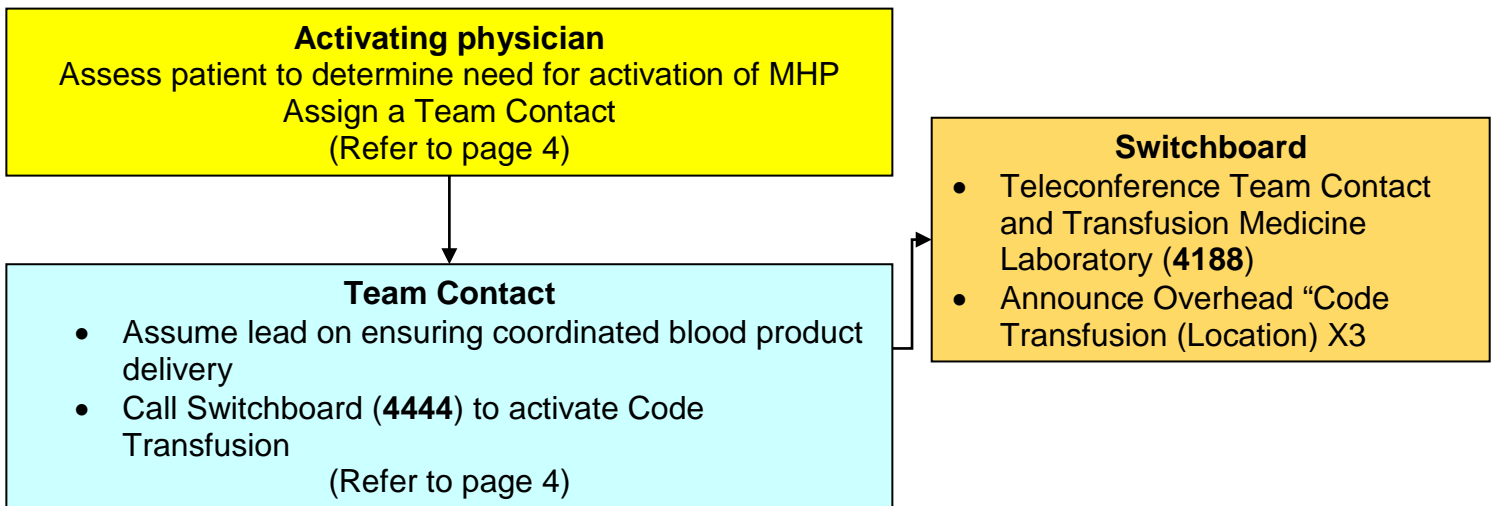


i. **OUTLINE**

CODE TRANSFUSION

Activation of Massive Hemorrhage Protocol (MHP)



UPON HEARING AN ACTIVATION OF MASSIVE HEMORRHAGE PROTOCOL (MHP) ANNOUNCED OVERHEAD

ALL DESIGNATED STAFF
Respond as required to MHP Emergency
(Refer to page 4)

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Appendix A – Massive Hemorrhage Protocol

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1.0 GENERAL OVERVIEW

1.1 Plan to Be Used In Case of an Activation of CODE TRANSFUSION/Massive Hemorrhage Protocol

When massive hemorrhage occurs, it is a significant challenge for the patient care team. The keys for success are early recognition of a massive hemorrhage situation and effective communication between the clinical care team, the laboratory, and Transfusion Medicine in order to ensure optimal patient care and outcomes. A massive hemorrhage protocol (MHP) is not simply ratio-based provision of blood products, but rather a framework for rapid hemorrhage control, monitoring patients for complications of massive hemorrhage/transfusion, timely transfusions and administration of therapies to control the rate of hemorrhage (e.g., PCC for warfarin reversal, tranexamic acid for trauma/obstetrical patients). Key aspects are active monitoring and management of acidosis, hypothermia, and dilutional/consumptive coagulopathy.

While most significant bleeding can be managed with ongoing requests for individual products (including uncrossmatched RBCs) and ongoing communication with Transfusion Medicine, the Massive Hemorrhage Protocol has been developed to standardize the care in major trauma situations as well as other acute and potentially catastrophic hemorrhage situations in the hospital.

