Greater Manchester
Major Trauma Network

GREATER MANCHESTER MAJOR TRAUMA

Clinical Management Guidelines (Adults)

Version 4.0

Version Control

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Associated documents	GM MTN Patient Pathways and Transfer Policy (v3.0) GM MTN Network Operational Policy (v.4.0) GM MTN Education Strategy (v.2.0)
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Amendments	As per 'Record of amendments' section
Queries	**For any queries please contact:** **GMCCMT.Network@mft.nhs.uk**

Record of Amendments

Section	Version	Date	Brief description
Document control	4.0	Aug 24	Addition of document control page
Record of Amendments	4.0	Aug 24	Addition of 'Record of Amendments'
Contents	4.0	Aug 24	Update and formatting change
Whole document	4.0	Aug 24	Updated organisation names and nomenclature
Whole document	4.0	Aug 24	Updated numbering and formatting
Whole document	4.0	Aug 24	References and links to national guidance (BOAST, NICE etc) updated to current versions
Introduction	4.0	Aug 24	Addition of link to the North West Children's Major Trauma Network clinical guidelines
Identification of Older, Frail Major Trauma Patients	4.0	Aug 24	Additional context around the NWAS Major Trauma Pathfinder (v2.0 2015) and GM MT Network Frail Injured Patient Pathway (NWAS guidance)
- Trauma Team Activation - Pit Stop Pathway - Injured Patient Pathway	4.0	Aug 24	Addition of reference to inclusion of patients in traumatic cardiac arrest
Adult Trauma Team Composition	4.0	Aug 24	Updated neuro trauma team member roles
Trauma Team Roles & Responsibilities – *TTL section*	4.0	Aug 24	Addition of reference around oversight of timely interventions to ensure compliance to national standards. Inclusion of reference to completing documentation as required. Inclusion around the TTLs having appropriate training to deliver all required emergency procedures.
Trauma Team Roles & Responsibilities – *Anaesthetist section*	4.0	Aug 24	Addition *'ensure maintenance of adequate ventilation'*
Trauma Team Roles & Responsibilities - *Emergency Department Doctors 1 & 2*	4.0	Aug 24	Addition *'Undertake emergency procedures they have previously gained competency in (or under appropriate supervision)'*
Trauma Team Roles & Responsibilities - *Scribe section*	4.0	Aug 24	Ensure TTL has reviewed and approved appropriate clinical notes prior to the patient leaving the emergency department
Trauma Team Roles & Responsibilities	4.0	Aug 24	Addition of 'The Trauma Team Ethos' box

Section	Version	Date	Brief description
First Hour of Care in the Emergency Department	4.0	Aug 24	Addition to *'(Gain cardiovascular control...) this includes reversing anticoagulants if appropriate'*
Guidance in Adult Trauma CT	4.0	Aug 24	Addition of 'record if splint in situ' Addition of Trauma Unit standard T20-2B-308 (2021) for context
Vascular Interventional Radiology	4.0	Aug 24	Updated IR indications table Updated contact details Included updated link to new guidelines and aligned content to these
Vascular Injuries	4.0	Aug 24	Addition of text around vascular 'hard signs'
Guidelines on requesting a vascular opinion	4.0	Aug 24	Addition of text regarding neuro/spinal patients and stability to transfer to MRI Correction of wording 'The NWAS Pathfinder…' changed to 'The GM supplementary pathfinder…'
Acute Airway Management in the Major Trauma Patient	4.0	Aug 24	General update
Emergency Anaesthesia	4.0	Aug 24	General update
Emergency Anaesthesia – Overview	4.0	Aug 24	General update, new references, and suggestion of regular simulation sessions with shared learning. 2.3 Pharmacology - 2.3.8 Updated guidance around administration of Tranexamic Acid for patients with head injuries
Emergency Surgical Airway	4.0	Aug 24	General update
Resuscitative Thoracotomy	4.0	Aug 24	General update Addition of Resuscitative Thoracotomy overview
Blunt Abdominal Injury	4.0	Aug 24	General update Removal of paediatric content
Guide to management of liver trauma	4.0	Aug 24	Update to wording on flow chart. Specifically, *'CT of thorax, abdomen and pelvis if it all possible'* for haemodynamically unstable patients Added 'agree a management plan' to flow chart
Traumatic Spinal Cord Injury	4.0	Aug 24	New guidance for referrals to the Spinal Cord Injury Service
Lumbar and Thoracic Fracture Management (2023)	4.0	Aug 24	New guidance inclusion around fragility fractures

Section	Version	Date	Brief description
Clinical Guidance for Head Injury	4.0	Aug 24	Updated flow chart to align with guidance for Tranexamic Acid (TXA) administration
Severe Traumatic Brain Injury	4.0	Aug 24	Addition of narrative around primacy of injury and need for clinical discussion
Where transfer to SRH is not possible	4.0	Aug 24	Addition of further context around management of pregnant patients, and haemodynamically unstable patients
Pelvic Fractures	4.0	Aug 24	Text adjusted to align with the GM Pelvic Injury Pathway (2023)
GM Pelvic Injury Pathway	4.0	Aug 24	Addition of GM Pelvic Injury Pathway Removed reference to 'Pit Stop pathway'
Management of Frail, Older patients	4.0	Aug 24	New addition, context around the GM MT Network frailty resources Links for further information
Oral and Maxillofacial Trauma	4.0	Aug 24	Updated contact details
Ophthalmic Injury	4.0	Aug 24	Updated contact details

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Network Pathways: - Chest Injury - Open Lower Limb - Pelvic*	The Network team wishes to acknowledge the contribution of all involved in the development of these pathways. *Manchester Acetabulum and Pelvic Surgery (MAPS) MDT

Contents

Introduction

The GM Major Trauma Network (GM MTN) was formed in April 2012. Its purpose is to deliver safe, equitable and effective care to adult patients who have suffered serious injuries, often multiple, where there is a strong possibility of death or disability.

Due to the historical dispersal of services across the conurbation the **Major Trauma Centre** function is provided by a collaborative which comprises:

- Manchester Royal Infirmary (MRI), Manchester University NHS Foundation Trust (MFT)
- Salford Royal Hospital (SRH), Northern Care Alliance NHS Foundation Trust (NCA)

The GM MTN also comprises three designated **Trauma Units** (TU):

- Royal Albert Edward Infirmary, Wigan (Wrightington, Wigan & Leigh Teaching Hospitals NHS Foundation Trust)
- The Royal Oldham Hospital (Northern Care Alliance NHS Foundation Trust)
- Stepping Hill Hospital (Stockport NHS Foundation Trust)

The remaining Network members are **Local Emergency Hospitals** (LEH):

- Bolton NHS Foundation Trust
- Fairfield General Hospital (Northern Care Alliance NHS Foundation Trust)
- Macclesfield District General Hospital (East Cheshire NHS Trust)
- North Manchester General Hospital (Manchester University NHS Foundation Trust)
- Tameside & Glossop Integrated Care NHS Foundation Trust
- Wythenshawe Hospital (Manchester University NHS Foundation Trust)

Pre-hospital care is provided in the main by the North West Ambulance Service (NWAS) and North West Air Ambulance (NWAA). A small number of cases are also conveyed by the East Midlands Ambulance Service (EMAS). The GM MTN and MTCC provide **adult services only**. In this context, this relates to patients aged 16 or over. Children's major trauma services (15 and under) are managed by the North West Children's Major Trauma Network.

