Trauma Service Guidelines

Title:	**Massive Blood Transfusion in Trauma Guideline**
Created:	**Version 1.0 September 2009**
Developed by:	**V1.0 March 2009 K. Gumm, G. Kelsey, M. Haeusler, B. Hockey, J. Papson, P. Morley, R. Judson, Advisory Judson, ACT Committee**
Revised:	**V4.3 May 2021; V4.0 Aug 20, V3.0 Aug 18, V2.1 Jun 13, V2.0 Nov 11**
Revised By:	**K. Gumm, D. Read, G. Kelsey, M. Haeusler, G. Plunkett, D. Williams, Advisory Committee on Trauma; MH Transfusion Committee**
See Also	**Unknown Patient; TRM08.06 Trauma OPSTAT; TRM08.12 Traumatic Cardiac Arrest Guideline**

Introduction

Haemorrhage remains the leading cause of preventable death in injured patients. Severely injured patients experience acute trauma coagulopathy of trauma in addition to crystalloid solutions resuscitation without paying attention to patient's cellular physiology. This can cause an iatrogenic coagulopathy or "triad of death" of acidosis, hypothermia and coagulopathy [1-4].

In order to minimise the effects of this, it is essential to recognise the acutely bleeding patient and activate the Massive Transfusion Guideline. This enables the Transfusion Laboratory to prepare Massive Exsanguination Pack (MEP) in time to provide early blood product-based resuscitation.

Massive Blood Transfusion Definition

A massive blood transfusion may be defined either by prospectively identifying patients who are likely to have significant haemorrhage requiring transfusion or retrospectively.

Prospective definitions or predictors include the ABC tool / or shock index outlined below.

The traditional retrospective definition is as follows [1, 2, 4, 5]

- Loss or replacement of 50% of blood volume within 4 hours
- More than 4 units administered in the first 4 hours (Equivalent to 1 MEP)

Massive Transfusion Guideline Aims

Fresh whole blood has the best performance in terms of oxygen carrying capacity and coagulation of all available blood products. However fresh whole blood is not available in Australia, therefore in an attempt to come as close as possible, a 1:1:1 ratio of Packed Red Blood Cells (PRBC): Fresh Frozen Plasma (FFP): Platelets (Plts) is utilised [6].

This ratio aims to optimise delivery of oxygenated blood to the tissues while avoiding dilution of clotting factors and also ensuring the availability of platelets which are an essential component of coagulation [4, 5].

In addition to the PRBC, FFP and Plts, it is also essential to ensure that calcium is replaced if it is low. Calcium is an essential component of the clotting cascade and the way in which the body intrinsically forms a blood clot [4]. Early treatment of hypofibribinogenaemia with cryoprecipitate or fribringin concentrate.

Other vital considerations include avoidance of hypothermia and acidosis (in addition to coagulopathy) the vicious cycle referred to above. The clotting cascade does not work if the tempreature is too cold. Acidosis also interferes with clotting, and in addition can cause myocardial dysfunction which worsens shock.

The Massive Exsanguination Pack (MEP) contents:

- 4 units of Red blood cells (RBC)
- 4 units or 2 bags or 600mls of Fresh Frozen Plasma (FFP)
- 4 units or 1 pooled/ aphorised bag of Platelets (Plts)

When one all the contents of a MEP pack is transfused- this is equivalent to a 1:1:1 transfusion ratio. The MEP products are contained in a refrigerated bag, the contents can be stored for 2 hours before being used or returned to transfusion laboratory.

NOTE: The MEP does not contain fibrinogen or fibrinogen concentrate.

Activation of the Massive Transfusion Guideline (including activation of MEP)

Ordering the MEP Pack

A MEP pack should ideally be present in the ED resuscitation bay before the patient arrives.

Unopened MEP packs should be returned to blood bank as soon as possible (<2 hours).

The decision to call for MEP Pack will come down to the senior ED clinicians' assessment, but can be assisted by two tools, the shock index [7] and the ABC Tool [8].