1.2 Decision to activate a CODE TRANSFUSION/Massive Hemorrhage Protocol

A massive transfusion is retrospectively defined by the replacement of one blood volume within 24 hours or the replacement of > 50% blood volume within 3 hours. While most studied in trauma, the principles of a massive hemorrhage protocol may be applied to other acute hemorrhage situations: most commonly postpartum hemorrhage, upper gastrointestinal bleeding, operative/post-operative bleeding, or ruptured aortic aneurysms.

In settings outside the Emergency Department, OR, Obstetrics, PICU, NICU or ICU, the RACE or ICU team should be involved, to aid in the resuscitation of the critically bleeding patient until they are transferred to a monitored setting.

The MHP should not be activated to access uncrossmatched RBCs alone.

Uncrossmatched RBCs can be accessed with a call to the blood bank and asking for 2-4 units of uncrossmatched RBCs in a cooler.

Activation of an adult MHP may be indicated for:

1. Situations with a hemodynamically unstable patient with evidence of rapid (>150 mL/min) and/or massive (>1500mL) blood loss,
2. A **Critical Activation Threshold (CAT1)** of three or more units of RBC over an hour,

3. A **Resuscitation Index (RI)** of four or more 'units' of fluid (ie: 1 unit RBC, 1 unit FFP, 500mL colloid, or 1000mL crystalloid) within 30 minutes,
4. A **Shock Index** of 1.4 or higher (heart rate/systolic blood pressure).
5. An OB Shock Index of > 1.

Activation of a pediatric MHP may be indicated for:

1. Estimated need for more than 40 mL/kg RBC in 3 hours,
2. **Shock Index Pediatric Age Adjusted (SIPA)** 1-12 yrs >1,
3. Continued hemodynamic instability after two 10 mL/kg boluses of crystalloid,
4. Continued hemodynamic instability after 20 mL/kg RBC
5. Penetrating injury to thorax/abdomen,
6. Obvious critical bleeding
7. SBP <80mmHg \leq 5 yrs and <90mmHG 6-12 yrs

1.3 Scene Command

The activating physician will clinically assess the patient and determine when massive criteria are met and decide to activate the MHP and assume command of the response.

2.0 RESPONSE & RECOVERY – ALL STAFF

RESPONSE

2.1 Activation of a CODE TRANSFUSION/Massive Hemorrhage Protocol

Activating Physician

- The Activating Physician will clinically assess the patient and determine when activation criteria are met and provide the order to activate the MHP.
- The Activating Physician will designate a team contact to notify the Transfusion Medicine Laboratory (TML) of the MHP activation and provide ongoing communication between the laboratory and the clinical team.
- If uncrossmatched red blood cells are being requested the Activating Physician shall document in the patient's chart that the clinical situation justifies the transfusion and obtain consent from the recipient when possible (without delaying care).

Team Contact

- As soon as the MHP is initiated the Team Contact shall notify switchboard and a CODE TRANSFUSION will be initiated.
- To avoid miscommunication and inefficiency, the team contact should inform the TML of status changes and order subsequent blood products. The team contact will provide critical information to the clinical care team from the TML. The team contact will carry the CODE TRANSFUSION phone that will arrive with Pack 1.
- The Team Contact will provide the TML with the following information:
 - Location
 - Their name and best contact number
 - The patient's name
 - The patient's CR number
 - If the patient is in the OR **or** Connell 5 **or** going to the OR
 - Weight (for pediatric patients)
 - Biological sex
 - Age
 - Type of hemorrhage
 - History of antiplatelets or anticoagulants in last 7 days
- When there is a change in location or Activating Physician the team contact is responsible for informing the TML by phone at the time the change occurs and identifying the new Activating Physician and team contact. The team contact should hand over if there are blood components travelling with the patient and where those products are located as well as the CODE TRANSFUSION phone.

