



HELICOPTER OPERATING PROCEDURE

TRAUMATIC HAEMORRHAGE CONTROL	HOP No: C/19	Issued: September 2012
	Page: 1 of 14	Revision No:
	TRIM No: 09/300	Doc No: D12/13645
	Distribution: Sydney <input type="checkbox"/> Illawarra <input type="checkbox"/> Orange <input type="checkbox"/> Helicopter <input type="checkbox"/> Road <input type="checkbox"/> Fixed Wing <input type="checkbox"/>	

1. Introduction

Major haemorrhage is a life threatening emergency which can result from trauma (blunt, penetrating, or mixed) or a range of surgical and medical pathologies.

This operating procedure is primarily focussed on haemorrhage following trauma but the general principles of haemorrhage control and resuscitation apply to medical, surgical and obstetric patients. The full range of specific therapies and objectives for all of these pathologies are not covered here.

2. Objectives

To outline the assessment, clinical decision-making, means of haemorrhage control, triage, and transport of patients with major haemorrhage.

3. Scope

Doctors, Paramedics

4. Process

General Principles

1. **Assess for major haemorrhage early**
2. **Control haemorrhage**
3. **Gain adequate circulatory access**
4. **Fluid volume resuscitate to physiological endpoints**
5. **Avoid hypothermia**
6. **Adjust analgesia and RSI drug dosages**
7. **Logistical issues and Pre-Alerts**
8. **Special therapies**

4.1. Assess for Major Haemorrhage early

General Principles

- 4.1.1 Degree of haemorrhage can be very difficult to ascertain early in resuscitation as it may be occult and initially well compensated for with falsely reassuring normotension.¹ Tachycardia can be surprisingly mild and hypovolaemia may even manifest as bradycardia.² As hypovolaemic shock



progresses bleeding becomes less obvious and wounds can be missed. Following penetrating trauma entry and exit wounds may bear no relationship to internal injuries sustained by a knife or bullet path internally.

- 4.1.2 All traumatically injured patients need **full exposure and a thorough clinical assessment** to identify sources of haemorrhage. This should be done immediately in cases of penetrating wounds with a rapid head-to-toe survey including log-roll and assessment of all junctional areas such as groins and axillae.
- 4.1.3 In blunt mechanisms, internal injury and pelvic haemorrhage can be worsened by repeated movement. Aim for total patient stabilisation as early as possible, the use of a pelvic sling before log roll and minimising further movements.
- 4.1.4 Entrapped patients may have haemorrhage which is not yet visible to rescuers. Consideration should be given to applying tourniquets pre-emptively to trapped un-assessable limbs, especially in shocked patients.

4.2. Control Haemorrhage

General Principles

- 4.2.1 Control of life threatening haemorrhage should occur **as early as possible** in the patient's management. Other interventions to reduce bleeding should occur after initial life saving measures or en-route. Haemorrhage control is **ALWAYS** preferable to fluid administration or transfusion.

4.2.2. External haemorrhage

4.2.2.1 General wounds:

Direct (digital) pressure and elevation should be used initially where possible. Beware large dressings which dissipate force over a large area and so reduce effectiveness of pressure while absorbing large quantities of fluid. Topical haemostatic agents and other advanced techniques are covered below.

4.2.2.2 Limbs

Further options for control of external haemorrhage in limbs include pressure dressings, topical haemostatic gauze, balloon tamponade and tourniquets.

4.2.2.3 Junctional Areas (neck, groin, axilla)

Haemorrhage control at limb junctions and neck is challenging. Options include direct pressure, packing with a haemostatic dressing, balloon tamponade³ and surgical control using clamps or sutures.

4.2.2.4 Maxillo-Facial Haemorrhage.

In patients with severe facial fractures haemorrhage control can be challenging. Following intubation, nasal epistats, bilateral dental bite



blocks and well fitting cervical collar should be applied to splint the midface structures⁴.

4.2.2.5 Scalp wounds

Scalp wounds bleed profusely and may be a source of major haemorrhage. Management options include direct pressure, application of circumferential compression, wound staples or sutures.

