CLINICAL PRACTICE STANDARD — Aeromedical Operations
AO.CLI.19 – Traumatic Haemorrhage Control

Document No.	WI2020-084	
File No.	D20/15278 (20/34)	
Date issued	21 June 2024	
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Summary	The purpose of this procedure is to outline the assessment, clinical decision-making, and means of haemorrhage control, triage and transport of patients with major haemorrhage.	
Applies to	NSW Ambulance aeromedical doctors.	
Review Date	July 2026	
Previous Reference	Nil	
Status	Active	
Approved by	Executive Director, Aeromedical Operations	
Related Legislation	Nil	
Related Documents	Nil	

Compliance with this operating procedure is **mandatory**

CLINICAL PRACTICE STANDARD - Aeromedical Services
AO.CLI.19 – Traumatic Haemorrhage Control

1. Introduction

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

This operating procedure is primarily focused 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. Purpose

The purpose of this procedure is to outline the assessment, clinical decision-making and means of haemorrhage control, triage, and transport of patients with major haemorrhage.

3. Procedure

3.1 Assess for Major Haemorrhage Early

3.1.1 General Principles:

The 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 or absent 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.

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 inspection of the back and assessment of all junctional areas such as groins and axillae, the so-called “Blood-sweep”.

In blunt mechanisms, repeated movement can worsen internal injury and pelvic haemorrhage. Aim for total patient stabilisation as early as possible, the use of a pelvic binder before log roll and minimisation of further movements. In the absence of penetrating trauma or burns, a full log roll inspection of the back is not routinely recommended in blunt polytrauma patients during prehospital assessment.

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.

3.1.2 Haemorrhage Mimics:

Alternate causes of hypotension can resemble or co-exist with haemorrhage, including traumatic, eg. tension pneumothorax, cardiac tamponade, neurogenic shock, blunt myocardial injury; medical, eg. conditions that may have led to the trauma, such as myocardial infarction; and iatrogenic, eg. anaphylaxis to injected muscle relaxants or overzealous sedative / analgesic administration. A thorough assessment incorporating data from mechanism, physical exam, sonography, and response to therapy may be required.

Isolated traumatic brain injury may result in significant hypotension (Brain Injury Associated Shock (BIAS) leading to inappropriate transfusion. Multiple mechanisms may contribute including brainstem and autonomic dysfunction, vasoplegia from systemic inflammatory response, and catecholamine-mediated cardiogenic hypotension[3]. These patients are typically comatose and have a very high mortality[4]. Thorough physical examination supported by sonographic assessment of systolic function and exclusion of thoracic or abdominal free fluid may support a diagnosis of BIAS but in the presence of polytrauma transfusion is likely to be the appropriate intervention.

3.2 Control Haemorrhage

3.2.1 General Principles:

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.

3.2.2 External Haemorrhage:

- ***General Wounds***

  Direct (digital) pressure and elevation should be used initially where possible. Beware large dressings that 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.

- ***Limbs***

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

See Appendix 1 - Tourniquet Use; Appendix 2 - Topical Haemostatics; Appendix 3 - Balloon Catheter Tamponade.

- ***Junctional Areas (Neck, Groin, Axilla)***
  Haemorrhage control at limb junctions and neck is challenging. Options include direct pressure: packing with a haemostatic dressing, ie. Quik Clot, balloon tamponade[5] and surgical control using clamps or sutures.

- ***Maxillo-Facial Haemorrhage***
  In patients with severe facial fractures, haemorrhage control can be challenging. Following intubation, nasal epistats, bilateral dental bite blocks and a well-fitting cervical collar should be applied to splint the mid-face structures.[6] See Appendix 4 - Maxillo-Facial Haemorrhage Control.

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

3.2.3 Internal Haemorrhage Control:

- ***Pelvis and Long Bones***
  a. Pelvic Fracture - Refer to AO.CLI.07 - Pelvic Trauma.

  b. Femur Fracture:
     - Assess limb neurovascular status.
     - Draw out to length and apply a traction splint (**Slishman** or CT-6 femoral traction splint) provided the knee, ankle joints and tibia/fibula are clinically intact. See Appendix 6 - Slishman Traction Splint.
     - When the femoral traction splint is contraindicated, alternative field splinting can include box splints or tying the fractured limb to an intact limb.
     - Consider femoral nerve or fascia-iliaca block in otherwise hemodynamically stable patients.

  c. Other Limb Fractures – Draw out to length and splint (a Slishman/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. This will require anaesthesia or procedural sedation. Cefazolin 2g IV (paediatric patients 50mg/kg to max 2g) should be administered to all patients with open fractures if no history of allergy to cephalosporins.

