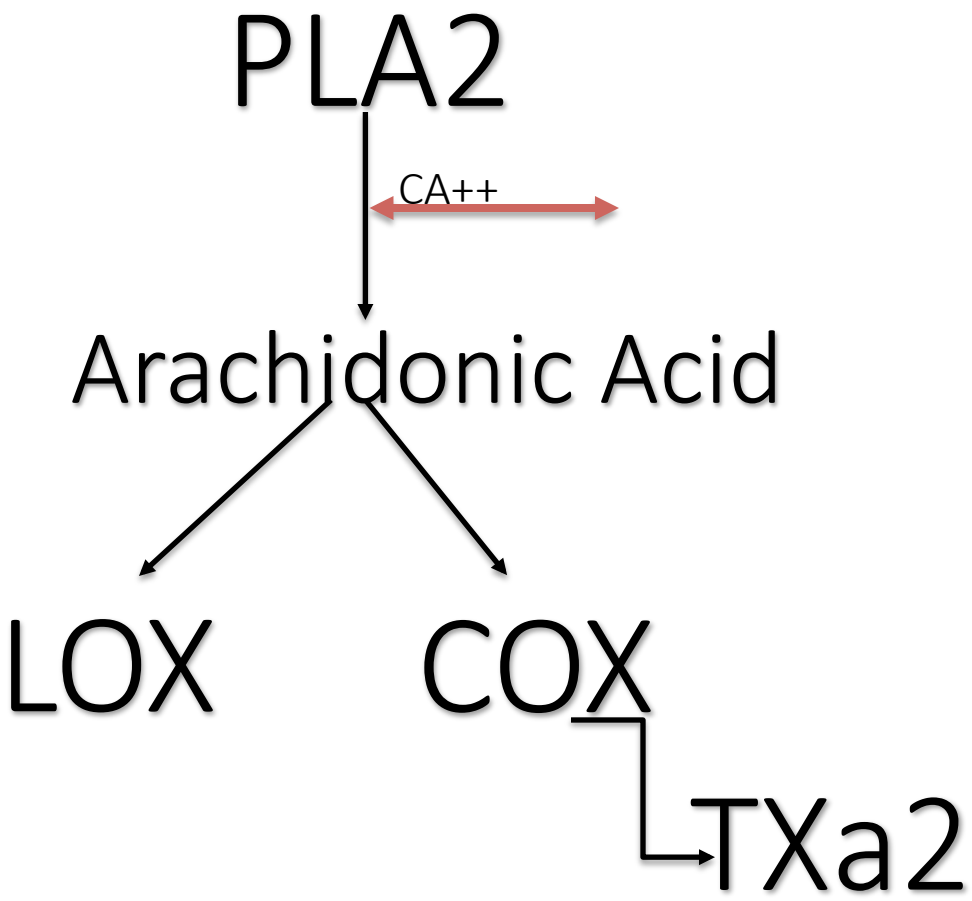
Physiology-Platelette Plug

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

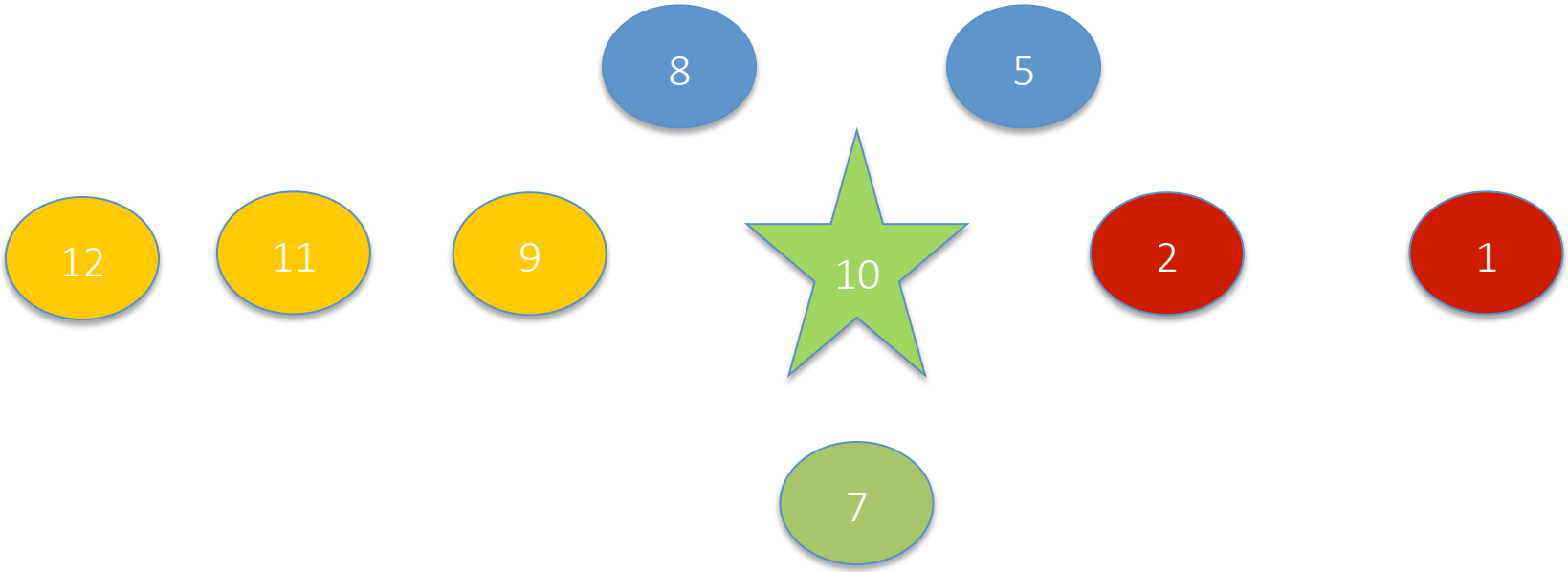


Physiology-Platelette Plug

What was the role of calcium in this process?