The North West Children's Major Trauma Network

For information around the management of children (under 16 years) please refer to the paediatric clinical guidelines at:

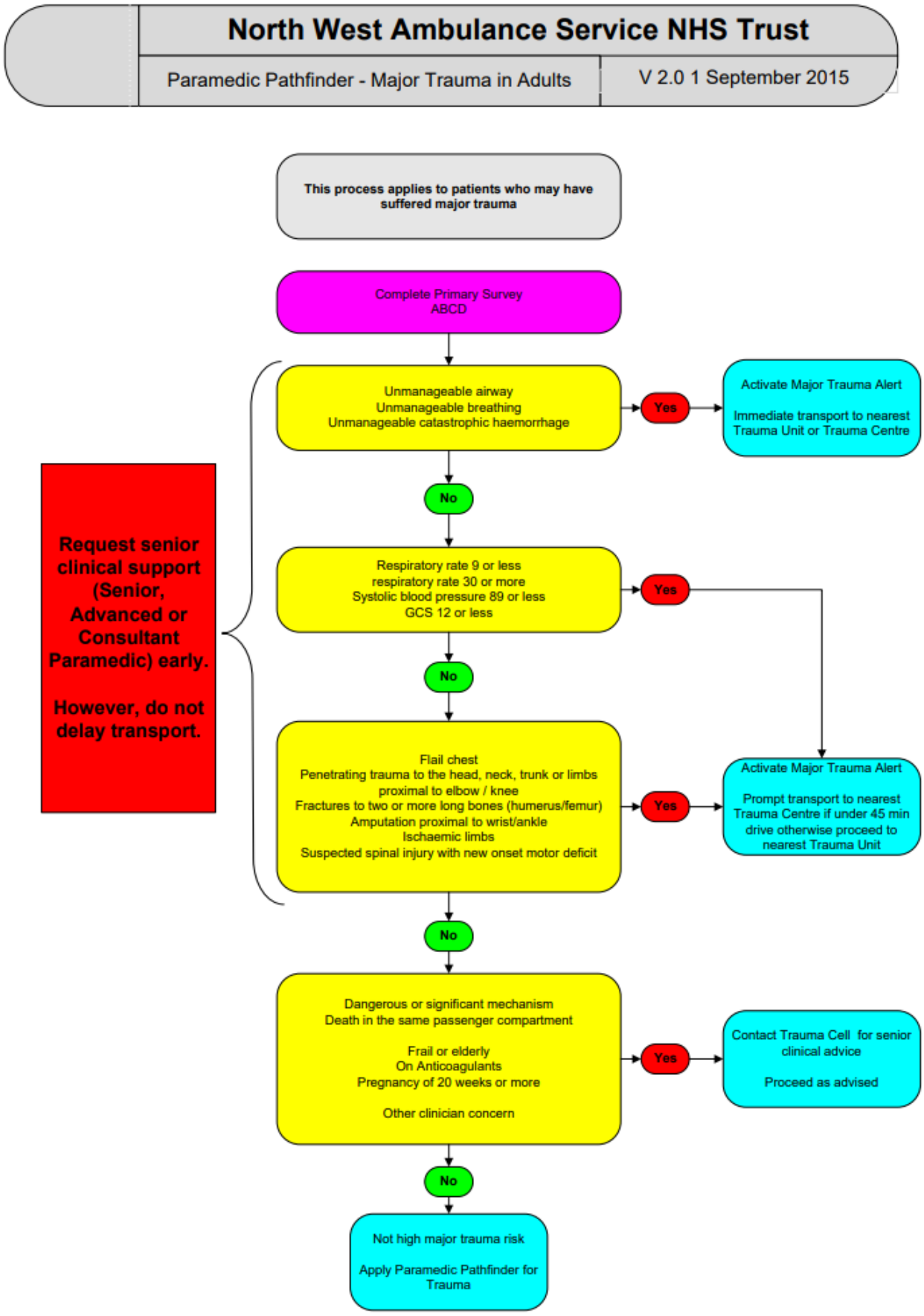
Pathways and Guidelines | The North West Children's Major Trauma Network (nwchildrenstrauma.nhs.uk)

Purpose of Document

This document sets out clinical management guidelines for the adult major trauma pathway. It is expected that each Trust will have its own individual set of guidelines detailing local operational arrangements. However, where services are provided on a collaborative basis, relevant policies, and protocols, are included here. These policies have been developed in collaboration with clinical leads and management colleagues across the Network and have been reviewed (and will continue to be reviewed) through the GM Network Clinical Effectiveness Committee.

Pre-Hospital Activation: Trauma Triage Tool

MT-Adult-Pathfinder-100515-1.pdf (gmccmt.org.uk)



Identification of Older, Frail Major Trauma Patients

THE NWAS Major Trauma Pathfinder (2015)

The pathfinder acts as a sieve to identify the most severely injured patients, to direct them to a major trauma centre (MTC) to expedite rapid imaging and diagnosis. The pathfinder recognises physiological abnormalities such as hypotension and low GCS as indicators of this.

Due to altered physiology, often low mechanisms of injury and complex medical history, major trauma in older patients can be difficult to identify.

The Frail Injured Patient (FrIP) pathway (2019)

In the North West, a secondary method of capture has been developed, known as the Frail Injured Patient pathway (FrIP). The pathway is used as a pre-hospital tool by NWAS to identify potential major trauma in elderly or frail patients who appear initially to be 'major trauma pathfinder negative'. These patients will usually have sustained relatively low mechanisms but may actually have occult injuries. NWAS crews are prompted to discuss at risk patients with the Complex Incident Hub (formerly known as the Trauma Cell). The patient will be conveyed to the nearest hospital but with a pre-alert highlighting the potential requirement for a senior review and early imaging.

THE FRAIL INJURED PATIENT PATHWAY (FrIP) – Pre-Hospital (v2.0)

Discuss the possibility of a FrIP pre-alert to nearest hospital with the Complex Incident Hub (CIH)

Mechanism of Injury

Low Impact Mechanisms

Falls <2m are the largest injury group in major trauma

Consider -

Collapse from Standing
Medical presentations
'Found on floor' presentations
Roll out of bed presentations

Impact Zone
Lack of peripheral injuries should elicit a high index of suspicion
Injury to 2 or more body systems

Pharmacology

Anticoagulants

Consider visible haemorrhage and occult bleeding to head, chest, abdomen, pelvis or long bones.

Consider -

Beta Blockers
Will mask tachycardia in the major trauma patient

Steroids
History of steroid use in chronic disease means fractures are more likely

Other medications
Consider polypharmacy and antiplatelet use (e.g. aspirin). Anticoagulants include warfarin, LMWH and DOACs (apixaban, rivaroxaban, dabigatran and edoxaban).