4.2.3 Internal haemorrhage control

4.2.3.1 Pelvis and Long Bones

a. **Pelvic fracture** - refer to *Pelvic Trauma HOP*.

b. **Femur fracture**

- assess limb neurovascular status
- draw out to length and splint with CT-6 femoral traction splint provided the knee, ankle joints and tibia/fibula are clinically intact.
- when CT-6 is contraindicated alternative field splinting can include box splints or tying fractured limb to an intact limb.
- consider femoral nerve or fascia-iliaca block in otherwise haemodynamically stable patients.

c. **Other limb fractures**– draw out to length and splint (shortened CT6 or box splint may be used).

d. **Open fractures** - should be treated with irrigation to remove gross contamination before straightening followed by application of a clean gauze dressing. Cefazolin 2g IV should be administered to all open fractures if no history of allergy to cephalosporins.

4.2.3.2 Haemothorax

Haemorrhage revealed by pleural drain placement is not tamponaded by drain clamping or removal. Pleural drains should be left open at all times. Patients should receive Cefazolin 1g with pleural drain placement unless allergic to cephalosporins.

4.3. Gain adequate circulatory access

4.3.1 In haemorrhagic shock access to the circulation will be required early for fluids and medications.

4.3.2 More than one access point is almost always desirable.

4.3.3 Deferring access until en-route by road vehicle may be appropriate in selected cases to minimise scene time and expedite transport to hospital.

4.3.4 In cases of difficult cannulation, IO access should be obtained. Humeral head access is the preferred site in the setting of major abdominal and/or pelvic injury.⁵ Refer to *Intra-osseous Access HOP*



4.4. Fluid volume resuscitate to physiological endpoints

Physiological End points of Resuscitation

- 4.4.1. “Permissive hypotension”, “Limited resuscitation”, “Damage Control Resuscitation”⁶ describe the controlled use of volume resuscitation in the period before definitive haemorrhage control in healthy adult trauma patients, concurrent with attempts to avoid hypothermia and initiate blood product use whilst limiting volumes of crystalloid.
- 4.4.2. Blood transfusion can contribute to lessening the coagulopathy of trauma when Hct >35% (approx. Hb 110g/l)⁷.
- 4.4.3. Suggested practice is to utilise permissive hypotension within the guidance below, for prehospital trauma, interhospital transfers for trauma or medical causes of haemorrhage, prior to definitive haemorrhage control.
- 4.4.4 Transfers from remote locations, involving long helicopter or fixed wing journeys may be outside of current available evidence. Prolonged hypotension of 2-3 hours may lead to irreversible damage to underperfused organs⁸. This must be weighed on an individual patient basis against the expected benefits of permissive hypotension.

Guidelines for Fluid/Blood Administration^{9,10}

Pathology	Aim
Traumatic Brain Injury (TBI)	SBP > 100mmHg
Blunt trauma without TBI or penetrating wounds:	Verbal contact (taken to indicate CNS perfusion) Or, SBP > 80mmhg / palpable radial pulse
Penetrating Torso	Verbal contact or palpable central pulses

4.4.5 Paediatrics

Whilst the evidence for permissive hypotension is more limited in children it is widely acceptable practice to substitute SBP 70+(twice age) as a target for resuscitation.⁹ Conscious level, when assessable, is the best guide to adequate blood flow to vital organs.

4.4.6 Pregnancy

Sympathetic nervous system vasoconstriction in response to hypovolaemia will compromise placental blood flow so when possible, physiological normality for that stage of pregnancy should be maintained. Left lateral tilt/manual uterine displacement (bolster under the right hip) should be used for all patients in 3rd trimester of pregnancy to avoid utero-caval compression lying supine.

4.4.7 Elderly

Due to changes in physiology, pathology and pharmacy during ageing, SBP targets are hard to define in this group of patients, and outcome-based evidence is lacking. Mental state, when available, is the best guide to adequate blood flow to vital organs.



4.4.8 Fluids:

4.4.8.1 Hartmann's

Hartmann's Fluid is the standard crystalloid carried by all ASNSW vehicles.

Boluses of 250mls Hartmann's in adults (10-20ml/kg up to 250mls in children) are titrated to clinical effect.

4.4.8.2 Blood (Red Blood Cell Concentrate)

Blood transfusion may be needed in patients with obvious serious injuries or clinical evidence of massive haemorrhage (hypotension, altered mental status from haemorrhagic shock). The need for massive transfusion is reasonably predicted by two or more of:

- penetrating mechanism
- SBP <90mmHg
- HR >120
- FAST scan positive. ¹¹.