See TRM 08.06 Trauma OPSTAT Exsanguinating Patient [9]

Procedure

Pre arrival (if able)
Senior ED Physician considers prehospital information (or initial clinical impression) and activates the Massive Exsanguination Pack (MEP)

Emergency Department Assistant (EDA) attends Transfusion Labratory with the blood product release form to pick up MEP +/- 30mins prior to arrival. The blood product release form can be created in EPIC, or paper copies are kept with the Emergency Department Floor Co-ordinator.

Transfusion laboratory requires at a minimum the patients UR number/ gender to prevent wastage of the O negative blood.

First MEP pack transfusion[5, 10].

ED and trauma staff initially assess and decide if the MEP pack is to be opened and given. Whenever possible ensure baseline blood taken and sent urgently via chute prior to transfusion. ROTEM sample (extra blue tube) should also be taken, however note that the results of this will not be available for at least 5-20 minutes.

PitFall
Not giving all of the contents of a MEP

The Transfusion Laboratory should be contacted and informed that the MEP Pack has been opened and that a ROTEM has been run ex 27275.

The MEP transfusion should begin with the FFP and Plts (unless all can be infused simultaneously), the ED and Trauma team should assess if the patient has either (a) responded, in which no further products will be immediately required or (b) partially or (c) not responded, where further products will be required. Depending upon the urgency, patients requiring further transfusion will receive either a second MEP pack, or more preferably a Targeted Transfusion pack based upon initial and subsequent ROTEM results.

It should be noted that such patients should be urgently moved to the most appropriate location to diagnose or definitively treat the bleeding source (i.e. angiography or theatre). Blood tests included ROTEM should be sent in between each MEP.

MEP
Give the Plts and FFP first

Fibrinogen replacement in trauma patients.

The dose of cryoprecipitate is generally 2 mL/kg body weight and one unit should increase the fibrinogen level by 0.1 g/L. (roughly 10 bags/70kg individual).

Where possible notify Transfusion Lab that the MEP has been opened, this will allow them to prepare more products including thawing, products, and assist in interpreting the ROTEM so as to provide a more targeted transfusion.

The Lab scientist if able should call the ED once the ROTEM has been reviewed and discuss the needs of the patient. If the patient has left ED, then the ED Physician is responsible for informing the lab staff where the patient has gone, which will usually be one of Operating Theatre, Angiography or ICU.

ROTEM

ROTEM is a point-of-care viscoelastic testing that assesses the formation, strength and rate of dissolution of a blood clot. It can be used as an adjunct to assess in vivo coagulation. Hypofibinoginaemia at presentation is an independent predictor of increased mortality. The use of ROTEM has allowed us to make the diagnosis of hypofibinoginaemia and trauma induced coagulopathy and resulting in earlier targeted blood product use and increase use of cryoprecipitate as an adjunct therapy [4, 11]. At RMH a ROTEM should be performed in all patients in whom massive transfusion has been commenced, and regularly as transfusion goes on e.g. at the end of every MEP pack or Targeted Transfusion Pack

ROTEM
On all patients who have commenced the MEP

To perform a ROTEM, a second citrate tube (blue top/coag tube) is taken. The Emergency Department Floor Co-ordinator will then run the test on the ROTEM machine. Results are subsequently visible directly on the ROTEM console, or using ROTEM Secure Viewer in the Emergency Department resuscitation and trauma bays. Information regarding the interpretation of results is available on EDCKB and included as an appendix.

Transexamic Acid (TXA)

TXA has been shown when given early (within 3 hours of injury) in patients with or at risk of significant haemorrhage to improve survival [4, 5, 12].

TXA is currently part of the PATCH study [13] which has an inclusion criteria of injured patients, aged ≥18, Coagulopathy of Severe Trauma (COAST) score ≥ 3, able to be dosed ≤ three hours and admitted to a study hospital. Patients are randomised by paramedics will give TXA or placebo at the scene and a second dose on arrival.