Transfusion Medicine Laboratory

- The core lab will be alerted by the TML regarding the activation of the MHP and provide the patient name, CR number, if patient is on anticoagulants (that may affect test results for coagulation), team contact name and phone number
- The lab will communicate all critical results and important coagulation parameters to the Team Contact.
- The Transfusion Medicine Physician is a 24/7/365 resource for the clinical team that can help guide difficult transfusion situations and expedite specialized testing. The can be reached by cell phone through locating on an as-needed basis through the Transfusion Medicine Laboratory

RECOVERY**2.2 Upon Notification That the Crisis Has Concluded****Activating Physician**

- The termination of the MHP is a decision of the Activating Physician and should be considered when definitive hemorrhage control has been achieved, the patient is hemodynamically stable, and the coagulation/biochemical evidence of shock are trending in the optimal direction.
- Patients and/or their substitute decision-maker for whom the massive hemorrhage protocol was activated should be informed of actual and potential adverse effects (e.g., transfusion associated circulatory overload, hyperkalemia). Women of child-bearing potential should be informed of the risk of red blood cell alloimmunization (risk 1 in 13).

Team Contact

- Will direct the Porter to return all unused blood products and the CODE TRANSFUSION phone to the blood bank immediately.**
- Notify the when blood bank the MHP has been terminated to allow for resuming of routine testing processes, and care of other patients. It also allows for evaluation and replenishing of stock as required. It is also important to provide feedback regarding aspects that went well and those that did not.
- Release any staff that have responded to emergency event i.e. Transportation; RACE Team, etc.

3.0 RESPONSE & RECOVERY – SWITCHBOARD

RESPONSE

3.1 Upon Receiving Notification of an Activation of a CODE TRANSFUSION/Massive Hemorrhage Protocol

For **ALL** Code Transfusions:

- Maintain team contact on the phone**
- Conference in the Transfusion Medicine Laboratory Technologist (**4188**)
- Switchboard will remain on the line until Team Contact has provided the blood bank with:
 - Location
 - Name of Team Contact and number for call back
 - Patient CR number
 - Last and first name of patient
 - In OR or Connell 5 or going to the OR
- Announce overhead “Code Transfusion (Location)” X3**
- Notify Transportation
 - Stat page for pickup of pack 1 from blood bank with Patient name and CR number – Message to transportation dispatch will be “We need to dispatch a porter for a Code Transfusion”
- If patient is in the OR, Connell 5, or planning to go to the OR the perfusionist on call will be paged
- Complete Mass Notification System (MNS) notification
- Call Operations Manager

For Code Transfusion (Connell 5)

- Call the OB Anesthesiologist if not present (7010 daytime/ 7071 after 15:30)
- Call the Anesthesia assistant (7079 daytime/ on call phone after 15:30)
- Page the Perfusionist on-call
- Call the Anesthesiology OR manager (7071 daytime only)
- Activate the RACE team

For Code Transfusion (Ward)

- Activate the RACE team

RECOVERY

3.2 Upon Notification That the Crisis Has Concluded

- If Team Contact calls switchboard, in error, to terminate the MHP the call should be forwarded to the TML (**4188**). Do NOT announce the termination or cancellation overhead.

4.0 RESPONSE & RECOVERY - TRANSPORTATION

RESPONSE

4.1 Upon Notification of an Activation of a CODE TRANSFUSION/Massive Hemorrhage Protocol (MHP)

Transportation Porter

- Transportation will be dispatched Priority 1 to the Transfusion Medicine Laboratory to pick up Pack 1 and deliver promptly to requested Unit
- The porter will remain at the location of the MHP and await further instruction from the Team Contact to deliver samples or retrieve more blood products from the TML.
- Upon arrival at Core Lab or Transfusion Laboratory announce "I am Porter for Code Transfusion" and speak directly to Lab Staff
 - Hand deliver any samples to Lab Staff

RECOVERY

4.2 Upon Notification That the Crisis Has Concluded

Transportation Porter

- Return all unused blood products and the CODE Transfusion phone to the blood bank as directed by the Team Contact
- Return to regular duties

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Appendix A – Massive Hemorrhage Protocol

Kingston Health Science Centre Massive Hemorrhage Protocol

Reviewed and Approved by the Transfusion Medicine Advisory Committee

Initial Document: July 2010,

Revised: November 2012, January 2018

Current Version: February 2022

1.0 Background

When massive hemorrhage occurs, it is a significant challenge for the patient care team. The keys for success are early recognition of a massive hemorrhage situation and effective communication between the clinical care team, the laboratory, and Transfusion Medicine in order to ensure optimal patient care and outcomes. A massive hemorrhage protocol (MHP) is not simply ratio-based provision of blood products, but rather a framework for rapid hemorrhage control, monitoring patients for complications of massive hemorrhage/transfusion, timely transfusions and administration of therapies to control the rate of hemorrhage (e.g., PCC for warfarin reversal, tranexamic acid for trauma/obstetrical patients). Key aspects are active monitoring and management of acidosis, hypothermia, and dilutional/consumptive coagulopathy.