LMWH: low molecular weight heparin, DOAC: direct oral anticoagulants

Physiology

SBP <110mmHg

***Worried? What is the patient's normal blood pressure?**

Consider -

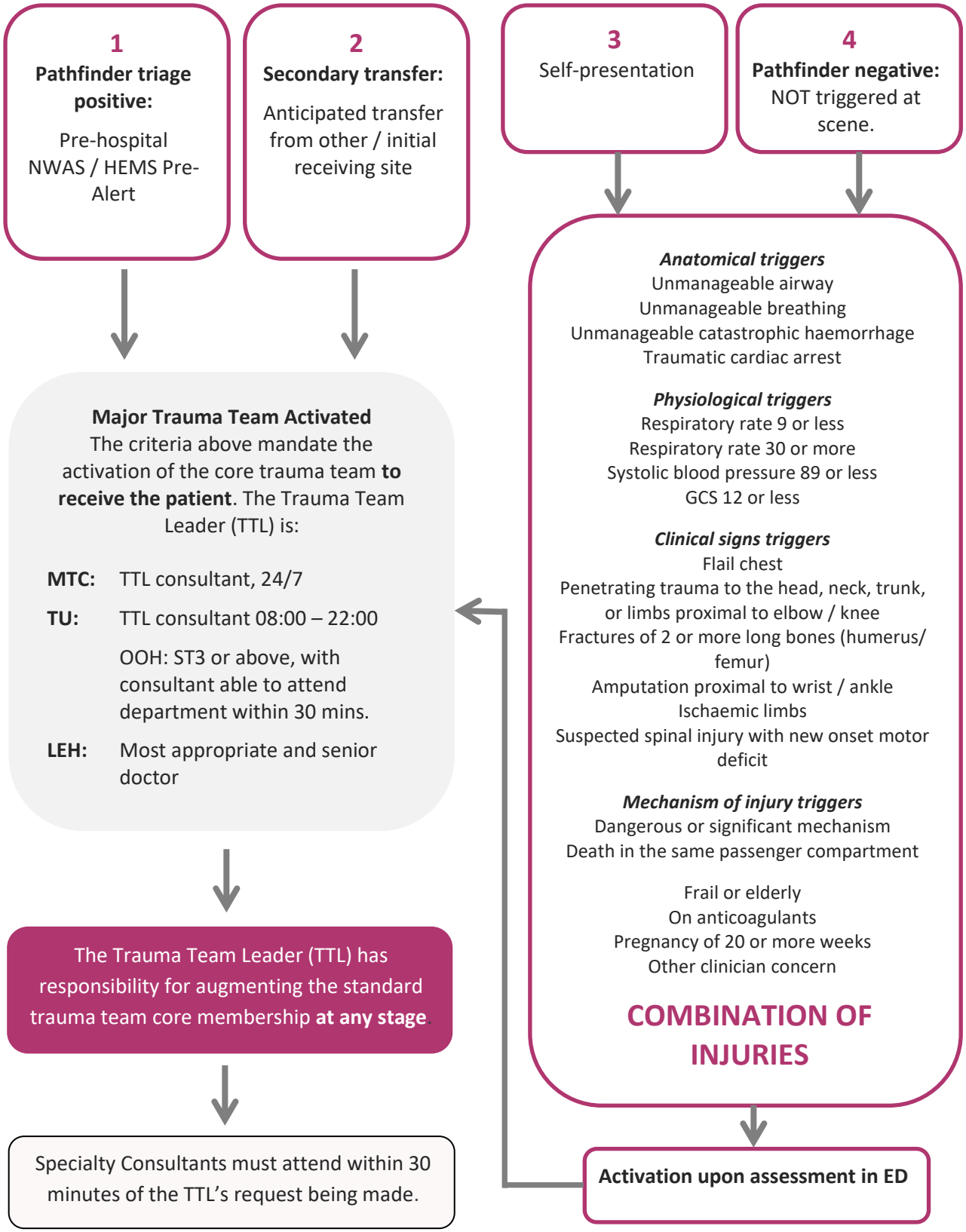
Existing Disease Process
Note any changes in physiology of the chest wall. Chest wall injuries are common and difficult to diagnose and require careful examination.

Previous Recent Injury History
Consider acute on chronic injury to the brain and other regions

- **Consider previous recent collapses**
- **Consider potential for undiagnosed injury with previous, recent hospital attendances**

Older people may sustain serious injury from low mechanisms. Illness may be present as well as injury. Consider early TXA and pre-alert. Be aware of anticoagulant use and potential for reversal. Recognise potential for occult injury.

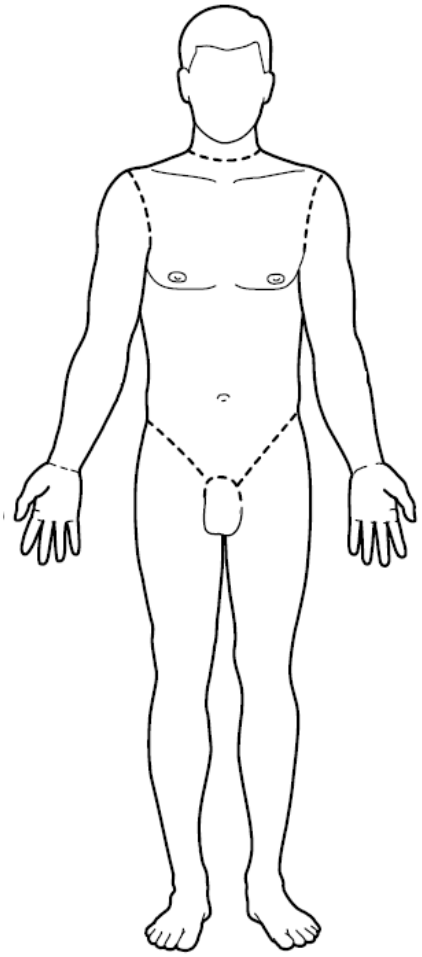
Trauma Team Activation



Adult Trauma Team Composition

Airway specialist
(Anaesthetic / Critical Care Registrar)

ODP / Airway assistant



Nurse 2

Doctor 2

Doctor 1

General Surgical Registrar

Orthopaedic Registrar

Nurse 1

Radiology Registrar

Radiographer

Scribe

Trauma Team Leader (TTL)

NEURO TRAUMA TEAM @ SRH:
Isolated head injury response based on information provided by NWAS or referring site.

→

ED Team plus:
Anaesthetic registrar, ODP, CT Radiographer, radiology registrar (in working hours).
Out of hours radiology reporting is outsourced at SRH.

The TTL has responsibility for augmenting the standard trauma team core membership **at any stage.**

→

Specialty consultants must attend within 30 minutes of the TTL's request being made.

Trauma Team Roles & Responsibilities

Trauma Team Leader (TTL):

MTC: A medical consultant trauma team leader on site 24/7 to lead the trauma team and available within 5 minutes of arrival of the patient.

TU: An ED consultant between 08:00-22.00 and available within 5 minutes of arrival of the patient. Out of hours (OOH), an ST3 or above with a consultant able to attend the department within 30 mins.

LEH: Most appropriate and senior doctor.

Training: ATLS, ETC, TTL training, regular simulation (PERT, Firefighting also advised).

The responsibilities of the trauma team are:

Trauma Team Leader

- Ensure team wear personal protective equipment including lead and tabards, allocated roles are clear and personal introductions made.
- Provide pre-arrival briefing as appropriate.
- Ensure safe transfer of care from pre-hospital providers and obtain history from paramedics.
- Direct team members in their actions.
- Ensure swift primary survey is undertaken and issue immediate actions with concerning findings.
- Establish priorities for investigation including transfer to CT in under 30 minutes where possible.
- Order or authorise investigations and procedures.
- Be mindful and ensure, wherever possible, the timely delivery of interventions to ensure they align with national standards (timely TXA, anticoagulant reversal and timely antibiotics).
- Receive and interpret all results of investigations and action interventions appropriately.
- Consult with other specialties including regarding ongoing care or transfer for specialist services.
- Coordinate MDT decision making, senior discussions and Code Red activations where appropriate
- Decide on appropriate disposition.
- Discuss care of patients with relatives/friends as appropriate
- Write in the notes – liaise with the scribe to ensure the initial record is complete before the patient leaves the ED.
- Dismiss and debrief team members as appropriate.
- At the MTC, the team leader should have all necessary emergency procedures within their skill set[1].
- At the Trauma Unit, the team leader should have all relevant emergency procedures within their skill set including relevant training in managing Pit Stop patients in cardiac arrest.

[1] Royal College of Emergency Medicine (RCEM) Certificate of Completion of Training (CCT) Curriculum

Airway Specialist (Anaesthetist)

- Airway control.
- Cervical spine control.
- Ensure maintenance of adequate ventilation.
- Monitoring of vital signs.
- Monitoring of fluid and drug administration.
- Provision of safe analgesia.
- Provide anaesthesia for surgical procedures.
- Communicate airway patency and issues to team leader / scribe.
- Assess respiratory rate and inform team leader / scribe.
- Write in the notes.
- Only leave patient when relieved by colleague or under the direction of the TTL.

Airway Assistant (ODP)

- Assist airway doctor.
- Prepare for RSI and placement of invasive monitoring lines.
- Ongoing monitoring and care for anaesthetised patients including during transit to CT scan and subsequent transfers within the hospital.
- Liaise with theatres regarding likely patient destination.
- Only leave patient when relieved by colleague or under the direction of the TTL.

