Guideline

1.0 SCOPE

1.1. To outline a standard process for safe, rapid preparation and delivery of blood products and coagulation factors for the pediatric, adult, or pregnant patient requiring massive blood transfusion.

2.0 DEFINITIONS

2.1 Massive blood transfusion is arbitrarily defined as the replacement of a patient's total blood volume in less than 24 hours or the acute administration of more than half the patient's estimated blood volume per hour. Estimated blood volume for a child is 80 mL/kg and for an adult is 65-70 mL/kg.

2.2 Complications of Massive Transfusion:

2.2.1 *Dilutional Thrombocytopenia* – Platelet function in stored blood declines to zero after only a few days of storage. At least 1.5 x blood volume must be replaced for this to become a clinical problem except in the presence of DIC or pre-existing thrombocytopenia.

2.2.2 *Coagulation Factor Depletion* – Stored blood contains all coagulation factors except V and VIII. DIC may also ensue as a consequence of delayed or inadequate resuscitation. Dilutional coagulopathy occurs with infusion of 2 blood volumes of fluid administration.

2.2.3 *Oxygen Affinity Changes* - Massive transfusion of stored blood with higher oxygen affinity could adversely affects oxygen delivery to the tissues. Evidence for this is as yet not forthcoming, but it would seem wise to use fairly fresh red cell transfusions (<1 week old), if possible. Use of fresh (<24 hours) blood is not indicated. 2,3 DPG levels rise rapidly following transfusion and normal oxygen affinity is usually restored in a few hours.

2.2.4 *Hypocalcemia* – Some residual citrate, which binds ionized calcium, is found in all blood components, with RBCs containing the least amount. . The healthy adult liver will metabolize 3g citrate every 5 minutes. Transfusion at rates higher than one unit every five minutes or impaired liver function may thus lead to citrate toxicity and hypocalcaemia (low ionized calcium levels). Hypocalcemia does not have a clinically apparent effect on coagulation, but patients may exhibit transient tetany and hypotension. Calcium should only be given if there is biochemical, clinical, or electrocardiographic evidence of hypocalcemia.

2.2.5 *Hyperkalemia* – The plasma potassium concentration increases with length of RBC storage due to sodium/potassium pump dysfunction during storage, however, the pump resumes normal function once cells are transfused. The maximum level of potassium in the supernatant of PRBCs is 40-50 mEq/L.

2.2.6 *Acid/Base Disturbances* – Lactic acid gives stored blood an acid load of up to 30-40 mmol/L. With transfusion of large volumes of plasma components in the presence of renal failure, citrate

is metabolized to bicarbonate, and massive transfusions can result in profound alkalosis. Final acid/base status is dependent on tissue perfusion, rate of administration of RBCs, and citrate metabolism. The pH of a unit of PRBCs is 6.9-7.0.

2.2.7 *Hypothermia* – Hypothermia leads to impaired citrate and lactate metabolism, increased affinity of hemoglobin for oxygen, platelet dysfunction, coagulopathy, and cardiac arrhythmias. Warming blood to 37°C may decrease the risk for these complications.

2.2.8 *Acute Respiratory Distress Syndrome (ARDS)* – Massive volume and blood transfusion overwhelm the ability of the lungs to maintain effective gas exchange due to increased shunting, capillary permeability/leak, interstitial pulmonary edema, and congestive atelectasis.

2.2.9 *Transfusion Reactions* – Although transfusion reactions may occur with low volume transfusions, the risk is even higher with massive transfusions.

3.0 GUIDELINE

3.1. Activation of MBTP

3.1.1. Activation of the MBTP will be at the discretion of the Responsible Physician. Once a threshold of > or = 40 ml/kg for a child or 4 to 5 units for an adult of PRBC's has been ordered in rapid succession (usually in <1 hour), activation of the MBTP should be strongly considered.