Initial management of bleeding and coagulopathy TXA be administered to the trauma patient who is bleeding or at risk of significant haemorrhage as soon as possible and ≤ three hours after injury at a loading dose of 1g infused over 10 min, followed by an i.v. infusion of 1 g over 8 hours.

Additional indications for use at RMH in patients who have evidence of hyperfibrinolysis on ROTEM; or if the trauma team leader feels that TXA has a role to play. We recommend that the administration of TXA not await results from a viscoelastic assessment.

Calcium

Acute hypocalcaemia is common in massive transfusion. Calcium plays a critical role due to its role in formation and stabilisation of fibrin polymerisation sites and the cardiac effects ionised calcium levels should be monitored and maintained within the normal range [1.1–1.3 mmol/L] during massive transfusion. Calcium chloride should be administered to correct hypocalcaemia[4, 14].

Endpoints of Massive Transfusion

Trauma patients receiving a massive transfusion are susceptible to several physiologic and biochemical derangement as a result of both further bleeding and the transfusion itself. The following parameters should be measured at the end of massive transfusion, and or within 24 hours, and corrected if identified.

Endpoints	Exit criteria for the Massive Transfusion Guideline and MEP Use
▪ INR 1.5 or less ▪ Fib 1.5 normal or more ▪ Plts > 50 or > 100 if critical structures are at risk of bleeding ▪ PH > 7.20 ▪ SBP: 80-90 mmHg ▪ Temperature > 36 degrees ▪ Calcium 1.1-1.3	Stabilisation of haemodynamic status Control and normalisation of haemorrhage (via damage control surgery or angiography) Normalised ROTEM

Appendix 1: Transfusion prediction Tools

The Assessment of Blood Consumption Tool (ABC Tool) [8]

The ABC Tool consists of 4 dichotomous components, which are readily available and assessed in all trauma patients on admission. The presence of any one component contributes one to the total score, with a range of zero to four. Vital signs and assessments are taken from those conducted in the emergency department.

A score of ≥ 2 will trigger the MBT protocol (75% likelihood of MBT). Higher scores demonstrate an increased need for MBT

e.g. score of 4 = 100% likelihood.

Mechanism	Yes=1 & No = 0
Penetrating Mechanism	
ED SBP ≤ 90mmHg	
ED HR ≥ 120 bpm	
Positive Fast	
Total Score	of ≥ 2 will trigger the MBT protocol

Shock Index (SI) [7]

Shock index is defined as heart rate (HR) divided by systolic blood pressure(SBP) a SI of >1.0 predicts not only an increase mortality and the need for a massive transfusion [7]. Shock Index of >1.0 predicts not only an increase mortality and the need for a massive transfusion

Shock Level	HR / SBP =
No Shock (Class I)	< 0.6
Mild Shock (Class II)	≥ 0.6 to <1.0
Moderate Shock (Class III)	>1.0 to < 1.4
Severe Shock (Class IV)	≥ 1.4