While most significant bleeding can be managed with ongoing requests for individual products (including uncrossmatched RBCs) and ongoing communication with Transfusion Medicine, the Massive Hemorrhage Protocol has been developed to standardize the care in major trauma situations as well as other acute and potentially catastrophic hemorrhage situations in the hospital.

2.0 Decision to Activate the Massive Hemorrhage Protocol

A massive transfusion is retrospectively defined by the replacement of one blood volume within 24 hours or the replacement of > 50% blood volume within 3 hours. While most studied in trauma, the principles of a massive hemorrhage protocol may be applied to other acute hemorrhage situations: most commonly postpartum hemorrhage, upper gastrointestinal bleeding, operative/post-operative bleeding, or ruptured abdominal aortic aneurysms.

In settings outside the Emergency Department, OR, Obstetrics, PICU, NICU or ICU, the RACE team must be involved. The responsible physician for the RACE team will assess the situation and implement the MHP if appropriate.

The MHP should not be activated to access uncrossmatched RBCs alone.

Uncrossmatched RBCs can be accessed with a call to the blood bank and asking for 2-4 units of uncrossmatched RBCs in a cooler.

Activation of an adult MHP may be indicated for:

6. Situations with a hemodynamically unstable patient with evidence of rapid (>150 mL/min) and/or massive (>1500mL) blood loss,
7. A **Critical Activation Threshold (CAT1)** of three or more units of RBC over an hour,
8. A **Resuscitation Index (RI)** of four or more 'units' of fluid (ie: 1 unit RBC, 1 unit FFP, 500mL colloid, or 1000mL crystalloid) within 30 minutes,
9. A **Shock Index** of 1.4 or higher (heart rate/systolic blood pressure).
10. An OB Shock Index of > 1.

Activation of a pediatric MPH may be indicated for:

8. Estimated need for more than 40 mL/kg RBC in 3 hours,
9. **Shock Index Pediatric Age Adjusted (SIPA)** 1-12 yrs >1,
10. Continued hemodynamic instability after two 10 mL/kg boluses of crystalloid,
11. Continued hemodynamic instability after 20 mL/kg RBC
12. Penetrating injury to thorax/abdomen,
13. Obvious critical bleeding
14. SBP <80mmHg ≤ 5 yrs and <90mmHG 6-12 yrs

3.0 Essential Elements of Massive Hemorrhage Protocol

There are seven critical process elements associated with massive hemorrhage protocols:
7 T's

1. Team

The activating physician will clinically assess the patient and determine when massive criteria are met and decide to activate the MHP.

If uncrossmatched red blood cells are being requested the activating physician shall document in the patient's chart that the clinical situation justifies the transfusion and obtain consent from the recipient when possible (without delaying care).

The activating physician will designate a team contact to notify the transfusion medicine laboratory (TML) of the MHP activation and provide ongoing communication between the laboratory and the clinical team.

- As soon as the MHP is initiated the Patient Care Unit should notify switchboard and a CODE TRANSFUSION will be initiated. A code will be called overhead with the location of the activation. Switchboard will notify the transfusion medicine laboratory

and start a conference call with the team contact who will provide additional patient information. Switchboard will notify Porterage and a porter will be dispatched to the Transfusion Medicine Laboratory to pick up Pack 1. The core lab will be contacted by the transfusion medicine laboratory to prepare for incoming blood samples from the MHP. The perfusionist on-call will be notified to explore potential for use of the cell saver for patients with obstetrical bleeding and/or those who are candidates for a surgical procedure. In the case of a code transfusion from Connell 5 the OB Anesthesiologist, anesthesia assistant, perfusionist, anesthesiology OR manager and the RACE team will be activated.