Doctor 1: Emergency Department Registrar

- Perform or supervise the undertaking of the initial primary survey.
- Clearly state findings to team leader, scribe, and other assembled team members.
- Act on immediate findings as directed by TTL.
- Undertake emergency procedures they have previously gained competency in (or under appropriate supervision).
- Document findings in the patient's notes.
- Only leave patient when relieved by colleague or under the direction of the TTL.

Doctor 2: Emergency Department Doctor

- Gain IV access and ensure bloods are sent correctly (as per local protocol).
- Gain venous/ arterial blood samples as required.
- Request investigations and chase results.
- Prescribe medications and blood products as required.
- Document relevant findings in patient notes.

- Undertake emergency procedures they have previously gained competence in (or under appropriate supervision).
- Only leave patient when relieved by colleague or under the direction of the TTL.

Scribe

The scribe is responsible for the full record of the trauma call. The scribe should be a separately allocated role. They should be situated near the team leader so that all information passing through the leader is then passed to the scribe. Records must include:

- Time of arrival.
- Mechanism of injury.
- Document team members including specialty and grade e.g., ST3.
- Flag major trauma patient on local system.
- Physical findings.
- Vital signs. Urine output. Glasgow Coma Scale.
- Results of X-rays and other investigations.
- Medications and blood products administered.
- Previous Medical History.
- Summary of injuries.
- A contemporaneous timeline of events and actions.
- Disposal of patient.
- The scribe should also take the role of timekeeper should this be necessary.
- Ensure TTL has reviewed and approved appropriate clinical notes prior to the patient leaving the emergency department.

Nursing staff

- Nursing staff should have pre-allocated roles agreed prior to the arrival of the patient and assist in preparing the area.
- Allocated tasks may include cannulation and venepuncture, cutting of clothing to gain access for examination, performing observations or securing haemorrhage control devices.
- The nurses should not have to leave the resuscitation room to fetch equipment or run samples to the labs. Ancillary staff should be available outside the main Resus area to provide this function.
- In cases of major haemorrhage, additional staff may be required to manage specialist equipment such as rapid infusers and to check blood products or drugs.
- Nursing staff will need to escort the patient to CT scan or on external transfers and also liaise with the patients' family/friends and provide support to staff assisting in the management of the patient.

General Surgeon

The General Surgeon focuses on assessment of the abdomen. Responsibilities are:

- Assessment of abdomen and consideration of immediate damage control surgery.
- Log roll participation.
- Document findings in the clinical notes.
- Liaise with theatre coordinators and specialist surgical colleagues as necessary.
- Only leave patient when relieved by colleague or under the direction of the TTL.

Orthopaedic Surgeon

- Assessment and consideration of haemorrhage control and requirement of Damage Control Surgery.
- Assessment of spine including neurology examination.
- Application of external fixator, splint, or pelvic binder.
- Assessment of limb/pelvic injury and associated wounds and liaise with TTL regarding imaging.
- Dressing of wounds and stabilisation/manipulation of fractures.
- Liaise with plastics service regarding open lower limb injury.
- Document clinical findings in the patient's notes.
- Only leave patient when relieved by colleague or under the direction of the TTL.

The Trauma Team Ethos

The allocated Trauma Team Leader (TTL) is responsible for coordinating all aspects of the patients care. This includes prioritising tasks, issuing instruction, and collating all relevant information.

The team should share findings from examinations, observations, and responses to interventions with the TTL.

In cases where patients are transferred to another site, the TTL should ensure there is adequate handover to the receiving TTL.

It should be recognised that civility and effective communication are crucial and while each attendant has their role, contribution to other tasks may be in the best interest of the patient.

First Hour of Care in the Emergency Department

All emergency departments in the Network are expected to follow the same emergency management of the major trauma patient based upon these guidelines.

Elapsed time	Processes undertaken
Prior to arrival (triage positive patients)	- Prepare receiving area - Allocate roles to staff - Prepare equipment and identify location of key items - Prepare for MHP activation if necessary following local protocol - Identify members not on the trauma team that may be required in addition and agree system for urgent activation if required - Identify additional staff members should they be required to assist
Time zero	- Patient on ED trolley
Within 10 minutes	- Reception/handover - Establish life-threatening presentations and action immediate responses - Primary survey and required interventions - Establish ED monitoring and gain full visual access of the patient - Establish anaesthesia and ventilation (if required) - Establish appropriate IV access, undertake venous blood gas and gain bloods as required - Confirm TXA has been administered, if indicated - Consider reversal of anticoagulants if appropriate - Administer analgesia and blood products as necessary - Request immediate imaging: CT scans (FAST scans should only be carried out if there is a delay to CT scan and this is thought to be of clinical benefit to the patient) - Identify and transfer to trauma theatre if patient necessitates immediate damage control surgery +/- diagnostics depending on clinical urgency
Within 30 minutes	- Gain cardiovascular control (this includes reversing anticoagulants if appropriate) - Any immediate radiological studies undertaken in resus complete and available for viewing - Transfer to CT and start scanning - Hot report should be available within 5 minutes
Within 60 minutes	- Formal CT report available **For TUs and LEHs - if injuries are considered to be 'Major Trauma' that require MTC care the 'Injured Patient Pathway' should be followed and the patient discussed with the TTL at the MTC** - Complete secondary survey and further treatments - Antibiotics / tetanus given. - Further imaging undertaken, e.g., limbs. - Tertiary specialist involvement, e.g., ENT, Max fax - Disposition / transition plan made
Within 90 minutes	- Transition to final destination

Secondary Transfer from a TU/LEH to the MTC

Patients who have been conveyed from the scene of an incident to a Trauma Unit or Local Emergency Hospital (or who have self-presented at one of those sites) may need to be transferred to an MTC for definitive treatment depending on the severity of their injuries.

The Network's secondary transfer protocol which is set out in the **GM MTN Adult Major Trauma Patient Pathways and Transfer Policy** should be used to assist decision making in these situations. There are two principal types of secondary transfer:

1. Pit Stop Pathway:

- When a patient is injured and presents with unmanageable airway, unmanageable breathing, or unmanageable catastrophic haemorrhage, NWAS will convey to the nearest MTC or TU. This includes patients in Traumatic Cardiac Arrest (TCA).
- When the receiving site is a TU, this should be considered an initial 'pit stop' where the patient is stabilised for onward transfer to the MTC. This will also apply to local emergency hospitals for patients who have self-presented.
- The Pit Stop pathway provides guidance in this situation.
- Management of pit stop patients should be limited to rapid investigation and interventions that will maximise stabilisation with the aim of **rapid transfer** onwards to the MTC for definitive treatment.

2. Urgent secondary transfer: The Injured Patient Pathway

- In Greater Manchester the most common occurring scenario requiring secondary transfer is when a patient has been conveyed to a TU/LEH because the pathfinder has not been triggered at the scene ***(trauma triage negative*)**, or the patient has **self-presented** at a TU or LEH.
- The intention of the Injured Patient Pathway is to support decision making and liaison with the MTC in this situation.
- The pathway provides guidance on patients with a clinical diagnosis of major trauma, those who should be 'fast tracked' to the MTC (see overleaf), and those who require further investigation.