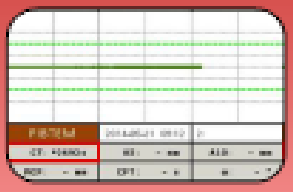
Appendix 2: ROTEM

V1.2

RMH Critical Bleeding ROTEM Algorithm

Perform a ROTEM (extra blue tube) when using the MEP

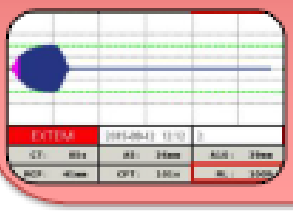
1. HYPERFIBRINOLYSIS



FIBTEM CT > 600 sec
AND
EXTEM A5 < 35 mm

→ TXA 1g
AND
CRYO 20 units

OR



ML% > 5%

→ TXA 1g

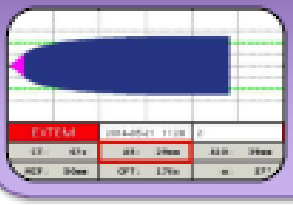
2. FIBRINOGEN

FIBTEM A5 < 10 mm

→ CRYO

FIBTEM A5	CRYO
9-10 mm	10 units
7-8 mm	15 units
4-6 mm	20 units
<4mm	25 units

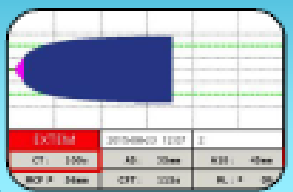
3. PLATELETS



FIBTEM A5 > 10mm
AND
EXTEM A5 < 35 mm

→ PLATELETS
1 pool

4. FACTORS

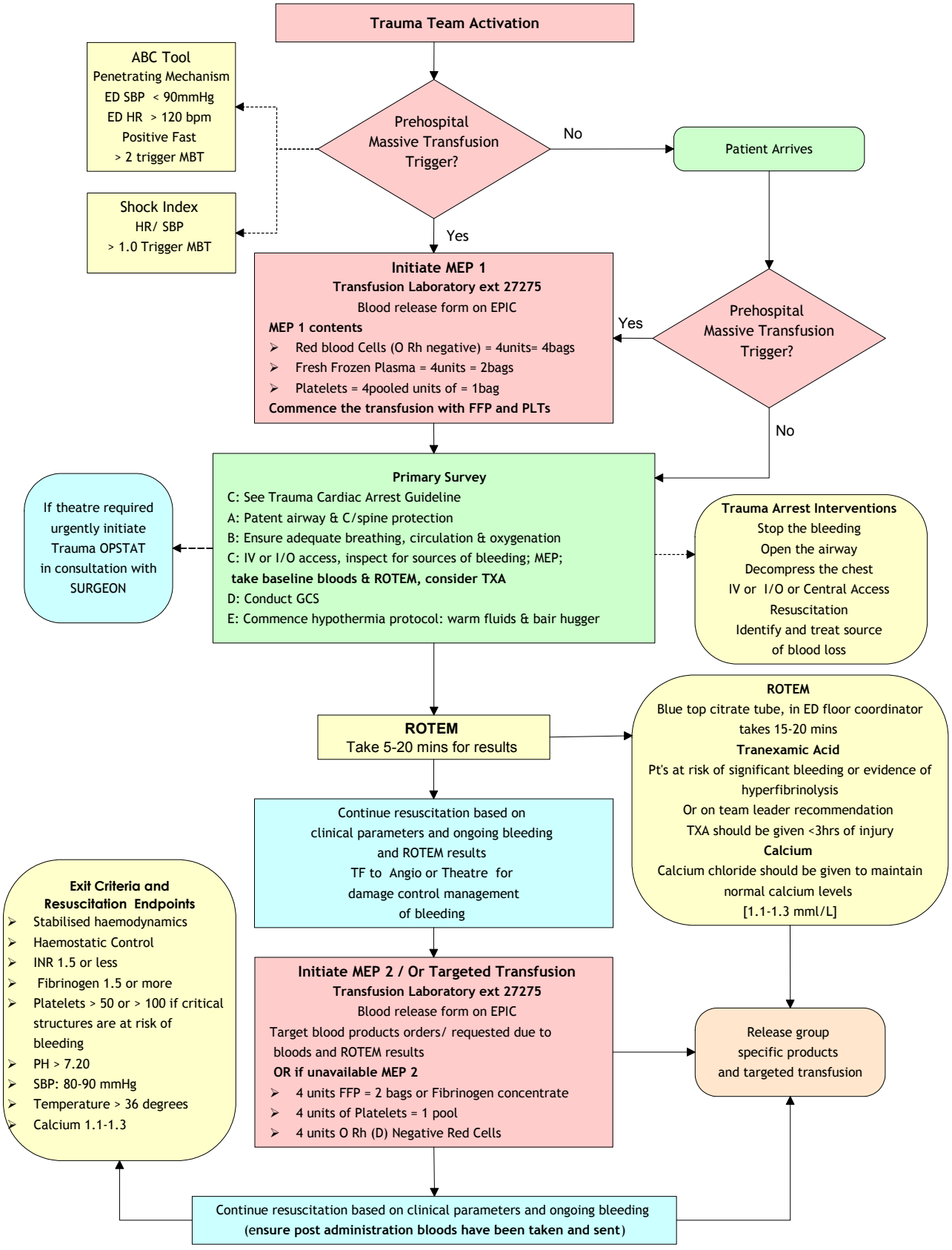


FIBTEM A5 > 10mm
AND
EXTEM CT > 90 sec

→ FFP
1 -2 bags

Order Blood Products from Haematology Lab 27275 (Registrar 27402)

Appendix 3: Massive Blood Transfusion in Trauma Guideline



References

1. Harris T, Davenport R, Mak M, Brohi K. The Evolving Science of Trauma Resusitation *Emergency Medical Clinics of North America.* 2018;36:85-106.
2. Surgeons ACo. *ATLS® , Advanced Trauma Life Support®* 10 th ed. Chicago; USA 2018
3. Cohen M, Christie A. New Understandings of post injury coagulation and resusitation. *International journal of Surgery.* 2016;33:242-245.
4. Spahn DR, Bouillon B, Cerny V, et al. The European guideline on management of major bleeding and coagulopathy following trauma: fifth edition. *Critical Care.* 2019/03/27 2019;23(1):98.
5. Cannon JW, Khan MA, Raja AS, et al. Damage control resuscitation in patients with severe traumatic hemorrhage: A practice management guideline from the Eastern Association for the Surgery of Trauma. *Journal of Trauma and Acute Care Surgery.* 2017;82(3):605-617.