3.2.4 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 (paediatric patients 15mg/kg to max 1g) with pleural drain placement, unless allergic to cephalosporins.

3.3 Gain Adequate Circulatory Access

- In haemorrhagic shock, access to the circulation will be required early for fluids and medications.
- More than one access point is almost always desirable.
- Deferring access until en-route by road vehicle may be appropriate in selected cases, to minimise scene time and expedite transport to hospital.
- 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 and will facilitate faster flow rates than tibial. If proximal humeral sites are contraindicated due to proximal fractures, the distal femur is an alternative option although a vertical cut down incision may be required in a minority of patients if there is excessive soft tissue over the site.[7,8]
- Central access may be indicated when a large bore PIVC has been unsuccessful and where IO devices are not achieving adequate flow rates for high volume fluid/blood resuscitation. See Appendix 7 - Trauma Line.

3.4 Fluid Volume Resuscitate to Physiological Endpoints

3.4.1 Physiological End points of Resuscitation:

- "Permissive hypotension", "limited resuscitation", and "damage control resuscitation" describe the *controlled use of volume resuscitation* in the period before definitive haemorrhage control in healthy adult trauma patients[9], concurrent with attempts to avoid hypothermia and initiate blood product use whilst limiting volumes of crystalloid.
- Blood transfusion can contribute to lessening the coagulopathy of trauma when Hct >35% (approx. Hb 110g/l).[10]
- Suggested practice is to utilise permissive hypotension within the guidance below, for pre-hospital trauma, inter-hospital transfers for trauma or medical causes of haemorrhage, prior to definitive haemorrhage control.
- Transfers from remote locations, involving long helicopter or fixed wing journeys may be outside of current available evidence. Prolonged hypotension of two (2) to three (3) hours may lead to irreversible damage to under-perfused organs.[11] This must be weighed on an individual patient basis against the expected benefits of permissive hypotension.

3.4.2 Guidelines for Fluid/Blood Administration: [12, 13]

Pathology	Aim
Traumatic CNS Injury	Brain injury(TBI): SBP > 110mmHg[14] Spinal cord injury: MAP > 85mmHg[15] Paediatric targets in TBI: 28 days and younger >70 mmHg 1–12 months > 84 mmHg 1–5 years > 90 mmHg 6 years and older > 100 mmHg
Blunt trauma without TBI or penetrating wounds	Verbal contact (taken to indicate CNS perfusion) or SBP > 80mmhg or palpable radial pulse
Penetrating Torso	Verbal contact or palpable central pulses

3.4.3 Paediatrics:

Whilst the evidence for permissive hypotension is more limited in children it is widely acceptable practice to substitute SBP = 70 + (age x 2) as a target for resuscitation.[14] Conscious level, when assessable, is the best guide to adequate blood flow to vital organs.

3.4.4 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 third trimester of pregnancy to avoid utero-caval compression lying supine.

3.4.5 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.

3.4.6 Fluids:

- ***Hartmann's***

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

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

- ***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. [15]

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

- ***Extended-Life Plasma (ELP)***
  In the process of achieving the "balanced transfusion", a limited supply of ELP has been made available (currently only at Bankstown base). One such special blood box contains two units of PRBC and two units of ELP. ELP, when available, should be given to achieve 1:1 transfusion ratio.

  Refer to HELI.CLI.11 - Blood Management.

- ***Hypertonic Saline***
  7.5% hypertonic saline is carried for the purpose of osmotherapy in patients with intracranial hypertension and signs of herniation. There are no proven roles outside of this indication in trauma and should only be used for fluid resuscitation if other crystalloids and blood products are depleted.[16]

  Refer to HELI.CLI.03 - Hypertonic Saline.

3.5 Avoid Hypothermia

- Hypothermia (especially core temperature $<35^0$C)[10, 17] 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. [17]
- 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 inter-hospital.

- Blood products may be immediately given at stored (4^0C) temperature as a lifesaving therapy in the peri-arrest or arrested patient, but where time permits, warming of blood units is desirable and the MEQU should be used to warm all blood and fluids administered.