The Transfusion Medicine Physician is a 24/7/365 resource for the clinical team that can help guide difficult transfusion situations and expedite specialized testing. The can be reached by cell phone on an as-needed basis through the Transfusion Medicine Laboratory.

2. Triggering and Talking

To avoid miscommunication and inefficiency, the team contact should inform the TML of status changes and order subsequent blood products. The team contact will provide critical information to the clinical care team from the TML. The team contact will be provided a CODE TRANSFUSION phone that will arrive with Pack 1.

When there is a change in location or activating physician the team contact is responsible for informing the TML by phone at the time the change occurs and identifying the new activating physician and team contact. The team contact should hand over if there are blood components travelling with the patient and where those product are located and hand over the CODE TRANSFUSION phone. The team contact is responsible for alerting the TML upon MTP discontinuation of the MHP

3. Testing

It is critical to collect a group and screen sample as soon as possible to enable issue of group specific blood products. Patients with an unknown ABO group will be issued group O RBCs and group AB plasma until a patient ABO group is confirmed (two independent specimens required if patient identity is unknown or no previous blood group available).

For patients who are Rh-negative or whose Rh status is unknown, Rh-negative RBCs and platelets will be issued only if the patient is female (or uncertain biologic sex) and ≤ 45 years old. Kell-negative blood will be issued to females ≤ 45 years old. Rh-negative male patients will be switched to O-positive at the discretion of the Transfusion Medicine technologist depending on supply and rate of issue of red cells.

Regular monitoring of coagulation status, electrolytes, and shock indicators (ie: CBC, INR, Fibrinogen, Lactate, VBG, lytes, ionized calcium) is essential to identify and address causes of coagulopathy, and should occur **at least every hour** and upon significant deteriorations in bleeding control.

For efficiency, EDIS has a MHP order set and the **MHP Panel** is available in the PCS Laboratory Order Entry menu. Inclusion of the **RED STICKERS on bag containing blood samples** ensures expedited processing by the laboratory and communication of results. During an MHP no samples should be sent through the automated tube system. Hand deliver all samples. Critical laboratory results and important coagulation parameters will be communicated verbally to the clinical team as soon as they are available.

4. Temperature

Hypothermia decreases tissue perfusion, increases acidosis, and inhibits activation-propagation of the coagulation cascade. Patients should be actively warmed to keep a core temperature greater than 36 degrees Celsius, including use of a blood warmer for all fluids, minimizing exposure where possible, and use of forced air blankets. Temperature should be measured on arrival, at exit from the ED, on arrival to OR, on arrival to ICU, and on half-hour intervals.

5. Tranexamic Acid (TxA)

All trauma patients within 3 hours of injury with bleeding and heart rate exceeding 110 or systolic less than 90 should receive 2g of TXA. All women with post-partum hemorrhage should receive 1g IV and then 1g IV repeat at 30 minutes if ongoing bleeding. TXA should not be given to patients with isolated gastrointestinal hemorrhage. For all other bleeding situations, the activating physician should determine if tranexamic acid should be provided.

Pediatric Dosing for tranexamic acid is 15mg/kg IV bolus then 5mg/kg/hr IV infusion for 8 hours, to a maximum total dose of 2 grams.

Evidence from the CRASH-2 (trauma), CRASH-3 (traumatic brain injury), and WOMAN (post-partum hemorrhage) trials demonstrate possible benefit to upfront treatment with tranexamic acid (1g IV over 10 min then 1g IV over 8 hours to 2 grams single bolus) without evidence of harm. The HALT-IT trial did not identify benefit to tranexamic acid in upper or lower gastrointestinal bleeding.

Tranexamic acid is most effective if given within 60 minutes of injury or onset of hemorrhage.

6. Transfusion

To ensure prompt provision of blood components and correction of coagulopathy, the initial MHP pack is divided into two parts, referred to as Pack 1 and Pack 2.

