MASSIVE TRANSFUSION AND RAPID INFUSION

CLINICAL BEST PRACTICES - JULY 2020

Internal Use Only

BELMONT MEDICAL TECHNOLOGIES

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OBJECTIVES

- Understand variables and considerations during massive transfusion
- Understand what complications can occur
- Understand the importance of good communications and setting expectations with customers

MASSIVE TRANSFUSION

Historically defined as the infusion of 10 units of red cells in within 24 hours[1]

With advances in medical technology, rapid infusion can alternatively be defined as the following[1]:

- Total blood volume replaced within 24 hours
- 50% of Total Blood Volume replaced within 3 hours
- Rapid bleeding rate is documented or observed (generally >150 ml/min)

TRAUMA MTP'S

- Physical trauma
  - Where physical injury and blood loss combine

NON-TRAUMA MTP's

- Cardiac surgery
- Ruptured Aortic Aneurism
- Liver Transplant
- Postpartum Hemorrhage

MTP: Massive Transfusion Protocol

1. Guidelines for Massive Transfusion for the Scientific Section Coordinating Committee by Arthur Bracey, MD, Chantal Harrison, MD, Richard Weiskopf, MD, Belva Sipherd, MT(ASCP), E. Ann Steiner, MT(ASCP)SBB

CLINICAL CONDITIONS TO CONSIDER DURING MASSIVE TRANSFUSION

VOLUME STATUS AND TISSUE OXYGENATION[2,3]

- The main concern with massive blood loss is maintaining oxygen delivery to tissues
- Volume expanders like crystalloids or colloids are employed to maintain blood pressure during acute blood loss
  - Volume expanders maintain perfusion rates but dilute blood, thus affecting hemoglobin, clotting factors and other blood components
  - For continued or massive blood loss, blood product is needed to maintain hemostasis

2. Jennings LK, Watson S. Massive Transfusion. [Updated 2020 Feb 11]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK499929/
3. Leibner, Evan et al. “Damage control resuscitation.” Clinical and experimental emergency medicine vol. 7,1 (2020): 5-13. doi:10.15441/ceem.19.089 https://pubmed.ncbi.nlm.nih.gov/22414409/?from_term=massive+transfusion+acidosis&from_pos=5

ACIDOSIS

- Acidosis: a condition in which there is too much acid in the body fluids

- Prolonged states of hypoperfusion cause acidosis[1, 2]
  - Patients are often already acidotic prior to transfusion

- Once set in, acidosis further interferes with coagulation reducing coagulation factors, resulting in delayed fibrin clot formation (clot over a wound site) particularly in the presence of hypothermia[2, 4, 5]

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4. Lier H, Krep H, Schroeder S, Stuber F. Preconditions of hemostasis in trauma: a review. The influence of acidosis, hypocalcemia, anemia, and hypothermia on functional hemostasis in trauma. J Trauma 2008; 65: 951–960.
5. Dirkmann D, Hanke AA, Gorlinger K, Peters J. Hypothermia and acidosis synergistically impair coagulation in human whole blood. Anesth Analg 2008; 106: 1627–1632.

HYPOTHERMIA

- Lower ambient temperatures and decreased blood volume can predispose these patients to hypothermia[2]
- Hypothermia has an adverse effect on metabolic pathways driven by enzymatic reactions, including the coagulation cascade[2, 4, 5]
- From the AABB Guidelines on Massive Transfusion[1]:
  - "A core temperature below 34°C is associated with poor clinical outcomes. Additive although not synergistic, effects of hypothermia and hemodilution are noted at temperatures lower than 35°C. Platelet dysfunction has also been associated with low core temperature."
  - "…the most important issue in hypothermia is the onset of ventricular tachycardia and ventricular fibrillation at core temperatures of less than 30°C. Massively transfused patients should receive blood through high-capacity blood-warming devices capable of rapid heat exchange without placing transfused cells at risk for thermal injury."

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COAGULOPATHY AND DYSFUNCTIONAL HEMOSTASIS[1,2]

- Coagulation factors are consumed at a high rate in patients with acute blood loss
- Volume expanders cause dilution to remaining coagulation components
- Hypothermia and acidosis combined with the decrease in available coagulation factors can lead to coagulopathy and altered hemostasis
- The decreased ability to stop bleeding leads to a cycle of additional hypothermia and acidosis, creating a positive feedback loop that results in worsened patient outcomes

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ADDITIONAL VARIABLES FOR MASSIVE TRANSFUSION

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Access for infusion

- With all catheters, the Hagen-Poiseuille equation applies. The rate of flow is directly related to the inner radius of the catheter and is inversely related to the length of catheter
  - Peripheral Access (Large Bore/RIC)
  - Central IV Catheters
  - Intraosseous (IO) catheters*

- May not reach the necessary flow rates and may trigger pressure control
- Use only as a bridge until sufficient access can be obtained to achieve necessary flow rates

Availability of products/Ratios[6]

- Military tends to advocate whole blood usage in MTP's, many hospitals are making the transition to using whole blood. However, many facilities are still using individual products.

A common ratio is a 1:1:1 of FFP, Platelets, and PRBC's. However, other ratios are used, including 1:2 Plasma to PRBCs[6] and 6:2:1 of PRBCs, Plasma, and Platelets[8]

- Platelets should not be infused via the rapid infuser as they should not be diluted.

6. Cap et. Al Damage Control Resuscitation, Military Medicine, Volume 183, Issue suppl_2, 1 September 2018, Pages 36–43, https://doi.org/10.1093/milmed/usy112

* Max flow rate of 125ml/min

POSSIBLE COMPLICATIONS FROM MASSIVE TRANSFUSION

- Metabolic Alkalosis / Hypocalcemia from sodium citrate and citric acid that is an additive to blood products in storage to prevent coagulation[1, 2]
  - AABB recommends coordinated dialysis to minimize the metabolic impact in patients with acute renal failure[1]
- Hypothermia- Rapid infusion of cold blood products can lead to a lower core temperature[1, 2]
- Hyperkalemia- typically only seen when blood products that have been stored for long periods and are infused through central access at high speeds[1, 2]
- Transfusion Related Acute Lung Injury (TRALI) and Transfusion Associated Circulatory Overload (TACO) [7]
  - Rapid onset of hypoxemia indicates TRALI or TACO within 6 hours of transfusion. Patients present with very similar etiology of patient in acute respiratory distress syndrome (ARDS)[4]

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7. Semple JW, Rebetz J, Kapur R. Transfusion-associated circulatory overload and transfusion-related acute lung injury. Blood. 2019;133(17):1840-1853. doi:10.1182/blood-2018-10-860809

KEY TAKEAWAYS

Know the various members of the team for Massive Transfusion and their scope of practice/responsibility – who is on point to run the Rapid Infuser?

- This is extremely important as some facilities give larger scopes than others. For example, in military medicine, the medic would be the person starting the IV or IO and running the Rapid Infuser. Whereas, another facility may not even allow the anesthesia techs to prime the Rapid Infuser because normal saline is a drug and it's out of their scope.

Understanding that access is just as important as administration

- The activation of a Massive Transfusion Protocol brings stress for all team members. Placing a catheter during this time can be especially stressful. Making sure the facility understands that just because they HAVE access (i.e. a 22g peripheral), it doesn't mean it is going to get them where they need to go. Catheter size and length play a major role in administration.

Management of ALL patient factors will determine patient success rate

- The Belmont Rapid Infuser RI-2 can control numerous factors like temperature, pressure, and rate. It's important to understand why these features play such a large role in the bigger picture of a Massive Transfusion Protocol.