Massive Transfusion for Trauma Protocol

Purpose

Hemorrhage is the leading cause of early death following traumatic injury. Protocol-driven transfusion strategies that approach a 1:1:1 ratio in patients who require massive transfusion improve patient survival, reduce hospital and ICU length of stay, decrease ventilator days, and ultimately reduce patient care costs.

These guidelines are meant to standardize the approach to resuscitation of an injured patient in hemorrhagic shock utilizing massive transfusion.

This guideline is a supplement to and is to be used in conjunction with Nebraska Medicine's organizational policies "Massive Transfusion/Severe Coagulopathy" (TX-36) and "Guidelines for Management in Patients Receiving Anticoagulation" (MP 11).

Background/Definitions

Massive transfusion may be defined as transfusion in response to massive and uncontrolled hemorrhage resulting in any of the following:

- Replacement of half of a patient's total blood volume in a 4 hour period
- Replacement of a patient's total blood volume within 24 hours
- Transfusion of >10 units of PRBCs in 24 hours
- Specific pediatric parameters are more challenging to define and include transfusion of >40mL/kg PRBCs in a short period of time.

Hemorrhage is the most common cause of death within the first hour of arrival to a trauma center. Blood product resuscitation, specifically massive transfusions, are often unplanned and require the processing and delivery of large amounts of blood products rapidly for a sustained period of time, significant preplanning and coordination between the blood bank, resuscitating unit (i.e. emergency department, operating room, intensive care unit) and pharmacy is required. The initiation of a massive transfusion protocol (MTP) outlines a standard process for the safe, rapid preparation and delivery of blood products and coagulation factors for the pediatric patient experiencing massive hemorrhage. Additionally, implementation of a standardized guideline may prevent the anticipated complications of massive transfusion including thrombocytopenia, coagulopathies, electrolyte and acid/base disturbances,

hypothermia and transfusion reactions as well as utilize valuable blood components in a resourceful manner.

At Nebraska Medicine, the massive transfusion protocol is divided into 3 categories based on the patient's weight with each pack within that category containing the following blood product components.

MTP type	Packed Red Blood Cells (PRBC)	Thawed Plasma (FFP)	Apheresis Platelets	Pre-pooled cryoprecipitate (cryo)
Adult (> 40 kg)	6 (O pos)	6 (A)	1	On pack #3 and every pack thereafter
Pediatric (10-40kg)	6 (O pos)	6 (a)	1	On pack #3 and every pack thereafter
Neonate/Infant (<10 kg)	1 (O neg, irradiated)		1 (irradiated)	

Guideline Inclusion Criteria

Injured patients with concern for massive or uncontrolled hemorrhage.

Guideline Exclusion Criteria

This is a guideline only. Individual circumstances need to be considered, as there may be times when it is appropriate to deviate from this guideline.

Diagnostic Evaluation

Injured patients should be assessed per ATLS guidelines paying close attention to circulation. Presence or history of hemodynamic instability, poor perfusion and external blood loss are red flags for hemorrhage. Signs of hemodynamic instability or poor perfusion may include altered mental status, pallor, delayed capillary refill, tachycardia, and hypotension. Hypotension is often a late sign of hypovolemic/hemorrhagic shock.

Practice Recommendations for Management

Initiation and Activation

- The decision to activate MTP is a clinical decision made by the trauma or emergency medicine attending physician and should be strongly considered with one or more of the following criteria:
    - Persistent hemodynamic instability