For patients >40 kg or ≥13 years of age:

- Pack 1 contains 4 units RBC
- Pack 2 contains 4 units RBC and 4 units FP
- Pack 3 contains 4 units RBC and 2 units FP and fibrinogen concentrate (all doses 4 grams)
- Pack 4+ contains 4 units RBC and 2 units FP
- A la carte – platelets and additional fibrinogen concentrate after pack 3
- For obstetrical hemorrhages – 4 grams of fibrinogen concentrate will be prepared and issued with Pack 2

For patients ≤40 kg:

Blood components will be provided in pediatric packs. The ordering team will need to provide a weight.

Pack 1:

Weight	Contents of Pack
31-40 kg	3U RBC
10-30 kg	2U RBC
<10 kg	1U RBC

Pack 2:

Weight	Contents of Pack
31-40 kg	3U RBC + 3U FP
10-30 kg	2U RBC + 2U FP
<10	1U RBC + 1U FP

Pack 3:

Weight	Contents of Pack
31-40 kg	3U RBC + 2U FP + 4g Fibrinogen
10-30 kg	2U RBC + 1U FP + 2g Fibrinogen
<10	1U RBC + 1U FP + 2g Fibrinogen

Pack 4+:

Weight	Contents of Pack
31-40 kg	3U RBC + 2U FP
10-30 kg	2U RBC + 1U FP
<10	1U RBC + 1U FP

Adjust RBC:FP ratio 1-2:1 as needed until lab guided dosing possible; consider platelets if no result available for trauma patient

Consider reversal for Warfarin, NOACs and Antiplatelet agents.

Drug	Antidote	Dosage
Warfarin	PCC IV Vitamin K	INR 1.5 to 3.0 – 1000 IU INR 3.0 to 5.0 – 2000 IU INR > 5.0 - 3000 IU Unknown INR – 2000 IU 10 mg IV
Dabigatran	Idarucizumab (Praxbind)	5 g IV Repeat at 24 hours if PTT elevated and ongoing bleeding risk
Xa Inhibitors	PCC	2000 IU Repeat at 1 hour if ongoing hemorrhage
ASA	Nothing*	n/a
Clopidogrel	Nothing*	n/a

*Clinical studies failed to confirm a benefit of platelet transfusions for ASA/Clopidogrel treated patients with GI bleeding and ICH and raised concern regarding harm (Use platelets with caution).

7. Termination

The termination of the MHP is a decision of the activating physician and should be considered when definitive hemorrhage control has been achieved, the patient is hemodynamically stable, the coagulation/biochemical evidence of shock are trending in the optimal direction or the patient is deceased.

All unused blood products and the CODE TRANSFUSION phone will be returned to the blood bank immediately by the porter.

Patients and/or their substitute decision-maker for whom the massive hemorrhage protocol was activated should be informed of actual and potential adverse effects (e.g., transfusion associated circulatory overload, hyperkalemia). Women of child-bearing potential should be informed of the risk of red blood cell alloimmunization.

It is important to notify the blood bank when the MHP has been terminated to allow for resuming of routine testing processes, and care of other patients. It also allows for evaluation and replenishing of stock as required. It is also important to provide feedback regarding aspects that went well and those that did not.

A safety report for all deviations from protocol will be distributed annually and discussed at the Transfusion Medicine Advisory Committee meeting. The Provincial Quality Metrics will be tracked as required by ORBCON and reviewed annually at the Transfusion Medicine Advisory Committee.

4.0 Massive Hemorrhage Protocol Procedure

1. Ensure adequate venous access with 2 large bore peripheral IVs, IO, and/or a central venous catheter. Select standard blood tubing with Y-connector and 170-micron microaggregate filter. Infuse all fluids via blood warmer, if available.
2. Follow standard hospital identification and banding procedures.
3. Ensure switchboard is notified of a code transfusion and all additional necessary services are notified. These may include surgery, interventional radiology, anesthesia and critical care.
4. If blood loss is from a clean surgical field in a patient without underlying malignancy, initiate cell salvage procedures if available.
5. If the patient does not have a valid group and screen, draw a group and screen (perform this step even if uncrossmatched RBCs are being requested). Concurrent collection of a confirmation specimen is permitted *only* when the patient is independently identified and specimens labelled at the bedside
6. The Transfusion Medicine Laboratory will be notified by switchboard, and will contact the team contact who will provide the following information:
 - a. Patient name (or alias, if applicable), age, biologic sex, CR number, weight, location of patient, and phone extension;
 - b. Name of the most responsible physician initiating the MHP;
 - c. Name of the designated contact individual who will be ordering blood components and products;
 - d. Type of bleed (i.e. trauma, obstetrical, gastrointestinal, cardiovascular, etc.)
 - e. Any anticoagulation, antiplatelet or special transfusion requirements, if known.
7. Ensure that MHP panel/coagulation testing specimens are collected and sent in an urgent fashion. Include the red MHP stickers with testing samples to ensure priority testing. Deliver all samples by hand – do not use automated tube system.
8. A porter or designated runner will proceed to the blood bank to pick up Pack 1:
 1. If an uncrossmatched MHP is requested and patient is > 40 kg: 4 units of unmatched group O RBCs will be provided and accompanied by a sheet for ACTIVATING PHYSICIAN signature.