3.6 Adjust Analgesia and RSI Drug Dosages

- Evidence supports ketamine as the induction agent with the safest haemodynamic profile in hypovolaemic patients.[18]
- 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.[18, 19, 20] A fluid flush should be given to ensure medications reach the circulation.
- In cases of moderate volume depletion (SBP < 90) or reduced conscious level due to hypovolaemia, reduce the dose of ketamine for induction (reduce to 0.5 - 1mg/kg).
- In extreme cases of peri-arrest patients and those unconsciousness from hypovolaemia, only the paralysing agents may be required.
- Consider volume loading of any hypovolaemic patient prior to drug administration.
- Stay alert to the fact that IPPV itself may precipitate cardiac arrest by reducing venous return.
- Small aliquots of ketamine and fentanyl, or commencement of low dose infusions, are preferred for analgesia and to maintain sedation in the setting of hypovolaemia.
- Infusions must be closely monitored for interruption and desired effect.

3.7 Logistical Issues and Pre-Alerts

Urgent mobilisation of the team is warranted for patients with suspected significant haemorrhage.

Blood box and portable ultrasound should be transported with the team whenever possible to pre-hospital trauma missions.

A **Retrieval Transfusion Protocol** (**RTP**) can be activated by medical teams for entrapped patients or those distant from MTCs provided notification is early and appropriate. The State Retrieval Consultant (SRC) should be notified on 9553 2222 with a SITREP given in **CLOT** format: Clinical report/Logistics/Operational report/Transport plan.

An RTP may be activated prior to the Medical Teams arrival on scene if the information available indicates a high likelihood of requirement for additional blood products. Unopened products can be returned to the blood bank immediately after the mission if not required.

If RTP is activated, FFP and platelets must be stored at room temperature, and not included in the 4˚C blood esky. See Appendix 8 - Prehospital Massive Transfusion Pathway.

3.7.1 Team PPE:

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

3.7.2 Scene Times:

Penetrating injuries may require urgent surgery to control bleeding. For this reason, time to theatre is important and scene times should be kept very short. **Assessment AND management should be done en route in non-arrested patients.**

Refer to HELI.CLI.04 - Ultrasound.

3.7.3 Penetrating Chest Injuries:

Any penetrating 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 major trauma centres (MTC) have cardiothoracic services available 24/7.

Refer to HELI.CLI.23 – Pre-Hospital Trauma Triage.

3.7.4 Pre-Hospital Code Crimson Activation:

There is likely to be little added benefit of trauma team reception in ED for a sub-group of patients in haemorrhagic shock who are intubated and ventilated on scene and have had pneumothoraces treated or excluded by ultrasound. This is particularly so in the setting of blunt trauma with positive pre-hospital E-FAST or those patients with penetrating trauma.

There is a statewide pre-hospital Code Crimson Policy for all metropolitan MTCs. The policy defines which patients are suitable for pre-hospital Code Crimson activation:

> Persistent haemodynamic instability despite standard trauma resuscitation assessed as being secondary to ongoing haemorrhage in blunt or penetrating trauma, which is unresponsive to intravenous fluids and or blood transfusion.

The policy defines the response of the MTC – notification of senior surgeon on-call, preparation of ED resus, OT/IR and MTP to receive a patient.

The aim of the policy is to provide maximal pre-warning and minimal ED time for patients with uncontrolled haemorrhage.

Pre-hospital code crimsons should be activated as early as possible to allow senior surgical attendance. This is best done via ACC who are able to teleconference a call to the MTC 'Batphone'. A Code 3 should also be passed by radio with an updated ETA when en route.

Handover will be in the IMIST format. If the source of haemorrhage is clear (eg. +ve E-FAST, massive haemothorax or external haemorrhage) then this information should be passed at this time. See Appendix 9 - Pre-Hospital Code Crimson Algorithm.

3.8 Special Therapies

3.8.1 Tranexamic Acid:

Tranexamic acid (TXA) has been shown to reduce overall mortality in the setting of suspected major haemorrhage by a modest amount when given within three hours (with most benefit seen in the first hour following trauma).[21, 22] and the prehospital administration of TXA reduced early death due to haemorrhage in major trauma patients in an Australasian setting.[23]

Treatment after three hours may be associated with harm and is not recommended. See Appendix 5 - Tranexamic Acid.

3.8.2 Other Blood Products:

In inter-hospital 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. Fibrinogen concentrate may be given as an alternative to cryoprecipitate which is faster to administer[24] although

early empiric high dose cryoprecipitate has not been shown to improve mortality in patients requiring major transfusion protocols in comparison with standard therapies.[25]

3.8.3 Reversal of Anticoagulants:

Anticoagulated patients with haemorrhage have a much higher mortality.[26]

Where available reversal agents should be administered to patients with life-threatening haemorrhage who are taking anticoagulants or antiplatelet drugs. These are summarized in Appendix 10.