    - Shock Index >1 (SI = HR/SBP)
    - Active bleeding requiring operation or angioembolization
    - Blood transfusion in the Trauma Bay
    - Adult patients (>40 kg)--Anticipated of transfusion of >10 units PRBC in 24 hrs or >4 units in 1 hr.
    - Pediatric patients (≤40kg) -- Anticipated or actual use of ≥ 40 mL/kg PRBCs in 2 hours or replacement of total blood volume (approximately ≥ 80 mL/kg) in 24 hrs
    - Assessment of blood consumption (ABC) score is **≥2** (adults only):
        - Penetrating mechanism of injury (1pt)
        - Systolic blood pressure less than or equal to 90 mm Hg (1pt)
        - Heart rate greater than or equal to 120 (1pt)
        - Positive FAST exam (1pt)
- Initiation of MTP should not be delayed for lab results.
    - Universally compatible RBC (O Rh-negative) and thawed plasma may be given.
- Emergency release blood should be utilized as indicated until MTP blood products are available.
    - Whole blood is preferred in the initial resuscitation of hemorrhagic shock in patients age 6 and older.
        - 4 units of whole blood (O positive) are available for trauma resuscitations in the emergency department (ED) and can be found in the ED trauma bay kiosk refrigerator pending inventory availability.
        - Use of whole blood in pediatric patients age 6-12 years of age should be limited to **1 unit** due to potential risk of hemolysis.
    - Emergency release blood is located in the following locations:
        - Emergency Department (ED) trauma bay kiosk refrigerators (2 kiosks located in T1 and T4) each containing 2 units O positive whole blood, 2 units O negative PRBC, 6 units O positive PRBCs, and 3 units A plasma
        - Blood bank keeps 4 units O negative PRBC, 12 units O positive PRBC, 12 units A plasma, 8 units platelets, and 25 units pre-pooled cryoglobulin (frozen).
- To activate the MTP, the attending physician (or designee) will notify the Blood Bank via telephone (402-559-3639) that MTP is being activated and provide the following information:
    - Caller name and title
    - Caller location
    - Caller contact number
    - Ordering provider’s name
    - Patient’s name (may be the trauma name or real name)

    - Patient’s MRN
    - Category of MTP being activated (adult, pediatric, neonate/infant)
    - Patient’s weight (kg)

Blood Product Administration and Transfusion Goals

- Minimize crystalloid or colloid resuscitation to prevent dilutional coagulopathy.
- Utilize emergency release blood products until MTP products are available.
- Blood products are released in 1:1 ratios of whole units but will be administered based on the clinical status of the patient and at the discretion of the attending physician.
    - Maintaining a 1:1:1 transfusion ration of PRBC to FFP to Platelets is recommended. (Platelets are pooled-packs thus one apheresis platelets should be transfused for every 6 units of PRBC/FFP with the exception of neonatal/infant MTP resuscitations where apheresis platelets serves as FFP and platelet components). These rations help to avoid dilutional coagulopathy and thrombocytopenia and have been associated with decreased mortality.

- **Pediatric Patients** (≤40 kg), recommended volumes include:
    - Whole blood -- 20 mL/kg
        - if using whole blood during pediatric MTP, utilize entire unit of whole blood with repeated boluses of 20mL/kg before moving on to blood components.
    - PRBC – 20 mL/kg
    - FFP – 20 mL/kg
    - Apheresis Platelets – 5 mL/kg
    - Cryoprecipitate – 0.1 unit/kg
        - Consider cryoprecipitate if serum fibrinogen levels remain less than 150 mg/dL following FFP.

- Massive transfusion products should be administered rapidly and warmed via a rapid infuser with the exception of platelets
    - For pediatric patients requiring smaller volumes, a “push-pull” system with 60mL syringe, stop-cock, and tubing may be utilized.
- Initial rate of transfusion should restore perfusion but allow permissive hypotension until bleeding has been controlled in the operating room or interventional radiology.
- Blood product resuscitation should be based on clinical evidence of ongoing bleeding in addition to quantitative data, such as ROTEM when available.
- Utilization of the patient’s own blood when safe (i.e. cell saver, autotransfusion from chest tube, etc) also provides readily available warm, matched blood.

Therapeutic Adjuncts in MTP

Tranexamic Acid (TXA)

- TXA is an antifibrinolytic used to treat coagulopathy. TXA should be initiated early in the coagulopathic cascade – within the first 3 hours of bleeding, in order to be effective.
- TXA should be administered based on the evidence of shutdown of fibrinolysis or hyper-fibrinolysis on ROTEM and/or provider discretion.
- Recommended dosing:
    - <12 years:
        - Loading dose of 15 mg/kg (max dose 1000mg) intravenous administered over 10 minutes
        - Maintenance infusion of 2mg/kg/hr intravenous for 8 hours (max dose 1000mg)
    - ≥12 years/Adult Dosing:
        - Loading dose of 1000 mg intravenous administered over 10 minutes
        - Maintenance infusion of 1000 mg intravenous over 8 hours

Calcium

- The rapid rate of transfusion during MTP often exceeds the liver's capacity to metabolize citrate, leading to severe hypocalcemia. Calcium is also required by several clotting factors for activation, stabilization of thrombus formation and contractility of myocardial and smooth muscle cells. Hypocalcemia can lead to coagulopathy, myocardial depression and vasodilation—all physiologic changes that complicate the management of hemorrhagic shock. Thus, adequate calcium repletion is an important component of MTP.
- Adults (>40 kg): 3g IV calcium chloride should be administered following completion of each MTP cooler.
- Pediatric patients (≤40 kg): 20 mg/kg IV calcium chloride should be administered after every 2 rounds of PRBC/FFP

Anticoagulant Reversal

- Injured patients in hemorrhagic shock with pre-existing anticoagulant use should be reversed with the appropriate reversal agent. See "Guidelines for Management of Bleeding in Patients Receiving Anticoagulation" (MP 11) for additional details.