2. Patients > 40 kg with current Crossmatch: 4 units of group specific/compatible RBC.
3. Patients ≤ 40 kg: Blood components will be provided in pediatric transfusion packs according to patient weight as described above.

As soon as Pack 1 has been delivered, the porter or designate will await direction from the team contact to return to the blood bank to pick up Pack 2.

4. If an uncrossmatched MHP is requested and patient is >40 kg: 4 units of group O RBCs and 4 units of AB plasma will be provided.
5. Patients >40 kg: 4 units of group specific/compatible RBCs and 4 units of group specific plasma, with or without platelets as per the transfusion medicine physician.
6. Patients ≤ 40 kg: Blood components will be provided in pediatric transfusion packs according to patient weight as described above.
7. Subsequent MHP packs will contain all blood products in a single box containing 4 units of RBCs and 2 units of plasma, modified as per the instructions of the Transfusion Medicine physician using the clinical diagnosis and available laboratory parameters as a guide.
8. Permissive hypotension, defined as the lowest blood pressure tolerated before evidence of end organ ischemia, is reasonable for adult patients in hemorrhagic shock.
9. Order the following laboratory tests as standing orders for as long as the patient is massively hemorrhaging:
 - CBC, INR, fibrinogen and arterial blood gas at least q1 hour;
 - Electrolytes, ionized Ca, Mg, serum creatinine, serum lactate q4hours.
9. Ensure patient temperature is > 36°C, including administration of fluids through warming devices, active patient warming.
10. Consider indication for tranexamic acid:
 - Adults: 2 g bolus; women with post-partum hemorrhage should receive 1g IV and then 1g IV repeat at 30 minutes if ongoing bleeding
 - Pediatrics: 15mg/kg IV bolus then 5mg/kg/hr IV infusion for 8 hours, to a maximum total dose of 2 grams.
11. Order additional blood components or products on the basis of the last available laboratory tests:

Product	Goal	Dose
RBCs	Hb >80 g/L	As per rate of blood loss

Plasma	INR <1.8	10-20 mL/kg
Fibrinogen Concentrate	Fibrinogen \geq 1.5g/L (\geq 2.0 g/L for obstetrical hemorrhage)	50 mg/kg per 1g/L deficit Adult dose is typically 4g
Platelets	Maintain PLT >50 x10 ⁹ /L or >100 x10 ⁹ /L for TBI	1 unit of platelets if patient weight >25 kg, or 10 mL/kg if <25 kg
Prothrombin Complex Concentrate	Management of Warfarin (Coumadin) or Direct Anti-Xa anticoagulant effects (rivaroxaban (Xarelto), apixaban (Eliquis), edoxaban (Savaysa))	Single dose of 2000 IU
Praxbind (Idarucizimab) – From Pharmacy	Reversal of dabigatran (Pradaxa)	5g IV
Protamine	Reversal of Heparin Reversal of Dalteparin Reversal of Enoxaparin	1 mg of protamine sulfate will neutralize not less than 100 units of heparin; give by slow IV injection over 10 minutes up to a MAX of 50 mg per dose; if 30 minutes have elapsed since the injection of heparin, one-half the dose may be sufficient 1 mg IV for every 100 anti-Xa international units of dalteparin; if APTT (measured 2 to 4 hours after the first infusion) remains prolonged, a second infusion of 0.5 mg protamine sulfate per 100 anti-Xa international units of dalteparin may be administered

