MASSIVE BLOOD TRANSFUSION PROTOCOL (MBTP)
Cincinnati Children's Hospital Medical Center

OBJECTIVE

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

DEFINITION

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.

COMPLICATIONS OF MASSIVE TRANSFUSION

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.

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.

High Oxygen Affinity – Depletion of 2,3 DPG in stored blood results in increased oxygen affinity and diminished release of oxygen to the tissues, however, within 3 to 8 hours after transfusion, previously stored red blood cells (RBCs) regenerate 50% of normal 2,3 DPG levels. Complete restoration occurs within 24 hours for severely depleted RBCs.

Hypocalcemia – Each unit of plasma component contains citrate which binds ionized calcium. Transfusion in the presence of impaired liver function of high volumes of plasma components may lead to citrate toxicity and hypocalcemia. Hypocalcemia may result in hypotension and tetany.

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.

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.

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.

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.

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

Activation of MBTP

Activation of the MBTP will be at the discretion of the Responsible Physician. Once a threshold of ≥ 40 ml/kg of PRBCs has been ordered in rapid succession, activation of the MBTP should be strongly considered.

Indications for activation may include the following:

Massive blood loss with profound hemorrhagic/hypovolemic shock

Refractory hypotension not responsive to 40 ml/kg PRBCs

INR > 1.5, depressed fibrinogen levels (< 100mg/dL), platelet count < 50,000/ml during resuscitation

Procedure

1. Once the decision is made by the Responsible Physician to activate the MBTP, the Blood Bank should be notified immediately.
2. 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++ .
3. For trauma patients arriving as a Trauma Stat in the ED Trauma Bay, uncrossmatched O Negative blood (4 units) is immediately available upon patient arrival and should be used until type specific blood becomes available.
4. Uncrossmatched O Negative blood should also be readily available for in-house patients requiring emergent transfusions upon notification of the Blood Bank.

Notification of the Blood Bank

1. Upon activation of MBTP, the Blood Bank will make arrangements for adequate staffing as needed to assist with rapid preparation of blood products.
2. The following information must be provided to the Blood Bank Technologist receiving the call for activation of MBTP:
    a. Patient name (or designated state name for trauma patients). Trauma identifiers should stay with patient for at least 24 hours.
    b. Patient medical record number
    c. Estimated weight of patient
    d. Patient location
    e. Name and pager or cell phone number of responsible attending physician.
3. Upon activation of the MBTP, the Blood Bank will provide uncrossmatched O Negative blood until type specific blood becomes available. Once the Type and Screen blood sample is received, the specified number of blood products will be sent to the proper location.
4. Once the first units of blood products have been sent to the specified location, the Blood Bank will begin preparation of the MBTP packs.
5. MBTP packs will be sent to the specified location 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 Responsible Physician of blood availability, they will ask specifically if they need to start another round of the MBTP packs.
6. MBTP packs (for children ≤ 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
1 unit FFP	1 unit FFP	1 unit FFP	1 unit FFP
1 platelet pheresis pack or 5 random donor platelets	1 platelet pheresis pack or 5 random donor platelets	1 platelet pheresis pack or 5 random donor platelets	1 platelet pheresis pack or 5 random donor platelets
	5 pack pre-pooled cryoprecipitate	5 pack pre-pooled cryoprecipitate	5 pack pre-pooled cryoprecipitate

7. MBTP packs (for children >20 – 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
2 units FFP	2 units FFP	2 units FFP	2 units FFP
1 platelet pheresis pack or 5 random donor platelets	1 platelet pheresis pack or 5 random donor platelets	1 platelet pheresis pack or 5 random donor platelets	1 platelet pheresis pack or 5 random donor platelets
	5 pack pre-pooled cryoprecipitate	5 pack pre-pooled cryoprecipitate	5 pack pre-pooled cryoprecipitate

8. MBTP packs (for children > 50 kg)

1st MBTP pack	**2nd MBTP pack**	**3rd MBTP pack**	**4th MBTP pack**
10 units PRBCs	10 units PRBCs	10 units PRBCs	10 units PRBCs
6 units FFP	6 units FFP	6 units FFP	6 units FFP
1 platelet pheresis pack or 5 random donor platelets	1 platelet pheresis pack or 5 random donor platelets	1 platelet pheresis pack or 5 random donor platelets	1 platelet pheresis pack or 5 random donor platelets
	10 units cryoprecipitate	10 units cryoprecipitate	10 units cryoprecipitate

9. The Blood Bank will continue to prepare and send MBTP packs until notification is received by the Responsible Physician to terminate the protocol.

Nursing Responsibilities

1. Provide appropriate patient identifying information to the Blood Bank.
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. Arrange for transport of 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.
4. Ensure appropriate patient identification prior to administration of blood products.
5. Draw STAT CBC with platelets, PT/PTT/INR, fibrinogen, blood gas, Na+, K+, Ca++ every 30 minutes to help guide transfusion therapy. Additional blood or blood components may be requested based on lab results (ie., platelet count < 50,000; PTT > 60 sec; INR > 1.5 x control level; fibrinogen < 100; for head-injured patients, INR > 1.3 x control level and platelet count < 100, 000). However, labs are only used to direct the need for additional products. Delivery of MBTP packs should not be delayed based on pending labs or results.
6. Document temperature, vital signs, coagulation, chemistry, and blood gas profiles.

7. Accurately record time, volume, and type of blood component transfused.
8. Periodically inform the Responsible Physician of transfusion status and inquire whether the MBTP should continue.

Physician Responsibilities

1. The Reponsible Physician is responsible for activation of the MBTP when indicated.
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. The Responsible Physician is responsible for termination of the MBTP 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 Responsible Physician, the Blood Bank will no longer automatically supply blood or component products. The Responsible Physician is responsible for ordering all transfusions once the MBTP has been terminated.