Please utilize Pharmacy for any questions regarding dosage and use of therapeutic adjuncts.

<u>Assessment of Coagulopathy and Transfusion Targets</u>

- Coagulopathy
    - Recommended initial lab testing at initiation of MTP include:
        - CBC, PT/PTT, INR, fibrinogen, ROTEM
    - Ongoing lab testing during MTP include:

        - CBC, PT/PTT, INR, fibrinogen, and ROTEM every 4 hrs or as clinical situation indicates.
    - ROTEM parameters
        - $A5_{EXTEM}$ <35 mm OR ML ≥ 5% (within 60 min) à give TXA
        - $A5_{EXTEM}$ <35 mm AND $A5_{FIBTEM}$ <9 mm à give cryoprecipitate
        - $A5_{EXTEM}$ <35 mm AND $A5_{FIBTEM}$ ≥9 mm à give platelets
        - CT_{EXTEM} >80 s AND $A5_{FIBTEM}$ ≥9 mm à Give PCC or plasma
        - CT_{INTEM} > 240 s AND (CT_{INTEM}/CT_{HEPTEM}) > 1.25 à give protamine, if suspected heparin activity or heparin like effects
        - CT_{INTEM} > 240 s AND (CT_{INTEM}/CT_{HEPTEM}) < 1.25 à give plasma

- Acidosis
    - Goal: Lactic Acid < 2
    - Goal: Base Deficit <4
    - Ongoing lab testing: Lactic acid and arterial blood gas (ABG) to assess acid-base status every 6 hrs during MTP or as clinical situation indicates.

- Hypothermia
    - Goal: 36 degrees Celsius or warmer
    - All trauma patients should undergo passive external rewarming including warmed blankets and increased ambient room temperature
    - Administer warm blood products
    - Continuously monitor utilizing core temperature probe.

- Hypocalcemia
    - Goal: ionized calcium (iCa) >1.0 mmol/L
    - Ongoing testing: iCa should be monitored at initiation of MTP and after completion of each MTP cooler.

- Hyperkalemia
    - Goal: potassium <5
    - Ongoing lab testing: Potassium every 6 hours or as clinical situation indicates.

<u>Discontinuation and Transition to Goal Directed Therapy</u>

- Ratio-driven massive transfusion may be discontinued and transitioned to goal-directed transfusion based on laboratory findings if surgical bleeding has been controlled or there is radiographic and physiologic evidence of bleeding control after embolization.
- MTP may also be discontinued when there is recognition that further resuscitation is futile.

- Suggested values for Goal Directed Therapy:
  - Hemoglobin ≥ 10g/dL
  - Platelets >150,000/mcL
  - PT <18 seconds
  - PTT < 35 seconds
  - INR <1.5
  - Fibrinogen >180
  - ROTEM
    - Clotting time (CT) – CT_{IN}<215 and CT_{EX}<75
    - Amplitude 5 min after CT (A5)—$A5_{IN,EX}$>33
    - Amplitude 10 min after CT (A10)—$A10_{IN,EX}$>45
    - Maximum clot firmness (MCF)—$MCF_{IN,EX}$>56 and MCF_{FIB}>5
    - Maximum Lysis (ML)—$ML_{IN,EX,FIB}$<7%

Outcome Measures and Guideline Adherance

All trauma massive transfusion activations will be monitored through the trauma performance improvement (PI) process. Specific indicators that will be monitored/assessed include:

1. Time from initiation of MTP to infusion of the first unit PRBCs
2. Time from initiation of MTP to infusion of the first unit of plasma
3. Overall ration of blood product transfusion and at 2 hours
4. Total blood products used from MTP activation to 24 hours
5. Notifying blood bank within 1 hour of MTP termination
6. Use of therapeutic adjuncts
7. Complications

Related Policies:

- TX36 Massive Transfusion/Severe Coagulopathy
- MP 11 Guidelines for Management of Bleeding in Patients Receiving Anticoagulation

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