Any specific haematology advice and discussions about other treatments are best directed to the DRC in the first instance.

3.8.4 Calcium:

Calcium depletion in major trauma is now recognised as common even before transfusion of stored components. In one study[27] 55 % of major trauma patients were hypocalaemic prior to first transfusion and 89% post initial Emergency Department transfusion. Prehospital administration of calcium chloride has been shown to significantly reduce the incidence of hypocalcaemia in patients receiving blood transfusion.[28]

Administration of 10ml of 10% CaCl is indicated following the second unit of red blood cell concentrate as a slow IV push over 5-10min to avoid hypotension.

Calcium should not be administered into a line containing blood due the risk of precipitation.

Paediatric Dosing:

- Calcium Chloride 20mg/kg (0.2mL/kg)

Calcium chloride solution should be diluted with equal volume of saline and administered as a slow IV push over 5-10min. A well-functioning proximal cannula is preferred due to the potential for venous irritation.

3.8.5 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 the Bakri balloon, Rusch uterine balloon or even an oesophageal balloon such as Sengstaken - Blakemore or Minnesota tube
- Immediate advice from a high risk obstetric consultant is available via the Perinatal Advice Line (PAL) accessed via NETS on 1300 362 500
- Potential pharmacological therapies that may be recommended by a high risk obstetric consultant include ergometrine and prostaglandin F2 alpha

4. References

[1] Shippy CR, Appel PL, Shoemaker WC. Reliability of clinical monitoring to assess blood volume in critically ill patients. Critical Care Medicine [1984, 12(2):107-112].

[2] Brasel K et al. Heart Rate: Is It Truly a Vital Sign? Journal of Trauma-Injury Infection & Critical Care. April 2007 – Vol 62(4) p812-817.

[3] Gregory T, Smith M. Cardiovascular complications of brain injury. *Contin. Educ. Anaesth. Crit. Care Pain* 12, 67-71 (2012).

[4] Mahoney EJ et al. Isolated brain injury as a cause of hypotension in the blunt trauma patient. *The Journal of Trauma: Injury, Infection, and Critical Care* 55(6), 1065-1069 (2003).

[5] Navsaria P et al. Foley catheter balloon tamponade for life-threatening haemorrhage in penetrating neck trauma. *World Journal of Surgery* 30(7) 1265 (2006).

[6] Harris T et al. The emergency control of traumatic maxillofacial haemorrhage. *European Journal of Emergency Medicine*; 17: 230-33 (2010).

[7] Ankol S et al. Distal femur intraosseous access in adult trauma patients: A feasible option? *Am. J. Emerg. Med.* 65, 192-194 (2023).

[8] Rayas EG et al. Distal femur versus humeral or tibial IO, access in adult out of hospital cardiac resuscitation. *Resuscitation* 170, 11-16 (2022).

[9] EAST Practice Parameter Workgroup for Pre-hospital Fluid Resuscitation. Pre-hospital fluid resuscitation. *J Trauma*. 2009, Aug; 67 (2): 389-402.

[10] Hardy JF et al. The coagulopathy of massive transfusion. Vox Sanguinis 2005; 89: 123-7.

[11] Skarda DE et al. Eight hours of hypotensive versus normotensive resuscitation in a porcine model of controlled haemorrhagic shock. *Acad Emerg Med* 2008; 15(9): 845-52.

[12] www.nice.org.uk/TA074guidance.

[13] BATLS manual 2008 edition.

[14] Lulla A et al. Pre-hospital guidelines for the management of traumatic brain injury. *Prehospital Emergency Care*. 27:5, 507-538 (2023).

[15] Cotton BA et al. Multicenter validation of a simplified score to predict massive transfusion in trauma. *J Trauma* 2010; 69: S33-39.

[16] Blanchard IE et al. The effectiveness of prehospital hypertonic saline for hypotensive trauma patients: a systematic review and meta-analysis. *BMC Emerg Med*. 2017 Nov 28; 17(1): 35.

[17] Midwinter MJ, Woolley T. Resuscitation and coagulation in the severely injured trauma patient. *Phil Trans R Soc* 2011; 366: 192-203.