Adult boluses of 250ml (one bag PRBC) and paediatric boluses of 10 ml/kg up to one bag (250mls) titrated to physiological end points as described. *Refer to Blood Management HOP.*

4.4.8.3 Hypertonic saline

Evidence for an improved outcome with prehospital use of hypertonic saline for TBI or haemorrhage is lacking with recent RCTs of 7.5% vs 0.9% saline terminated early for futility. ^{12,13,14} Without evidence of harm however, 3% hypertonic saline may be used as a low volume alternative to crystalloid in aliquots of 100ml with reassessment of clinical parameters. ¹⁴ *Refer to Hypertonic Saline SOP.*

4.5. Avoid hypothermia

4.5.1 Hypothermia (especially core temperature <35°C) ^{7,15} is associated with worsening patient outcome and Acute Traumatic Coagulopathy (ATC) by mechanisms including platelet dysfunction and altered coagulation factor function not necessarily revealed by standard hospital coagulation studies. ¹⁵

4.5.2 Core body temperature should be maintained by reducing heat loss via radiation, conduction and convection. Drying patients, removing wet clothing, covering with hospital and/or space blankets and warming the vehicle environment can all be used to maintain core temperature. Active warming should be used if available interhospitally.

4.5.3 Blood products may be immediately given at stored (4°C) temperature as a life saving therapy but where time permits warming of blood units is desirable and basic methods of warming blood units such as caregiver body heat should be used wherever possible. Intravenous fluid warmers are not carried by the team presently.



4.6. Adjust analgesia and RSI drug dosages

- 4.6.1 Evidence supports ketamine as the induction agent with the safest haemodynamic profile in hypovolaemic patients.¹⁶
- 4.6.2 The pharmaco-dynamics and kinetics of anaesthetic agents are altered in hypovolaemic patients. Reduced cardiac output causes slower onset times and less induction agent is needed for hypnosis. Dose adjustments are therefore recommended^{16,17,18}. A fluid flush should be given to ensure medications reach the circulation.
- 4.6.3 In cases of moderate volume depletion (SBP < 90) or reduced conscious level due to hypovolaemia, reduce the dose of ketamine for induction (0.5 - 1 mg/kg).
- 4.6.4 In extreme cases of peri-arrest patients and unconsciousness from hypovolaemia only the paralysing agents may be required.
- 4.6.5 Consider volume loading of any hypovolaemic patient prior to drug administration.
- 4.6.6 Stay alert to the fact that IPPV itself may precipitate cardiac arrest by reducing venous return.
- 4.6.7 Small aliquots of ketamine and fentanyl are preferred for analgesia and to maintain sedation in the setting of hypovolaemia.

4.7. Logistical issues and pre-alerts

- 4.7.1 Urgent mobilisation of the team is warranted for patients with suspected significant haemorrhage.
- 4.7.2 Blood box and portable ultrasound should be transported with the team whenever possible to prehospital trauma missions.

Team PPE

- 4.7.3 Haemorrhage control often involves the risk of blood exposure. The team should wear gloves and eye protection to all patients with visible bleeding.
- 4.7.4 The medical team should inform the aircrewman as soon as practicable of the likely need of a fluid containment bag to prevent soiling of the aircraft.
- 4.7.5 The team carry only limited fluids within their trauma packs – consider taking extra fluids from scene where transport times are long.

Scene Times.

- 4.7.6 Penetrating injuries may require urgent surgery to control bleeding. For this reason time to theatre is important and scene times should be kept short. FAST scans should only be performed en-route. *Refer to Ultrasound HOP.*

Penetrating chest injuries

- 4.7.7 Any injury between the nipple lines, in the epigastrium or between the shoulder blades should be triaged to a cardiothoracic centre irrespective of clinical state. All MTCs have cardiothoracic services available 24/7. *Refer to Trauma Triage HOP.*



ED Bypass.

4.7.8 There is likely to be little added benefit of trauma team reception in ED for a subgroup of patients in haemorrhagic shock who are intubated and ventilated on scene and have had pneumothoracies treated or excluded by ultrasound,. This is particularly so in the setting of blunt trauma with positive prehospital FAST or those patients with penetrating trauma.