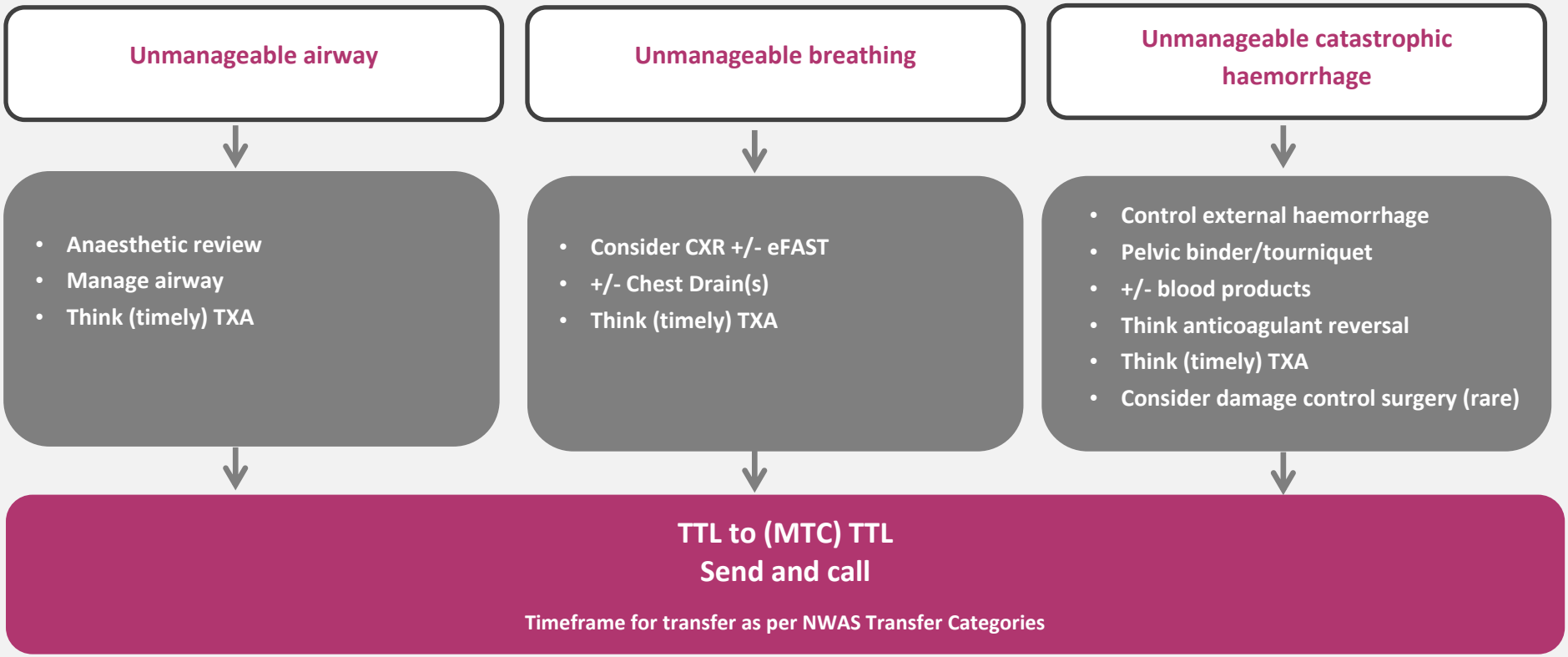
Pit Stop at Trauma Unit

(NWAS Triage Positive for Major Trauma Pathfinder)

For patients who require life-saving intervention prior to ongoing transfer to MTC
This includes patients in TRAUMATIC CARDIAC ARREST

RED STANDBY MAJOR TRAUMA 'PIT STOP' CALL TO TRAUMA UNIT

Where possible, request that crew remain with patient to complete pit stop and continue transfer to MTC



If in doubt about whether to transfer, liaise with the MTC TTL (SRH: 0161 206 2226 / MRI: 0161 276 4012)

If you have concerns about the timeframe for transfer, liaise with MTC TTL and Complex Incident Hub (formally Trauma cell) (0161 227 7011)

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The Injured Patient Pathway

For pre-hospital pathway TRIAGE NEGATIVE or self-presenting patients

'Fast track' Criteria	
Head injured patients aged 70 or under **≤70 yrs**	Intubated **AND** abnormal scan, **OR** Extra-dural haematoma: >15mm thickness or >5mm midline shift, **OR** **Acute** subdural haematoma: >10mm thickness or >5mm midline shift
Head injured patients over 70 **>70 yrs**	GCS > 8 **AND** living independently, **AND** One of the following: - Extradural haematoma >15mm thickness or >5mm midline shift - **Acute** subdural haematoma > 10mm thickness or >5mm midline shift
Spinal Injuries	Spinal injuries with hard motor neurology

For catastrophic injuries (unmanageable: airway, breathing, or catastrophic haemorrhage) including traumatic cardiac arrest (TCA), go to PIT STOP guidance

Is there a clinical diagnosis of major trauma? One or more of the following:

- Flail chest
- Penetrating trauma to neck, trunk or limbs proximal to elbow/knee **(discuss with MRI)**
- Fractures to two or more long bones (humerus / femur)
- Amputation proximal to wrist / ankle
- Open lower limb fracture
- Ischaemic limbs – post manipulation **(discuss with MRI)**
- Suspected spinal injury with new onset motor deficit **(discuss with SRH)**
- Head Injury with GCS 12 or less or penetrating trauma to the head **(discuss with SRH)**

YES

NO

Does the patient meet 'fast track' criteria?

YES

NO

Diagnostics

Positive radiological findings for **MAJOR** trauma?

YES

NO

Contact MTC TTL

TTL-TTL discussion / decision regarding management plan

SRH: 0161 206 2226 / 206 5354
MRI: 0161 276 4012

TTL to TTL
Send and call

NWAS transfer to MTC within appropriate timeframe

(See NWAS Transfer categories)

Agreed that patient requires MTC care?

YES

NO

MTC

Treat / admit locally

If conveyed by NWAS, ambulance crew must alert triage clinician of any previous CIH discussion.

Think TXA

Think anticoagulant reversal

Frailty/futility: Discuss with MTC – will the patient benefit from transfer?

AS A MINIMUM:

1. Patients should be booked into receiving hospital
2. Primary set of observations recorded
3. Review by senior ED clinician

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There will be automatic acceptance to the MTCC for patients who meet any of the criteria detailed below. These patients should be transferred under the TTL-to-TTL process of **'send and call'**.

'Fast track' Criteria	
'Pit stop' patients	Patients who have presented at the TU with catastrophic injuries: - Unmanageable airway - Unmanageable breathing - Unmanageable catastrophic haemorrhage
Head injured patients 70 years of age or under **≤70 yrs.**	Intubated **AND** abnormal scan, **OR** Extra-Dural haematoma: >15mm thickness or >5mm midline shift, **OR** **Acute** subdural haematoma: >10mm thickness or >5mm midline shift
Head injured patients over 70 years of age. **>70 yrs.**	GCS > 8 **AND** Living independently, **AND** One of the following: - Extradural haematoma >15mm thickness or >5mm midline shift - **Acute** subdural haematoma > 10mm thickness or >5mm midline shift
Spinal Injuries	Spinal injuries with hard motor neurology

Activate TTL to TTL referral process – send and call.

MRI: 0161 276 4012 SRH: 0161 206 2226/5354

Before onward transfer to the MTCC, the following minimum requirements of care are necessary:

- Patients should be booked into the initial receiving hospital
- A primary set of observations should be recorded
- A review by a senior clinician/decision maker should take place

Please also think about the following:

- TXA
- Anti-coagulant reversal
- Frailty / futility – discuss with the MTCC – will the patient benefit from transfer?