[18] Morris et al. Anaesthesia in haemodynamically compromised emergency patients: does ketamine represent the best choice of induction agent? *Anaesthesia* 2009; 64; 532-539.

[19] Gad B-J. Effectiveness of ketamine in decreasing intracranial pressure in children with intracranial hypertension. *J Neurosurg Paediatrics* 2009; 4: 40-46.

[20] Chasapakis G. Use of ketamine and pancuronium for anaesthesia for patients in haemorrhagic shock. *Anaesthesia and analgesia* 1973; 52(2): 282-287.

[21] Effects of tranexamic acid on death, vascular occlusive events and blood transfusion in trauma patients with significant haemorrhage (CRASH-2): a randomized, placebo controlled trial. *Lancet* 2010; 376: 23-32.

[22] Morrison JJ et al. Military application of tranexamic acid in trauma emergency resuscitation (MATTERs) study. *Arch Surg*. 2012 Feb; 147(2): 113-9.

[23] PATCH-Trauma Investigators and the ANZICS Clinical Trial Group. Prehospital tranexamic acid for severe trauma. *N Engl J Med.* 2023 Jul 13;389(2): 127-136.

[24] Winearls J et al. Fibrinogen early in severe trauma study (FEISTY): results from an Australian multicentre randomized controlled pilot trial. *Crit Care Resusc*. 2023 Oct 18; 23(1): 32-46.

[25] Davenport R et al. Early and empirical high-dose cryoprecipitate for haemorrhage after traumatic injury: the CRYOSTAT-2 randomised clinical trial. *JAMA.* 2023; 330(19): 1882-1891.

[26] Perkins JG et al. Massive transfusion and non-surgical hemostatic agents. *Critical Care Medicine* 2008; 36:Suppl S325-39.

[27] Webster S et al. Ionised calcium levels in major trauma patients who received blood in the emergency department. *Emerg Med J* 2016 Aug;33(8) 569-72.

[28] Kyle T et al. Ionised calcium levels in major trauma patients who received blood en route to a military medical treatment facility. *Emerg Med J* 2017 – 206717.

APPENDICES

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REVISION HISTORY

Version (Document #)	Amendment notes
Version 6.0 Issued June 2024	New literature review Updated Brain Injury Associated Shock section Updated Code Crimson /RTP references Updated tourniquet conversion advice Added appendices: Appendix 8 - Pre-Hospital Massive Transfusion Pathway Appendix 9 - Pre-Hospital Code Crimson Algorithm Appendix 10 - Reversal agents for anticoagulants and antiplatelet drugs
Version 5.0 WI2020-084 Issued 29 July 2020	Section 4.2.3 Slishman traction splint added Section 4.3 Central access via Trauma line added Section 4.4.6 ELP added Appendix 6 - Slishman Traction Splint added Appendix 7 -Trauma Line added Approved by A/Executive Director, Aeromedical Operations
Version 4.0 Issued 17 April 2018	Section 4.8.5 administration of Calcium added Approved by Executive Director, Aeromedical Operations

Version 3.0 Issued 27 September 2017	Section 4.7 amended to reflect the introduction of the statewide Rural/Regional/Pre-Hospital Massive Transfusion Protocol. Section 4.7.4 amended: previously “Emergency Department (ED) Bypass”, now “Pre-hospital Code Crimson Activation.” Appendix 6 and appendix 7 added, as per above. Approved by Executive Director, Health Emergency & Aeromedical Services.
Version 2.0 Issued 31 March 2017	Minor amendments, and transition to new format. Approved by Executive Director, Health Emergency & Aeromedical Services.
Version 1.0 Issued September 2012	Approved by Executive Director, Health Emergency & Aeromedical Services.

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 NSW Ambulance vehicles.

Indications

- Active arterial bleeding (pulsatile exsanguination).
- Prior to field limb amputation (Contact DRC 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.

Re-assessment and Removal

Whilst tourniquets can be life-saving if left on for more than 2 hrs is associated with increased rates of unsalvageable ischaemia. Many wounds can be managed by local pressure alone. It is reasonable to reassess tourniquets placed in the following instances:

- Entrapped patients following extrication.
- Any wound with longer than 2 hrs of tourniquet time.
- 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 ready to be applied.

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Appendix 2 - Topical Haemostatics

Topical Haemostatics

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

Indications

- Haemorrhage not controllable using direct pressure alone.

General Principles

- Wear gloves and protect caregivers' eyes.
- Expose bleeding point by removing clot
- Pack the wound firmly with haemostatic gauze.
- Apply firm pressure for three minutes. Do not remove.
- Care should be taken with torso and head wounds – try to avoid pressing gauze into brain and internal organs.
- 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.