3.1.2. Indications for activation may include the following:

3.1.2.1. Massive blood loss with profound hemorrhagic/hypovolemic shock.

3.1.2.2. Refractory hypotension not responsive to 40 ml/kg PRBCs.

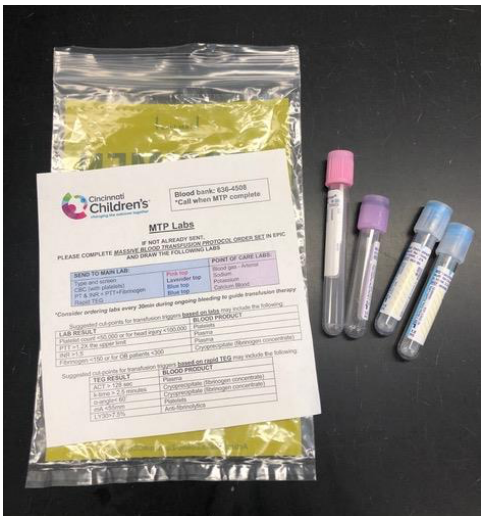
3.1.2.3. INR > 1.5, depressed fibrinogen levels (< 150 mg/dL), platelet count <50,000/ml during resuscitation.

3.1.3. Procedure

3.1.3.1. Once the decision is made by the Attending Physician to activate the MBTP, the Blood Bank should be notified immediately via a phone call. Activation of the MBTP is a verbal process. There is no need to place blood product orders in Epic. Blood products issued during the MBTP will automatically show up in the patient's Epic chart.

3.1.3.2. In Epic, order and collect a Type and Screen (this is the most important blood specimen to draw), CBC with platelets, PT/PTT/INR, fibrinogen, blood gas, Na+, K+, Ca++. These labs can be found under the Massive Blood Transfusion Labs order set in Epic. Consider ordering labs every 30min during ongoing bleeding to guide transfusion therapy.

3.1.3.2.1. To help obtain labs, if they haven't been sent already, the following Lab Pack will be sent with the first MBTP Pack:



3.1.3.3. For trauma patients arriving as a Trauma STAT in the ED Trauma Bay, a "Trauma cooler" consisting of 2 units of un-crossmatched O negative RBCs and 2 units of liquid AB plasma is immediately available (brought to ED by laboratory staff) upon patient arrival and should be used until type specific blood becomes available. To request additional blood for Trauma cases, call the blood bank to place a verbal request. If additional blood is requested, strongly consider activating the MBTP. The patient care unit is responsible for sending someone to pick up additional blood products from the blood bank.

3.1.3.4. Un-crossmatched O Negative blood should also be readily available for in-house patients requiring emergent transfusions upon notification of the Blood Bank via a phone call.

3.1.4. Notification of the Blood Bank

3.1.4.1. The following information must be provided to the Blood Bank Technologist receiving the call for activation of MBTP:

3.1.4.1.1. Patient name (or designated state name for trauma patients). Trauma identifiers should stay with patient for at least 24 hours.

3.1.4.1.2. Patient medical record number.

3.1.4.1.3. Estimated weight of the patient.

3.1.4.1.4. Patient location

3.1.4.1.5. Name of responsible attending physician.

3.1.4.1.6. Best contact number of one dedicated person responsible for communicating with the blood bank.

3.1.4.2. Upon activation of the MBTP, the Blood Bank will provide un-crossmatched O Negative blood until type specific blood becomes available. Once the patient has been ABO/Rh typed, type specific RBC will be made available for pickup.

3.1.4.3. Once the first units of blood products have been picked up by the specified location, the Blood Bank will begin preparation of the MBTP packs.

3.1.4.4. MBTP packs will be made available for pickup every 15 to 30 minutes (15 minutes for components that do not need to be thawed and 30 minutes for those that require thawing). When the Blood Bank personnel notify the clinical team of blood availability, they will ask specifically if they need to start another round of the MBTP packs.