Management of Major Haemorrhage in Trauma (Adult)

Site _____

Number to activate the MH pathway at this site _____

For further details, please refer to Trust MH policy/guidelines

Recognise
Major Haemorrhage

Estimated Blood Loss:
- Blood loss of 150ml/min [B]

Haemodynamic Parameters:
- Bleeding with a heart rate of >110 beats/min and/or systolic blood pressure <90mmHg [B] *or*
- Confirmed (or suspected) traumatic blood loss in the context of haemodynamic instability [B]

Activate the MH Pathway
Call for senior help

Activate the Major Haemorrhage Pathway and order Major Haemorrhage Pack 1
- Provide laboratory with patient information and a direct contact telephone number
- Note down the dedicated telephone number the laboratory will provide for ongoing communication _____

Assign team roles including communication lead
Involve consultant for ED, contact surgeons, anaesthetists and other relevant specialities

Monitor and Correct
- Monitor for hyperkalaemia
- Correct hypothermia (aim >36°C)
- Correct hypocalcaemia (Ca^{2+}>1.13mmol/L ionised)
- Aim to keep pH >7.35

Secure IV access
Send baseline bloods

Take bloods urgently and send to the laboratory [A, B]:
- ☐ Pre-transfusion crossmatch sample
- ☐ Full blood count (FBC)
- ☐ Coagulation screen*: PT, APTT, Clauss fibrinogen (plus PT/APTT ratios if available)
- ☐ Biochemistry including renal (U+Es), liver and bone profiles
- ☐ Send a second pre-transfusion transfusion sample when able to do so if no historical group

Near patient testing *if available*:
- ☐ TEG / ROTEM
- ☐ Arterial blood gas (for pH, lactate, base excess, potassium and ionised calcium)

TXA
Anticoagulant reversal

- ☐ Confirm tranexamic acid (TXA) bolus administered by paramedic
- ☐ If not, give **TXA 1g IV over 10 minutes immediately** (must be within 3 hours of injury)
- ☐ **Follow the TXA bolus by a 1g infusion over 8 hours**

If patient on warfarin, give prothrombin complex concentrate (PCC) and 5mg IV vitamin K
Urgently contact haematologist if on other anticoagulants e.g. DOACs (direct oral anticoagulants)

Transfuse and Monitor
Aim for Hb >80g/L

Keep the patient warm and use blood warmer

Location of emergency O negative blood:

_____

Contact Haematologist if uncontrolled, prolonged haemorrhage

Use emergency O negative blood in nearest fridge if blood is required immediately

Transfuse Major Haemorrhage Pack 1 (Minimum of 4 red cell units and 4 FFP units)
Aim to maintain a packed red cell: plasma transfusion ratio of 1:1 for traumatic haemorrhage [B]
Use pre-thawed FFP in MH Pack 1 where available
Laboratories may provide group O positive red cells for males over 18 and women of non-child bearing potential (over 50 years) where suitable, change to group specific when able to do so [C]
If ongoing haemorrhage, order MH Pack 2 (do not wait until the end of Pack 1 to order)

Re-check FBC, coagulation screen*, U+Es, Ca^{2+} and TEG/ROTEM between each pack or at least hourly
Tailor component transfusion when blood results become available, see 'Aims for Therapy' below

Transfuse Major Haemorrhage Pack 2 (Minimum of 4 red cell units, 4 FFP units and 1 dose of platelets)
Consider cryoprecipitate to maintain fibrinogen >1.5g/L* or as guided by TEG/ROTEM

Until bleeding ceases, continue regular blood monitoring**,** repeat **and tailor** MH Pack 2 (aims below)

Stand down
Contact the laboratory to confirm **stand down** when reached, **document** and **debrief**

Limit Blood Loss
Consider, *where appropriate*:
- Direct pressure/ tourniquet use [A]
- Topical haemostatic agents [A]
- Pelvic binder if suspected fracture [A]
- Early surgical intervention
- Cell salvage

1 unit of red cells = c.250mls of salvaged blood

Aims for Therapy

Haemoglobin 80-100g/L	**If haemoglobin falling - give red cells**
Platelets >75x10^9/L	**If <75x10^9/L - give 1 adult dose (order if <100x10^9/L)** *Maintain platelets >100x10^9/L if a total brain injury (TBI) and consider increasing platelet threshold to >100x10^9/L for ongoing haemorrhage [A]*
PT/APTT ratio <1.5	**If >1.5 - give FFP (15-20mls/kg)**
Fibrinogen >1.5g/L*	**If <1.5g/L* - give cryoprecipitate (2 pools)** **Maintain a fibrinogen >2.0g/L in pregnancy*

[A] Spahn et al. The European guideline on management of major bleeding and coagulopathy following major bleeding and coagulopathy following trauma: fifth edition. Critical Care (2019) 23:98, [B] Hunt et al. A practical guideline for the haematological management of major haemorrhage. British Journal of Haematology (2015) 170, 788-803, [C] National Blood Transfusion Committee (2019) The appropriate use of O negative red cells. https://www.transfusionguidelines.org/document-library/documents/nbtc-appropriate-use-of-group-o-d-negative-red-cells-final-pdf (last accessed: 17th Jan 2020)

Guidance on Adult Trauma CT

CT is recommended as the investigation of choice in The Royal College of Radiologists document,

Royal College of Radiologists:

Major adult trauma radiology guidance (2024)

The aim of this protocol is:

- To appropriately triage trauma patients, rapidly identifying those patients fulfilling the criteria for trauma whole body CT (WBCT).
- To effect CT scanning in **30 minutes or under** following arrival in resus
- To provide standardised processes for preparation and transfer to CT
- To establish a standard scan protocol and reporting priorities.

1. Patient selection

Any patient who triggers a 'major trauma activation' should receive a CT. The target for 'time to CT' is 30 minutes from arrival in resus. Each site should have local arrangements in place to achieve this target.

Where this is not achieved (whether because of clinical/medical issues or process delay) an exception reason should be recorded and should form part of the review at the daily trauma MDT.

Indications for whole body CT are detailed below:

Indications for immediate WBCT scan in Trauma[2]

A: High Risk Mechanism	B: Anatomical	C: Physiological
RTC with death of another passenger in the same vehicle	Visible injury to > 2 body regions: ▪ Head ▪ Neck ▪ Chest ▪ Abdomen ▪ Pelvis ▪ Long bones	GCS < 12 ▪ or intubated ▪ or surgical airway
RTC with ejection of casualty from vehicle	Hard signs of vascular injury ▪ Expanding haematoma ▪ Deep laceration over arterial course	Systolic BP < 90 mmHg in the ED
RTC with prolonged extrication (> 15 minutes) of casualty from vehicle	Hard signs of spinal cord injury	Respiratory rate < 10 or > 30 per minute
Pedestrian / Cyclist / Motorcyclist versus Vehicle		Pulse > 120bpm in the ED
Fall > 2 metres / flight of stairs		Age > 65 years
		Warfarinised patient
Use clinical judgment for patients with crushed, mangled or degloved extremities, amputation of limb proximal to wrist or ankle and stab wounds		
Whole body CT is indicated emergently for 1 or more criteria from 2 separate categories **OR** **Where the patient DOES NOT meet guideline indications for WBCT but there is sufficient clinical concern from the trauma lead**		

Clinical judgment is still required in the sensible application of this triage system e.g., targeted CT of head and neck will be more appropriate in certain low energy traumas (GCS <9 following single punch etc.)

The trauma team leader may additionally request WBCT at his/her discretion where there is sufficient clinical concern.

Patients who do not meet guideline indications should have targeted CT.

[2] Harvey JJ, West ATH (2013) (Clin Rad 68: 871-886)

2. Preparation for CT

- Secure airway and spinal immobilisation.
- Exclusion of all immediate life-threatening presentations requiring immediate interventions.
- Vascular access (R ante cubital fossa if possible).
- Pelvic splint, where appropriate. Record if splint in situ.
- Limb conserving splintage.
- Urinary catheter (so long as it does not delay access to CT scan or suspicion of significant pelvic #).
- (FAST – in the unstable patient, **IF** it can be performed without causing **ANY** delay in transferring to CT, **OR** if patient cannot be stabilised sufficiently for transfer to CT).
- Ensure appropriately trained escort and adequate monitoring is in place.
- Ensure emergency equipment/drugs/blood products are conveyed with patient if necessary.

Decision-making regarding 'stability' for transfer from ED to other clinical areas (e.g., CT) can be difficult. Consider what is needed, priorities for transfer and risks versus benefits.

CT has become the gold standard for the secondary survey of the head, neck, and trunk.