Physiology-Clotting Cascade



Fibrinogen

>0.56mmol/L Ca++

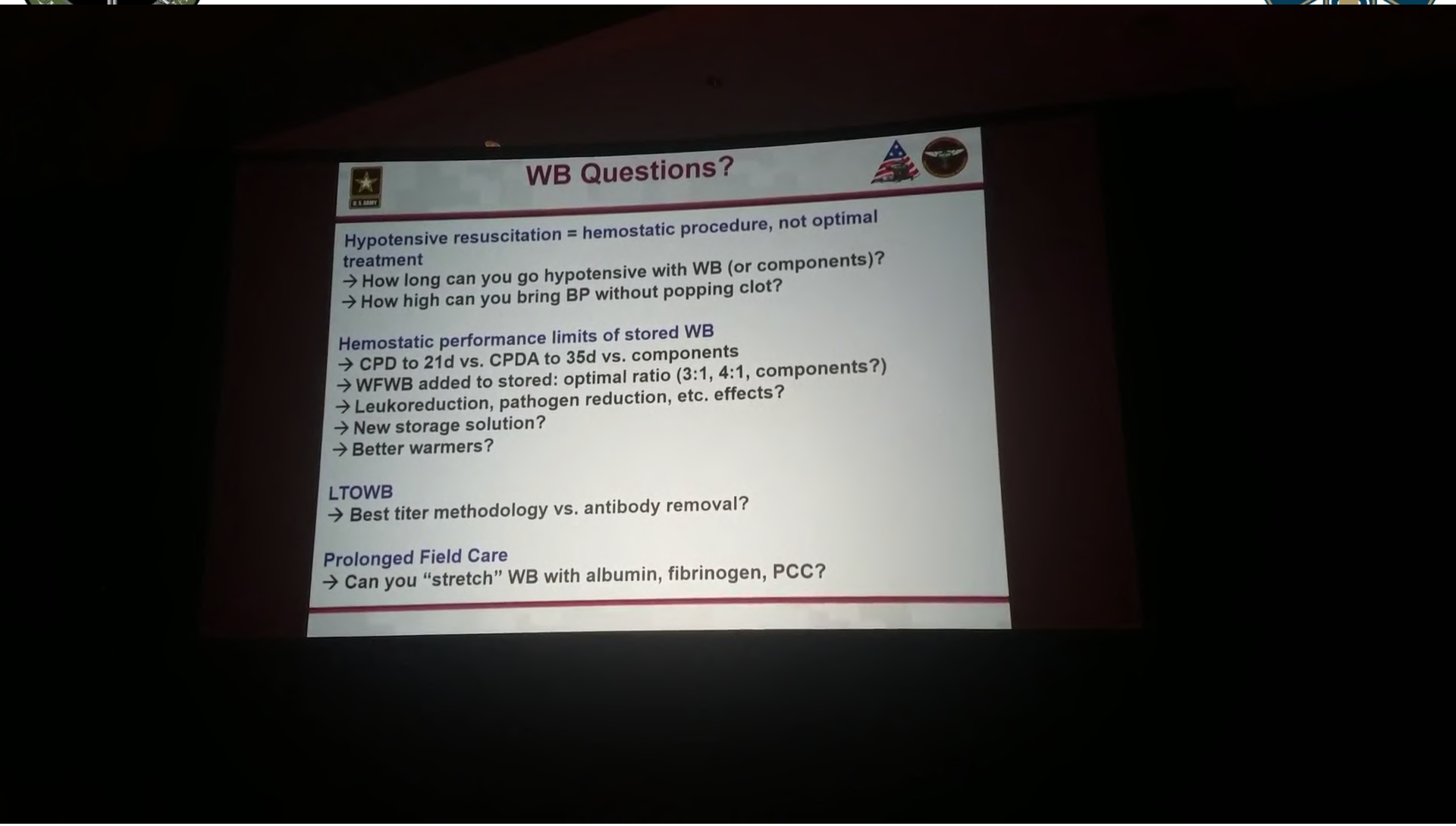
Fibrin

SOF INITIATIVE

"There hasn't been a new idea since 1776."

LTC Theodore Redman

SOF INITIATIVE-SOMA 2017



EVIDENCE

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

Who: Royal British Military 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

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.

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.

K. Ho 2016

EVIDENCE-A Common Denominator

Research

Conclusions

Proposal

Hypocalcemia

Acidosis

Coagulopathy

Hypothermia

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.

Current Protocol

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)

C-TECC Guidelines

Administer approviate IV Fluid bolus (500cc NS/LR) and re-assess casualty. Repeat bolus once after 30 minutes if still in shock.

If Blood products are available, consider resuscitation with plasma(FFP) and packed red blood cells(PRBCs) in a 1:1 ratio.

Proposed Protocol-DCR

Best

1. Obtain IV/IO access x2
2. Start infusion of LTOWB/FDP/pRBC through one line w/ fluid warmer attached.
3. Infuse 1G calcium chloride/gluconate in 100mL bag of NS bolus.
4. After infusion of calcium, flush line, infuse 1G TXA over 1-2min IV push.

Proposed Protocol-DCR

No blood/products

1. Obtain IV/IO access x2
2. Infuse 1G calcium Chloride/Gluconate in 100mL bag of NS bolus w/ fluid warmer.
3. Infuse 1G TXA IV push over 1-2min

Synopsis

- 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.

Synopsis

School of Medicine & Health Sciences

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Questions?

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