General Principles

- Insert balloon catheter or epistat balloon 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 or epistat 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 mid-face structures against the clavicles and tamponade nasal bleeding.
- Patient must be intubated prior to this procedure.
- Re-apply appropriately sized cervical collar.
- Re-align mid-face by pulling maxilla into anatomical position.
- Insert nasal epistats by gentle pressure backwards (not upwards) but do not 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.
- Re-assess haemorrhage control and adjust balloons.

Appendix 5 - Tranexamic Acid

Tranexamic Acid

Indications
Within three hours of injury for:

a. Blunt or penetrating trauma when a decision has been made to administer blood (red blood cell concentrate)

b. 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

c. Ongoing post-partum haemorrhage following local measures and uterotonics.

Relative Contra-Indications

Known history of thrombotic disorders including PE or DVT.

Dosing

- Adult 1g slow push over 10 minutes followed by infusion of 1g over eight hours. Paediatric dose is 15mg/kg.
- Maintenance infusion: In most cases, this will occur in the receiving trauma centre (1g over eight hours).

Administration

- Administration of TXA must not significantly prolong scene time.
- Slow IV/IO push in 10mL syringe over 10 minutes 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.

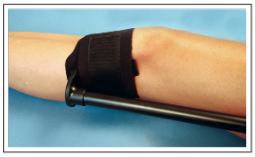
Appendix 6 – Slishman Traction Splint

HOW TO APPLY

1. Attach Ankle Strap

- Remove ankle strap and end cap from pole
- Unroll ankle strap and apply with end cap lateral and facing up to receive splint pole
- Secure with Velcro wrap

NOTE: May apply ankle strap above calf in cases of lower leg injury



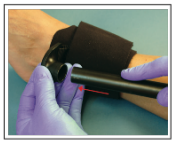
Prior to application assess CMS (circulation, motor and sensory) function and pain level per local protocol.

2. Attach Groin Strap

- Rest female buckle on anterior thigh
- Wrap male buckle and strap behind thigh
- Snap male to female buckle and tighten

3. Apply Coarse Traction

- Extend distal pole after releasing thumb screw on black pole clamp
- Insert distal pole into ankle strap end cap
- After achieving desired length, tighten thumb screw

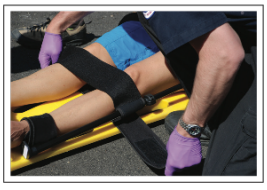


4. Apply Fine Traction

- Release thumb screw on red pole clamp
- Pull cord to apply desired traction
- Tighten thumb screw on red pole clamp and release cord

5. Reassess and Monitor

- Reassess CMS and pain level
- Adjust traction as needed to minimize pain, while maintaining perfusion
- For rotational stability attach mid leg strap to splint and wrap (one or both legs) below knee



PEDIATRIC APPLICATION

For patients under 110 cm (approx. 43 inches) in height and/or 3 years or less in age, lengthen the groin strap allowing the splint to rest more proximal to the hip.

Click on **QR code** to see instructional video OR visit **YouTube.com** and search **"Slishman Traction Splint"**