1. CT should be obtained as soon as possible, ideally within 30 minutes after arrival in ED.
2. Radiographer activates Major Trauma CT protocol.
3. If a patient with **SBP<90 mmHg** is to go to CT, this must be agreed between the anaesthetist and trauma team leader.
4. Patients with **SBP 70-90 mmHg** may benefit from the diagnostic accuracy of a scan but the decision is difficult:
    a. If high volumes of blood products are needed to maintain this BP a CT may not be safe.
    b. Consultant anaesthetist must be aware.
    c. If intra-abdominal bleeding suspected, Consultant General Surgeon must be aware.
    d. Trauma team should accompany patient to CT.
5. Patients with **SBP<70 mmHg** should probably go to theatre, not CT.
6. Trauma CT should be vertex to symphysis pubis in the absence of limb injuries. If limb injuries are present the CT must include the full limb/s inclusive of the arterial phase.
7. Move the arms to give optimal images whenever an option between the head and body scans.
8. IV contrast to be used unless contraindication e.g., allergy.
9. Oral contrast delays immediate scans so have limited role in emergency trauma CT.
10. Peripheral injuries e.g., plateau fractures **may** be scanned at the same time if the patient is fit enough. This is a decision to be made by trauma team leader, radiologist and orthopaedic registrar and will only take place if the patient is stable enough.
11. Resuscitation continues during CT, take blood products to CT if relevant and continue to monitor and warm the patient throughout.
12. Transfer using scoop stretcher / trauma board if any chance of pelvic fractures. The scoop/board can facilitate easy transfer of the patient and can be used in the CT scanner.
13. The scribe should move to CT with the team and observations continued on the trauma sheet with timings of key events documented.

The ultimate decision on scanning is with the Trauma Team Leader, in consultation with anaesthetist and specialty consultants.

3. Report

- A ‘hot’ report should be available and issued to the TTL immediately (within 5 minutes)
- A detailed radiological report should be available within 1 hour.
- Scans should be reported by a consultant radiologist within 24 hours.
- Consultant Radiologist review within 1 hour or sooner if any concern regarding Registrar report.

For Trauma Units and Local Emergency Hospitals:

Positive radiological findings for MAJOR trauma should be discussed with the appropriate MTC TTL utilising The Injured Patient Pathway.

The Trauma Unit Standards (March 2021) outline the requirement for imaging in patients that sustain traumatic injury. There are no published standards for Local Emergency Hospitals, but alignment with the below is recommended:

T20-2B-308 There is 24/7 CT scanning and reporting.

There should be CT scanning available within 60 minutes of the trauma team activation.

Reporting should include:

- a ‘hot’ report documented within 30 minutes for both CT and MRI.
- a detailed radiological report documented within 1 hour from the start of the scan.
- a report by a consultant radiologist within 24 hours.

Vascular Interventional Radiology

Key Points

The role of vascular interventional radiology (VIR) in major trauma is to stop haemorrhage as quickly as possible with minimal interference as part of damage control resuscitation (DCS). Information supplied by the head to pelvis CT scan is key to informing the decision-making process.

The Royal College of Radiology 'Major adult trauma radiology guidance' (June 2024) states that interventional radiology (IR) trauma teams should endeavour to begin treatment within 30 minutes of referral (Standard 14). rcr-major-adult-trauma-guidance-2024.pdf

- Trauma team leaders should be aware of possible indications for IR in trauma as detailed in the table below.[3]
- Decisions on the use of IR should be made in conjunction with a senior clinician from the appropriate specialty.

Site	Non-operative management (NOM)	Vascular Interventional radiology (VIR)	Damage Control Surgery (DCS)
Thoracic aorta	Grade I aortic injury Selected minimal aortic injuries	Stent graft for suitable lesions	Ascending aortic injury or arch injury involving great vessels
Abdominal aorta	Grade I aortic injury Selected minimal aortic injuries	Occlusion balloon Stent graft	Injury requiring visceral revascularisation or untreatable by EVAR
Peripheral/ branch artery	No active bleed Small bleed liable to tamponade	Occlusion balloon Stent graft Embolisation of bleeders	Any lesion which cannot rapidly be controlled, or which will require other revascularisation
Kidney	Contained Subcapsular/ retroperitoneal bleed Active bleed felt likely to tamponade	Embolisation Stent graft	Renal injury in association with multiple other bleeding sites or other injuries requiring urgent surgery
Spleen	Lacerations, haematoma without active bleeding or evidence of false aneurysm	Active arterial bleeding or false aneurysm Focal embolisation for focal lesion Proximal embolisation for diffuse injury	Packing or splenectomy for active bleeding in association with multiple other bleeding sites
Liver	Subcapsular or intraperitoneal haematoma or lacerations without active arterial bleeding	Active arterial bleeding Focal embolisation if possible Non-selective embolisation if multiple bleeding sites as long as portal vein is patent	Packing if emergency laparotomy needed with subsequent repeat CT and embolisation if required.
Pelvis	Minor injury with no active bleeding	Embolisation (IIA versus selective) for arterial injury	External compression and subsequent fixation if bleeding from veins or bones
Intestine	Focal contusion with no evidence of ischaemia, perforation, or haemorrhage	Focal bleeding with no evidence of ischaemia or perforation can be embolised. Occlusion balloon for damage control	Ischaemia or perforation requiring laparotomy +/- bowel resection

[3] Original table courtesy of East of England Trauma Network

1. Indications for Vascular Interventional Radiology (VIR)

1.1. The commonest indications for VIR in Trauma are:

- Pelvic haemorrhage due to pelvic fracture
- Haemorrhage due to visceral trauma (spleen, liver, kidney)
- Thoracic aortic transection

1.2. Following CT scan, the requirement for radiological intervention, as opposed to surgical intervention or conservative management, must be agreed by discussion between the IR and relevant surgical team(s).

2. Vascular Radiology Emergency Service

2.1. VIR services are based at MFT. VIRs will travel to Salford when required to provide a service there (in the event of the patient being too unstable for transfer and non-aortic pathology).

2.2. During working hours MRI and Salford are covered by the MFT VIR service. **Contact the VIR 09:00-17:00 on (0161) 2768588.**

2.3. Out-of-hours: All sites will be covered by the on-call VIR. Contact is through MFT on-call via MFT **switchboard (0161) 2761234.**

3. MTC personnel and equipment

3.1. MRI and Salford are equipped with suitable angiographic facilities and sufficient consumable stock to cover predictable emergency requirements**,** including a range of catheters, microcatheters, appropriate guidewires, embolic material, and peripheral covered stents.

3.2. Both sites will provide an on-call angiography radiographer.

3.3. Both sites will make arrangements for provision of adequate nursing staff out-of-hours to ensure a suitable level of patient care. The angiography rooms are remote from both A&E departments and emergency theatres, therefore major cases need to be accompanied by appropriate medical staff (A&E staff or anaesthetists) to continue resuscitation during IR procedure. Suitable theatre space is available at SRH if required.

3.4. Stent grafts for thoracic trauma are stored in MRI.

4. Patient pathway:

4.1. The decision to contact VIR will usually be based on the clinical findings/CT appearances.

4.2. VIR will only be required in a small proportion of major trauma cases; therefore, it is impractical to call VIR prior to scanning in most cases.

4.3. In the event of a patient warranting intervention and the CT scan showing a lesion suitable for treatment by VIR, the clinical team will contact the consultant Interventional Radiologist (IR). Once the decision to proceed has been made, the clinical team will call the angiography radiographer and arrange for transfer of the patient to the angiography room.

4.4. The angiography radiographer should be called in at the same time as the IR, to avoid delay.

Vascular Injuries

Patients should be assessed in line with ATLS principles with the understanding that catastrophic haemorrhage needs addressing immediately and as a priority action.

For MTCs this may mean the immediate involvement of a vascular surgeon, for Trauma Units this may indicate the need for immediate damage control surgery.

