

Clinical Pearls from the Preventable Mortality Review Committee

Q1 2024

Hypocalcemia in Hemorrhagic Shock and the Mass Transfusion Protocol

1. Calcium is necessary for coagulation, platelet adhesion, cardiac contractility, and vascular tone. Hypocalcemia is an expected complication in hemorrhage and subsequent blood product transfusion with products containing citrate as a preservative that binds ionized calcium.
2. Hypocalcemia must be readily anticipated and addressed in patients with hemorrhagic shock who are being massively transfused.
3. Calcium chloride (CaCl) contains 3 times more elemental calcium than calcium gluconate (CaGl) but is also more caustic to peripheral veins.
4. Calcium supplementation should be provided in patients receiving blood products for hemorrhagic shock in a continuous ratio of 1g CaCl in 100ml NS or 3g CaGl per 3 units of RBC during the balanced blood product resuscitation.

Recommend:

- 1g of Calcium (30 ml of 10% calcium gluconate or 10 ml of 10% calcium chloride) should be given with the first unit of blood product (plasma preferred) and with ongoing resuscitation after every 4 units of blood products.¹
- Others recommend 1g of calcium chloride or 3g of calcium gluconate for every third RBC in a balanced resuscitation or whole blood transfusion process.
- Ideally, ionized calcium should be monitored, and calcium should be given for ionized calcium less than 1.2mmol/L.



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Justification

Patients presenting in hemorrhagic shock can be expected to be hypocalcemic on arrival due to calcium consumption in the clotting cascade that has been in process since the initial insult and will worsen with a balanced mass transfusion. The adverse hemodynamic effects of hypocalcemia are critical to address in trauma patients. Hypocalcemia is directly linked to the other components of the lethal Trauma Triad of coagulopathy, hypothermia, and acidosis. It has been added to these elements to define the Diamond of Death. Failure to address and correct hypocalcemia in trauma patients has repeatedly been shown to increase morbidity and mortality by contributing to coagulopathy and further increasing the need for blood products.

Calcium is vital to coagulation, platelet adhesion, cardiac contractility, and vascular tone. It is required in the clotting cascade to activate factors II, VII, XIII, IX, and X, as well as Proteins C and S, stabilizing fibrinogen and thrombus formation. An ionized calcium below 0.9 mmol/l leads to impaired coagulation and cardiovascular function.

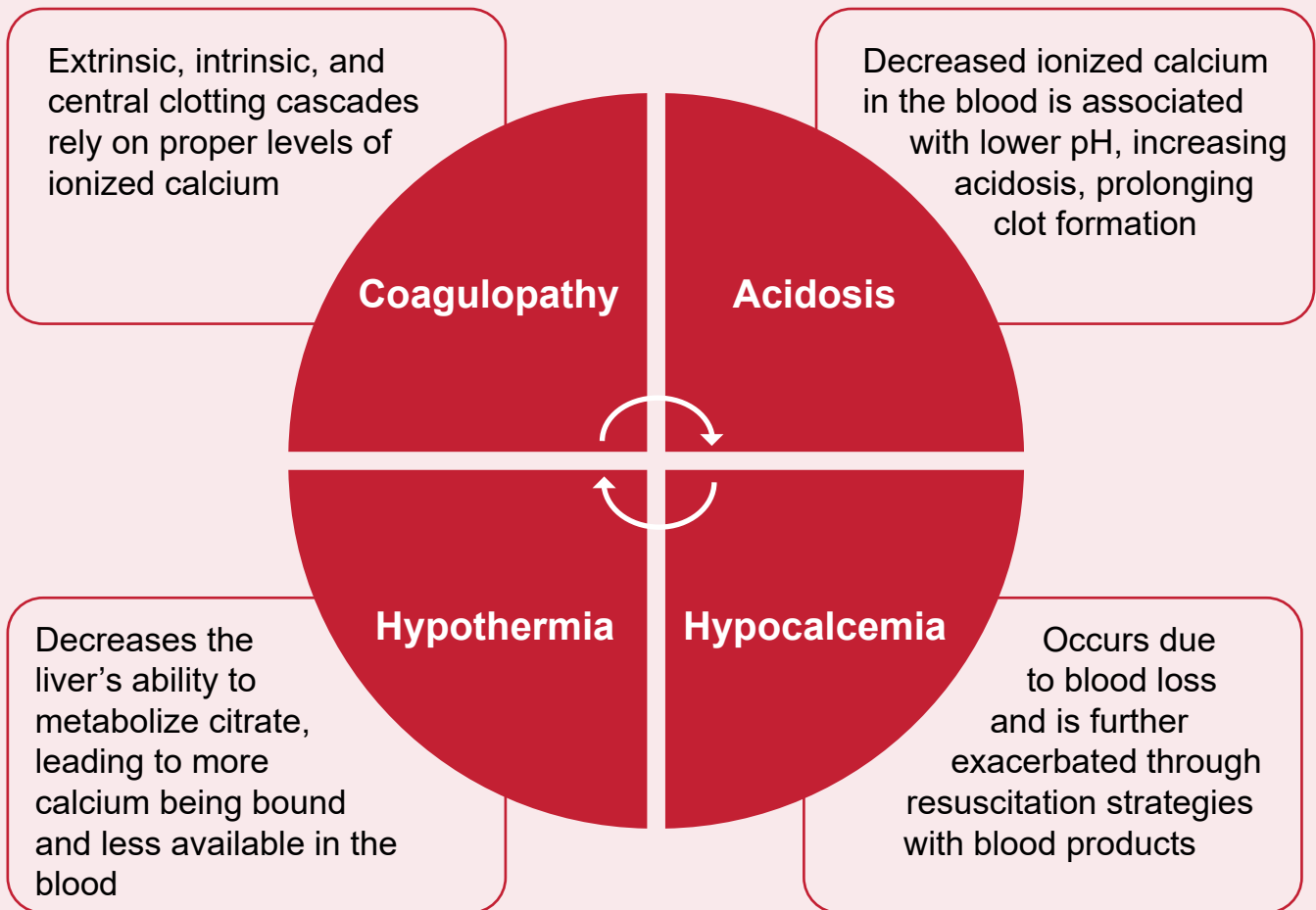
Calcium is rapidly consumed or bound through activation of the clotting cascade in massive hemorrhage and through binding with citrate in blood products during transfusion. The amount of citrate in plasma and packed red blood cells must be considered for calcium replacement. A normal, healthy liver can metabolize citrate; however, with liver trauma, hypothermia, and acidosis, this process is impaired, causing ionized calcium levels to decrease. Clinical signs of hypocalcemia include prolonged QTc, narrow pulse pressure, tetany, hypotension due to reduced cardiac contractility and decreased vascular resistance, muscle tremors, laryngospasm, paresthesia, and PEA/Ventricular fibrillation.

Calcium infusion with either Calcium chloride or calcium gluconate is necessary to maintain physiologically normal levels in the above settings. Calcium chloride (13.6mEq calcium) provides three times more elemental calcium than calcium gluconate (4.56mEq calcium). Calcium chloride releases calcium immediately upon infusion, whereas calcium gluconate requires hepatic metabolism to release the calcium. Calcium chloride, however, must be used cautiously through peripheral lines (central line preferred) due to vascular irritation and risk of tissue necrosis with extravasation. Therefore, CaCl should be diluted in 100ml NS and administered over 10 min.

These guidelines were prepared by the ADH (trauma medical consultant) and members of the Arkansas State Preventable Mortality Committee. They are intended to serve as guidelines based on a review of the current medical literature. They are not intended to be used as strict policies or protocols. Their use is at the discretion of the managing physician.



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