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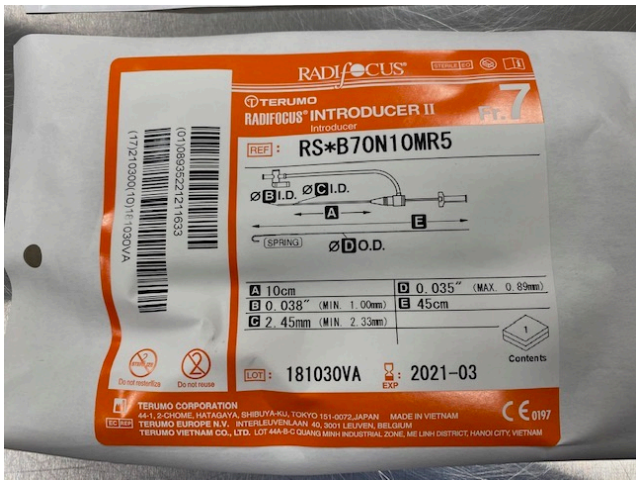
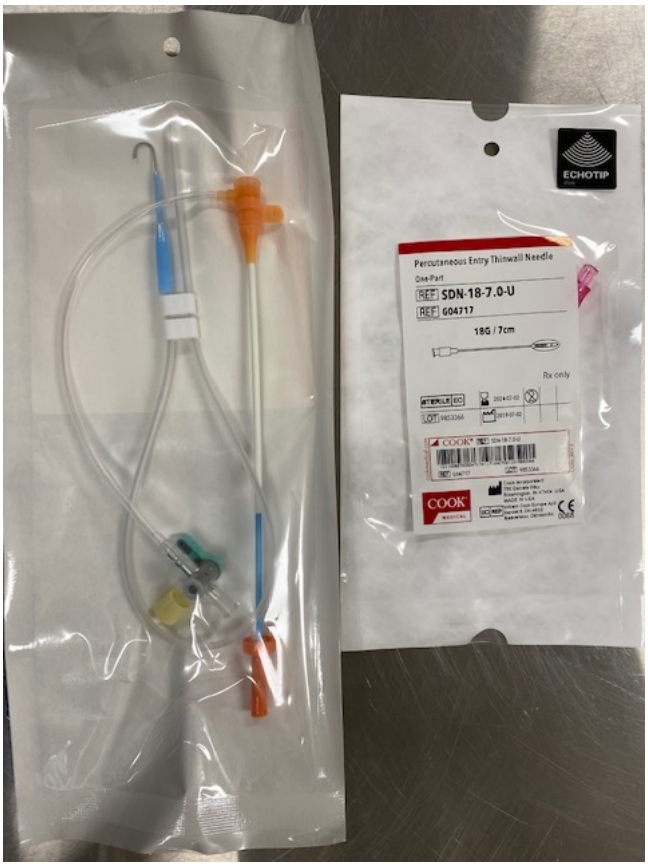
Appendix 7 - Central Access via Trauma Line

- ***RADIFOCUS Introducer II*** is a 7-Fr single lumen vascular access sheath with side port. It should be primed with saline first to avoid air embolism.
- A 7-cm 18G needle is used for vascular access and passing the guide wire.
- Choice of sites determined by logistics and clinical status; US guided recommended for IJ or femoral, though this may not be feasible in poly trauma patient. In such clinical circumstances, a landmark-guided approach for SCV is acceptable.
- Lines should be inserted in as clean a fashion as possible but true sterility is unlikely to be achieved in the prehospital environment and this should be conveyed to receiving hospital team.





Appendix 8 - Pre-Hospital Massive Transfusion Pathway

BLEEDING PATIENT?

Handover Tool: C.L.O.T

If advised EARLY, Massive Transfusion Packs (MTP) can now be arranged for patients attended by medical retrieval teams.

C	L	O	T
CLINICAL REPORT	**LOGISTICS AND/OR OPERATIONAL REPORT**		**TRANSPORT PLAN**
State patient condition and need for extra blood products	Time until extrication/Time 'window' on-scene or in hospital		Consider need for refuelling stops and patient destination

Massive Transfusion Packs should be considered for:

- Out of hospital scenes distant from major trauma centres
- Entrapped patients
- For rendezvous en-route from scene
- Patients bleeding in rural or remote hospitals