6. McQuilten Z, Crighton G, Brunskill S, et al. Optimal Dose, Timing and Ratio of Blood Products in Massive Transfusion: Results from a Systematic Review. *Transfusion Medicine Reviews.* 2018;32:9.
7. Koch E, Lovett S, Nghiem T, Riggs R, Rech M. Shock index in the emergency department: utility and limitations. *Open Access Emergency Medicine.* August 2019;11:179-199
8. Nunez T, Voskresensky I, Dossett L, Shinall R, Dutton W, Cotton B. Early Prediction of Massive Transfusion in Trauma; Simple as ABC (Assessment of Blood Consumption)? *The Journal of Trauma, Injury, Infection, and Critical Care.* Feburary 2009;66:346-352.
9. Gumm K, Judson R, Waslh M, et al. *TRM08.06 Trauma OPSTAT Exsanguinating Patient* Melbourne: The Royal Melbourne Hospital; August 2016.
10. Spahn DR, Bouillon B, Cerny V, et al. Management of bleeding and coagulopathy following major trauma: an updated European guideline. *Crit Care.* 2013;17(2):R76.
11. Cohen J, Scorer T, Wright Z, et al. A Prospective Evaluation of Thromboelastometry (ROTEM) to Identify Acute Traumatic Coagulopathy and Predict Massive Transfusion in Military Trauma Patients in Afghanistan. Transfusion. *Transfusion.* 2019;29(S2):1601-1607.
12. Crash-2 C. The importance of early treatment with tranexamic acid in bleeding trauma patients: an exploratory analysis of the CRASH-2 randomised controlled trial. *The Lancet* March 24 2011;377(9771).
13. Gruen R, Jacobs I, Reade M. PATCH-Trauma Stuyy. Trauma and tranexamic acid. *Medical Journal Australia.* 2 September 2013;199(5):310-311.
14. Rossiant R, B B, Cerny C, et al. The European guideline on management of major bleeding and coagulopathy following trauma: fourth edition. *Critical Care* April 12 2016;20:100.