3.1.4.5. MBTP packs (for children < or = 20 kg).

1st MBTP pack	**2nd MBTP pack**	**3rd MBTP pack**	**4th MBTP pack**
2 units PRBCs	2 units PRBCs	2 units PRBCs	2 units PRBCs
2 units FFP/plasma	2 units FFP/plasma	2 units FFP/plasma	2 units FFP/plasma
1 platelet apheresis or 1 pre-pooled platelet	No additional platelet components	1 platelet apheresis or 1 pre-pooled platelet	No additional platelet components

3.1.4.6. MBTP packs (for children >20 up to 49 kg)

1st MBTP pack	**2nd MBTP pack**	**3rd MBTP pack**	**4th MBTP pack**
4 units PRBCs	4 units PRBCs	4 units PRBCs	4 units PRBCs
4 units FFP/plasma	4 units FFP/plasma	4 units FFP/plasma	4 units FFP/plasma
1 platelet apheresis or 1 pre-pooled platelet	No additional platelet components	1 platelet apheresis or 1 pre-pooled platelet	No additional platelet components

3.1.4.7. MBTP packs (for children > or = 50 kg and adults)

1st MBTP pack	**2nd MBTP pack**	**3rd MBTP pack**	**4th MBTP pack**
6 units PRBCs	6 units PRBCs	6 units PRBCs	6 units PRBCs
6 units FFP/plasma	6 units FFP/plasma	6 units FFP/plasma	6 units FFP/plasma
1 platelet apheresis or 1 pre-pooled platelet	1 platelet apheresis or 1 pre-pooled platelet	1 platelet apheresis or 1 pre-pooled platelet	1 platelet apheresis or 1 pre-pooled platelet

3.1.4.8. Cryoprecipitate is not always indicated but should be considered in cardiac surgery and postpartum hemorrhage. Cryoprecipitate must be requested via a phone call to the blood bank.

3.1.4.9. The Blood Bank will continue to prepare MBTP packs for pickup until notification received by the Responsible Physician to terminate the protocol.

3.1.5. Nursing Responsibilities:

3.1.5.1. Provide appropriate patient identifying information to the Blood Bank.

3.1.5.2. Administer MBTP packs every 15-30 minutes as indicated by patient status. All packed cells will be administered with a 140 micron filter using a blood warming device. Pumps may be used when increased flow is needed.

3.1.5.3. Arrange for transport of the MBTP packs from the Blood Bank to the patient location and provide the transporter with the necessary patient identification to release blood from the Blood Bank.

3.1.5.4. Ensure appropriate patient identification prior to administration of blood products.

3.1.5.5. Draw STAT baseline ROTEM, CBC with platelets, PT/PTT/INR, fibrinogen, blood gas, Na+, K+, Ca++ upon initiation of MBTP.

3.1.5.5.1. ROTEM and other labs may be redrawn as indicated or every 60 to 90 minutes in actively bleeding patients to guide further therapy. Additional blood or blood components may be requested based on ROTEM or other lab results.