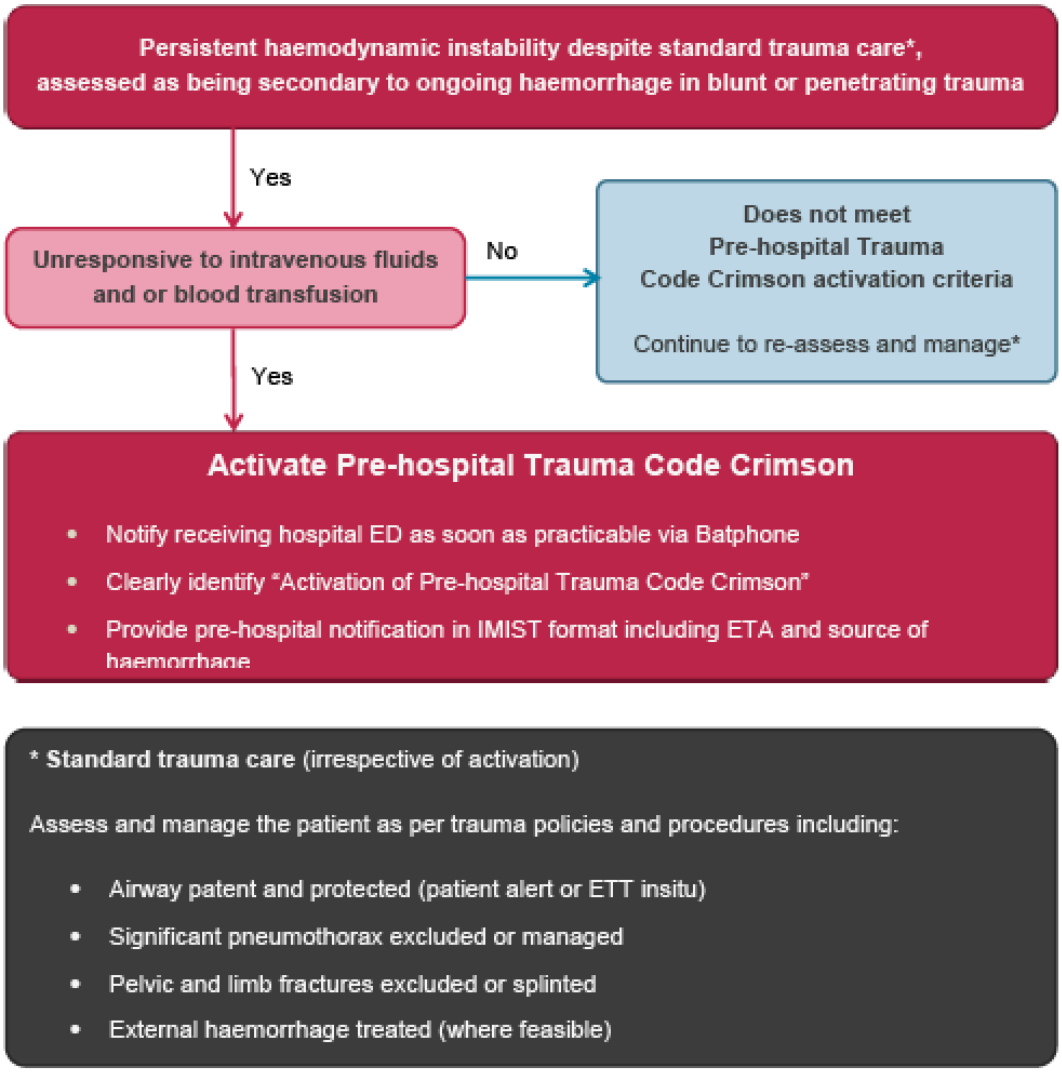
Call the State Retrieval Consulant AS SOON AS POSSIBLE

9553 2222

NSW Ambulance excellence in care

Appendix 9 – Pre-Hospital Code Crimson

3. Algorithm 1: Activation of Pre-hospital Trauma Code Crimson by the Aeromedical and Medical Retrieval Service



Appendix 10 - Reversal agents for anticoagulants and antiplatelet drugs

Medication	Reversal
Warfarin	*Investigation: INR* - Vitamin K IV 5-10mg PLUS either Prothrombin Complex Concentrate (PCC), such as Prothrombinex-VF; OR Fresh Frozen Plasma (FFP) - PCC first line if available - 50 IU/kg - FFP if PCC not available - 150-300 mL
Dabigatran	*Investigation: PTT (ideal = thrombin time)* - Idarucizumab 5g If ingested in < 2 hours may consider activated charcoal 50g
Factor Xa Inhibitors *Riveroxaban* *Apixaban*	*Investigation: INR (ideal = anti-Xa level)* - Andexanet Alfa – reversal agent for direct factor Xa inihibitors Dose 400-800mg IV based on regular dose and time since last dose taken If Andexanet Alfa not available: - 4-factor PCC 50 IU/kg (max. 5,000 units) - If ingested in < 2 hours may consider activated charcoal 50g - If INR elevated, consider Vitamin K 10mg IV to exclude vitamin K deficiency
Thrombolysis (tPA)	*Investigation: INR, PTT, fibrinogen* - TXA 1g IV bolus, then 1g over 8 hours - Cryoprecipitate 10 units IV - 2 units FFP - Platelet transfusion may be considered
Heparin	*Investigation: PTT (ideal = anti-Xa level)* - Protamine (dosing based on units of heparin administered per protocol) Avoid giving more than 50mg at once *Give slowly* over 15 minutes
Anti-platelet agents	*Investigation: Platelet function assays (if available)* - Desmopressin (DDAVP) 0.4 microgs/kg over 20-30 minutes - Consider addition of TXA 1g IV bolus - Consider targeting a higher fibrinogen level than usual.