There is currently no state-wide policy shared by the metropolitan MTCs regarding the transport of patients directly to the operating theatres or interventional radiology suite rather than ED resus.

A request to bypass ED should be made via the batphone in advance of patient arrival at the hospital with the pre-alert if the team feels it would significantly improve patient outcome. This is best achieved by requesting that the trauma team **meet the retrieval team in the operating theatre or angiography suite.**

Pre-Alert:

4.7.9 In all prehospital missions and any mission with a deteriorating patient with uncontrolled haemorrhage a pre-alert should be made to the hospital ED. In addition to patient identifiers, MIST handover, FAST result and ETA, specific requests may include:

- a) Activation of the hospital Massive Transfusion Protocol. Speak directly to the receiving ED via Batphone and clearly state "patient in haemorrhagic shock with uncontrolled/controlled bleeding. Please activate the Massive Transfusion Protocol"
- b) Cardiothoracic surgeon for unstable patients with penetrating chest wounds
- c) Tourniquet applied- to allow pneumatic tourniquets to be sourced by the trauma team.
- d) Request for ED Bypass to OT or angiography.

4.8. Special therapies

4.8.1 Tranexamic Acid

Tranexamic Acid has been shown to reduce overall mortality in the setting of suspected major haemorrhage by a modest amount when given within 3 hours (with most benefit seen in the first 1 hour following trauma.)^{19, 20, 21}.

Treatment after 3hrs may be associated with harm and is not recommended. *See Appendix 5.*

4.8.2 Other blood products

In interhospital missions consideration should be given to the addition of fresh frozen plasma in a ratio of 1:1 with red cells. Platelets and cryoprecipitate may also be considered based on availability and clinical need.



4.8.3 fVIIa

fVIIa is not currently carried by GSA-HEMS but may be considered if locally available on the advice of a haematologist or SRC. fVIIa dose of approx. 100mcg/kg gives clinical effect in approx. 15-20mins.

4.8.4 Reversal of Anticoagulants

Anticoagulated patients with haemorrhage have a much higher mortality.²² Vitamin K, Prothrombin Complex Concentrate and/or FFP should be administered to any patient with warfarin-induced coagulopathy with ongoing bleeding or major trauma as early as possible. Any specific haematology advice and discussions about other treatments are best directed to the SRC in the first instance.

4.8.5 Calcium.

Calcium depletion following massive transfusion is unlikely prehospitally and in hospital should be restricted to those patients with a demonstrable ionised calcium level of <1.0mmol/l on blood gas (or iSTAT) measurements.²² 10ml of 10% CaCl **OR** 30ml of CaGluconate is appropriate, given as a slow IV push to avoid hypertension.

4.8.6 Post Partum Haemorrhage

In patients with uncontrolled post partum haemorrhage the key principles are to:

- apply uterine massage
- ensure removal of retained products by gentle manual exploration
- administer uterotonic – Syntocinon – up to 40 units in 1L crystalloid at 250mL/hr

If first line therapies are unsuccessful consider:

- Emergent transfer for surgical haemorrhage control
- Tranexamic Acid
- Blood products in line with DCR (Damage Control Resuscitation) principles
- Aortic Compression
- Balloon Tamponade using dedicated balloon tamponade device such as Rusch uterine balloon or even an oesophageal balloon such as Sengstaken-Blakemore or Minnesota tube

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Appendix 1. Tourniquet Use

Tourniquets

Two Special Operations Force Tactical Tourniquet- Wide (SOF-TTW) tourniquets are carried in the major trauma pack. Mechanical Advantage Tourniquets (MAT) are carried by all ASNSW vehicles.

Indications

- Active arterial bleeding (pulsatile exsanguination)
- Prior to field limb amputation (Contact SRC before commencing ANY field amputation)
- Entrapped patients with a high suspicion major lower limb haemorrhage but entrapment prevents assessment and/or alternative management. (e.g. MVA driver with lower legs trapped). Reassess need for tourniquet immediately after extrication.