		<p>1 mg IV for every 1 mg of enoxaparin administered in the previous 8 hours; if more than 8 hours has elapsed since the last dose of enoxaparin was administered, or if APTT (measured 2 to 4 hours after the first infusion) remains prolonged, a second infusion of 0.5 mg per 1 mg of enoxaparin may be administered; if more than 12 hours has elapsed since enoxaparin administration, protamine sulfate administration may not be necessary</p>
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12. Reassess bleeding rate between doses of blood components and products. Where possible, transfusion should be guided by laboratory parameters in the clinical context.
13. Consult with the Transfusion Medicine Physician on-call if patient continues to have microvascular bleeding despite:
 1. Large vessel bleeding source ruled out by surgery and/or angiography;
 2. INR < 1.8, aPTT < 45 seconds, fibrinogen > 2.0 g/L within past hour ;
 3. Platelet count > 50 within past hour (or after two doses of platelets in setting of platelet dysfunction);
 4. Hb > 80 g/L within past hour;
 5. Core temperature $\geq 35^{\circ}\text{C}$ within past hour;
 6. pH ≥ 7.2 within past hour; and
 7. $\text{Ca}^{2+} \geq 0.8$ mmol/L within past hour.
14. Recombinant factor VIIa (rVIIa) should be considered only when massive hemorrhage is refractory to surgical hemostasis, medical optimization of coagulation parameters, acidosis and hypocalcemia, and be used in consultation with an expert in the management of coagulopathy in the massively bleeding patient.
15. Inform hospital blood bank when control of bleeding has been obtained, or when resuscitation efforts have been withdrawn. Return any unused blood components and products to blood bank as soon as possible.

16. Complete feedback form included in Pack 1 (Massive Hemorrhage Protocol Feedback for Quality Improvement - Clinical Team).

5.0 Additional Notes

1. Platelets **must** be kept at room temperature and **never in the blood transport box**. The red cells and plasma will be delivered in a temperature-controlled transport box and products should be removed only as they are ready to be transfused.
2. Frozen plasma is thawed after MHP activation: it takes 20-30 minutes to thaw for issue.
3. The net transfusion ratio of 4 units red cells:2 units plasma is based upon results from the PROPPR trial. There is no evidence for a fixed or ideal ratio of red blood cells to plasma: blood product transfusion and resuscitation should be based upon patient-specific factors and specifically address identified hemostatic defects.
4. The Transfusion Medicine Laboratory will contact the patient care team if any issues with supply arise. Constant reassessment of the patient situation and communication with Transfusion Medicine is critical to optimal patient care.
5. Any unused product must be stored correctly and returned to the Transfusion Medicine Laboratory immediately if not used. Products inappropriately stored or not returned to the Transfusion Medicine Laboratory account for a significant amount of blood component wastage in a MHP situation.

6.0 Quality Metrics

Box 1: Quality metrics to be tracked on all activations of the protocol		
Quality metric	Local reporting	Provincial reporting
Q1. Proportion of patients receiving tranexamic acid within 1 h of protocol activation	X	X
Q2. Proportion of patients in whom RBC transfusion is initiated within 15 min of protocol activation	X	X
Q3. Proportion of patients (of patients requiring transfer for definitive care) with initiation of call for transfer within 60 min of protocol activation	X	
Q4. Proportion of patients achieving temperature $\geq 35^{\circ}\text{C}$ at termination of the protocol	X	
Q5. Proportion of patients with hemoglobin levels maintained between 60 and 110 g/L during protocol activation, excluding certain pediatric populations (e.g., neonates) that may require higher hemoglobin values	X	
Q6. Proportion of patients transitioned to group-specific red blood cells and plasma within 90 min of arrival/onset of hemorrhage	X	X
Q7. Proportion of patients with appropriate activation (≥ 6 RBC units in first 24 h, > 40 mL/kg per 24 h of RBCs in pediatric patients) or before this level in patients dying due to hemorrhage within 24 h	X	
Q8. Proportion of patients without any blood component wastage (including plasma that is thawed and not used within the 5-day limit on another patient)	X	