3.1.5.5.2. Delivery of MBTP packs should not be delayed based on pending labs or ROTEM results.

3.1.5.6. Document temperature, vital signs, coagulation, chemistry, and blood gas profiles.

3.1.5.7. Accurately record time, volume, and type of blood component transfused.

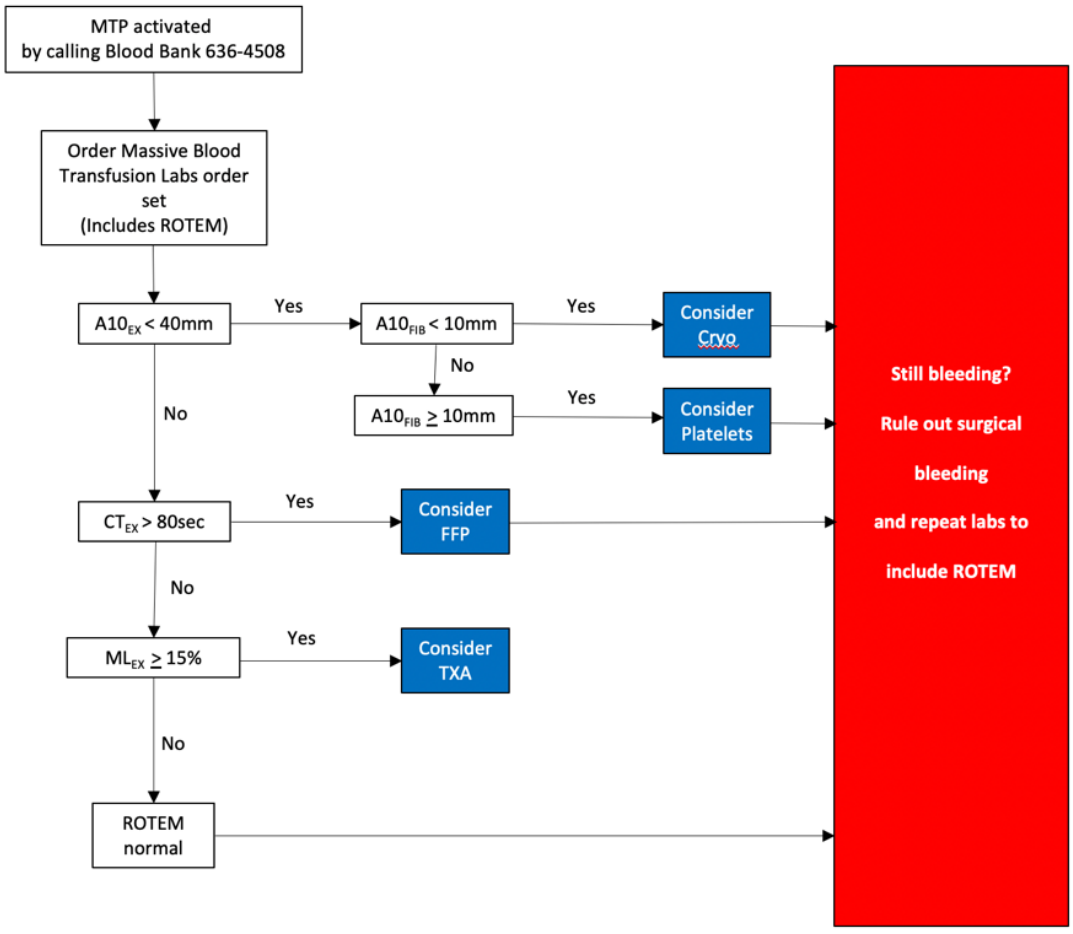
3.1.5.8. Periodically inform the Responsible Physician of transfusion status and inquire whether the MBTP should continue.

3.1.6. Physician Responsibilities:

3.1.6.1. The Attending Physician is responsible for activation of the MBTP when indicated.

3.1.6.2. The Responsible Physician is responsible for close monitoring of the hemodynamic status of the trauma patient with correction of hypotension, hypovolemia, hypothermia, hypocalcemia, electrolyte, osmolar, blood gas, and acid-base disturbances.

3.1.6.3. Suggested cut-points for transfusion triggers ***based on ROTEM*** results may include the following (See BB.MBT.211B *CCHMC MTP ROTEM Algorithm*) :



3.1.6.3.1 TXA dosing based on ROTEM results (Trauma Guideline TR-30)

Children ≥12 years – Loading dose is 1 g IV over 10 minutes (max 1 g) followed by a maintenance infusion of 1g over 8 hours

Children < 12 years – Loading dose is 15 mg/kg IV (max 1g) given over 10 minutes followed by a maintenance infusion of 2 mg/kg/hour for at least 8 hours or until bleeding stops

3.1.6.4. Suggested cut-points for transfusion triggers ***based on labs*** may include the following:

LAB RESULT	BLOOD PRODUCT
Platelet count <50,000 or for head injury <100,000	Platelets
PTT >1.2X the upper limit	Plasma
INR >1.5	Plasma
Fibrinogen <150 or for OB patients <300	Cryoprecipitate (fibrinogen concentrate)

3.1.6.5. The Attending Physician is responsible for termination of the MBTP and must notify the Blood Bank that the MBTP has been terminated once bleeding is under control and patient has stabilized or succumbed. Once the Blood Bank has been notified that the MBTP has been terminated by the Attending Physician, the Blood Bank will no longer prepare blood or component products.

4.0 REFERENCES

Technical Manual. Bethesda, MD: AABB, current edition.

5.0 APPROVALS

All revisions of this guideline are approved by the Blood Utilization and Safety Committee. This guideline is reviewed every three years or sooner if deemed necessary. Authority for this document resides with the Chair, Blood Utilization and Safety Committee. This guideline is approved by the Chair for the Blood Utilization and Safety Committee.

HISTORY		
Original Date		
10/25/2006		
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