General Principles

- Place tourniquet as low as possible over the intact part of limb, against skin or thin layer of clothing (emptied pockets).
- In high thigh tourniquets ensure genitalia not enclosed.
- Several tourniquets may be required for large muscular thighs.
- Adequate control of arterial haemorrhage will usually require the tourniquet placed as tightly as physically possible by the rescuers and will require significant analgesia, sedation and/or general anaesthesia.
- Time of tourniquet should be recorded and communicated to the receiving trauma team.
- Do not remove a tourniquet placed over a life threatening haemorrhage in the prehospital environment, especially in a shocked patient.

Re-assessment and Removal

It is reasonable to reassess tourniquets placed in the following instances:

- entrapped patients following extrication
- those placed prior to the team's arrival where signs of arterial haemorrhage are unclear and/or brisk venous ooze may be being exaggerated by loose (venous) tourniquet application
- those placed in initial assessment in patients without signs of hypovolaemia where haemorrhage may be controllable by other methods such as compression bandaging or haemostatic dressings.
- All tourniqueted wounds should be frequently reassessed as improved patient perfusion may cause renewed bleeding and require tightening of the tourniquet or application of second tourniquet.
- Trauma teams should be handed over not to remove field tourniquets until a pneumatic tourniquet device is correctly applied.



Appendix 2

Topical Haemostatics

Topical Haemostatics

Chitosan gauze is carried in the surgical kit of the major trauma pack.

Indications

- Haemorrhage not controllable using direct pressure alone

General principles

- Expose bleeding point
- Pack the wound firmly with haemostatic gauze
- Apply firm pressure for 2-3mins. Do not remove.
- Care should be taken with torso and head wounds – try to avoid pressing gauze into brain & internal organs.
- Wear gloves and protect caregivers' eyes.
- Inform hospital trauma team of use (radiolucent).



Appendix 3

Balloon Catheter Tamponade

Balloon Catheter Tamponade

Indications

- Haemorrhage control in penetrating wounds in accessible areas such as the neck.

CARRIAGE

General Principles

- Insert balloon catheter as deeply as possible.
- Gently inflate balloon using up to 5mLs of water or saline.
- A second or third balloon may need to be inserted in large wounds.
- The wound edge should then be sutured or stapled tightly around catheter/s to prevent the balloon herniating out of wound, being careful to avoid puncturing balloon.
- Tie catheter/s tightly to prevent blood flowing down lumen.
- The team should ensure that the foley catheter is not removed until surgical or interventional radiological means for haemorrhage control are physically present and ready to intervene.



Appendix 4
Maxillo-facial Haemorrhage Control

Maxillo-facial Haemorrhage Control

Indications

- Ongoing profuse haemorrhage following significant facial fractures with deformity.

General Principles

- Equipment consists of McKesson dental props and nasal epistats and when combined with appropriately sized and fitted cervical collar they serve to splint the midface structures against the clavicles and tamponade nasal bleeding.
- Patient must be intubated prior to this procedure
- Reapply appropriately sized cervical collar.
- Re-align midface by pulling maxilla into anatomical position.
- Insert nasal epistats by gentle pressure backwards (not upwards) but don't inflate until McKesson dental props are placed.
- Place a pair of appropriately sized McKesson dental props as far back as possible between the molars.
- Gently inflate the epistat balloons with water or saline starting with the posterior balloon.
- Apply gentle traction on the epistat and then inflate the anterior balloon.
- Reassess haemorrhage control and adjust balloons



Appendix 5 Tranexamic Acid

Tranexamic Acid

Indications:

Within 3hrs of injury for:

1. Blunt or penetrating trauma when a decision has been made to administer blood (Red Blood Cell Concentrate)

OR

2. Blunt or penetrating trauma with **both** of the following:

- persistent systolic BP <90mmHg following initial crystalloid therapy
- suspected active haemorrhage based on clinical examination or E-FAST

OR

3. Ongoing Post partum haemorrhage following local measures and uterotonic.

Relative Contra-indications

Known history of thrombotic disorders including PE or DVT

Dosing

- Adult 1g slow push over 10 min followed by infusion of 1g over 8hrs. Paediatric dose is 10mg/kg.
- Maintenance infusion: In most cases this will occur in the receiving trauma centre (1g over 8hrs)

Administration

- Administration of TXA must not significantly prolong scene time
- Slow IV/IO push in 10mL syringe over 10min flushed through with saline
- Rapid bolus has been associated with hypotension
- TXA should not be administered into the same IV line as blood
- Ensure handover to trauma team that TXA has been used