In the UK, vascular trauma remains a low percentage of the injuries seen secondary to trauma[4.] Despite this low incidence, associated mortality and morbidity are high as untreated injuries can either bleed, leading to exsanguination, or occlude, causing distal ischaemia.

Hard signs of vascular injury that require emergency surgery.

- Active haemorrhage
- External pulsatile bleeding
- Distal ischaemia (pain, pallor, paralysis, paraesthesia, perishingly cold) in the absence of a dislocated peripheral joint
- Expanding haematoma with signs of vascular compromise
- Loss of distal pulses (or above neurovascular signs) following relocation of the joint

Consider prompt discussion with a vascular surgeon with any clinical concerns.

CT angiography is the primary diagnostic study in a major trauma patient with a suspected vascular injury. This should be performed as soon as possible.

For patients with limb ischaemia secondary to displaced, angulated long bone fractures and / or joint:

Dislocations e.g., knee or ankle dislocation, mid shaft femoral or supracondylar humeral fracture, should have the injury realigned or relocated as quickly as possible. This will require appropriate analgesia with neurological and vascular examination documented both before and after any manipulation[5].

For patients that present with limb dislocation (and associated vascular compromise), attempts should be made to relocate the limb in an attempt to restore normal perfusion.

This should take place at ANY receiving site.

Further guidance:
BOAST - Diagnosis & Management of Arterial Injuries Associated with Extremity Fractures and Dislocations

[4] Perkins ZB, De'Ath HD, Aylwin C, Brohi K, Walsh M, Tai NRM. Epidemiology and Outcome of Vascular Trauma at a British Major Trauma Centre. European Journal of Vascular and Endovascular Surgery. 2012; 44 (2): 203-209

[5] NICE guideline (ng39) Major Trauma: assessment and initial management (2016) Major trauma: assessment and initial management (nice.org.uk)

Guidelines on requesting a Vascular Surgery Opinion

Control of haemorrhage is part of general surgical skill set, vascular surgeons repair vessels.

MAJOR VESSEL INJURY REQUIRING REPAIR WILL USUALLY BE ASSOCIATED WITH:

- Ongoing significant haemorrhage (visible blood, tachycardia, hypotension) **and/or**
- Limb ischaemia (pale, cold, painful, weak, or numb leg, no pulses)

Ischaemia

- Hypotension and stress response will shorten tissue tolerance of ischaemia.
- May occur with open or closed injury mechanisms.

Haemorrhage

- May stop rapidly due to arterial spasm, look for associated ischaemia.
- Major venous just as dangerous as arterial.

Information to have when contacting vascular surgeons:

- Mechanism of injury
- Time since injury
- Site of injury
- Appearance/examination of both sides
- Haemodynamic status of patient including blood loss at scene

- MFT (MRI) is the designated Vascular Hub for GM and provides 24/7 vascular surgery cover at Consultant and SpR grade, with access to Hybrid theatres.
- The GM supplementary pathfinder aims to identify patients with injuries that may involve a vascular element at scene (thoraco-abdominal and penetrating injuries) and convey them to MRI.
- Patients that are conveyed to or self-present at SRH should access the vascular service at MRI through the SRH Trauma Team:
    - If the patient does not have head or spinal injuries and is stable enough to travel, they should be transferred to MRI.
    - If the patient has multiple injuries including serious head and/or spinal injuries, the vascular service will attend at SRH (within 30 minutes of request by the TTL)
- Amputation in acute phase emergency for life saving scenario only.
- Decision on limb salvage is across vascular, neurological, and musculoskeletal damage, if 2 of 3 are unsalvageable then subsequent amputation will probably be required, case by case decision between teams
- Amputation performed at most distal level that will heal to preserve maximum function for prosthetic mobilisation

Contact MFT Vascular Team via switchboard: 0161 276 1234

Acute Airway Management in the Major Trauma Patient: Summary

Anaesthetists should be **routinely called as part of the trauma team** when the local trauma team leader receives an ambulance pre-alert for a patient with significant traumatic mechanism, injuries, signs, or symptoms, or if significant pre-hospital interventions have been required.

- The trauma team leader should perform a team briefing before arrival of the patient so that the need for intervention can be anticipated, equipment prepared, and roles allocated.

- The anaesthetist's plan of action in the case of failed intubation and oxygenation should be verbalised as part of the pre-induction checklist. This is likely to include use of a supraglottic airway device followed by front of neck access as per Difficult Airway Society (DAS) guidelines.

- All equipment required for airway management should be checked on a regular basis as per local guidelines and form part of the daily checklists in the Emergency Department.

- Video laryngoscopy is recommended as the first line technique for trauma patients requiring anaesthesia in the emergency department.

- Preparation of medications including those for paralysing and sedation are the responsibility of the anaesthetic team. Availability and use of pre-drawn anaesthetic drugs is recommended to reduce the potential for error, and to streamline the preparation for delivery of anaesthesia.

- During the hours of 0800-2000 Monday - Friday a consultant anaesthetist should be immediately available to support trainees attending major trauma patients and should ideally be part of the trauma team.

- The on-call consultant anaesthetist should be contacted at the earliest opportunity at times when they are not on site, if difficulty in airway management is predicted, or if operative intervention and/or interhospital transfer is likely to be required.

- All airway practitioners must be capable of performing a cricothyroidotomy.

Anaesthesia Management in the Major Trauma Patient

Scope

This guideline addresses a number of points pertinent to the delivery of anaesthetic services for major trauma patients in the Major Trauma Centres (MTCs), surrounding Trauma Units (TUs) and Local Emergency Hospitals (LEHs). Anaesthesia for major trauma patients is delivered and continued at a number of points in the patient journey, from the emergency department to the operating theatre, interventional radiology suite, intensive care unit and at all times in between, including during inter-hospital transfers. The scope of this guideline ends at the point care is transferred from the anaesthetist to the staff on the intensive care unit or hospital ward.

Since it is envisaged that anaesthetists will be involved in the reception and resuscitation of the most unstable trauma patients, this guideline includes general points on trauma resuscitation that may be of use to the wider trauma team.

1. Staff, training, and supervision

2. Practice of anaesthesia
   - Indications and preparation
   - Physiology
   - Pharmacology
   - Airway Management

3. Definitive interventions

Emergency Anaesthesia – Overview

Assess

- ATMIST report and AMPLE history
- Anticipated airway difficulties
- Indications for anaesthesia in trauma patients
    - Actual or impending airway compromise
    - Failure of ventilation
    - Reduced GCS with failure of airway protection +/- neuroprotection
    - Anticipated clinical course
    - Humanitarian reasons
- Ensure consultant support is available if required
- Ensure skilled assistance is present

Stabilise

- Use of Rapid Sequence Induction (RSI) checklist, 2020-B@Ease-Checklist.pdf (gmccmt.org.uk)
- Consider pre-anaesthetic sedation to facilitate pre-oxygenation and adequate monitoring/IV access
- Anaesthetic drug regimen
    - Ketamine 1-2mg/kg
    - Fentanyl 1-3mcg/kg if appropriate
    - Rocuronium 1mg/kg
- Ensure adequate post intubation sedation and analgesia
- Consider neuroprotective positioning and ventilation
- Ensure significant external haemorrhage is controlled before induction of anaesthesia. If required, long bone fractures and the pelvis should be splinted as soon as possible

Refer

- TU/LEH TTL to MTC TTL referral and automatic acceptance criteria
- Consider need for emergency surgery/haemorrhage control at TU - discuss with MTC TTL
- Isolated penetrating thoracic injuries should be referred directly to Manchester Royal Infirmary cardiothoracic team
- **Patients should leave the emergency department within 30 minutes of decision to transfer**

Transfer

- Appropriately trained and experienced anaesthetist should accompany anaesthetised trauma patients (typically ST4+) with trained skilled assistant
- Ensure adequate supplies of oxygen, infusions and blood if required
- Complete the network transfer documentation and ensure it is returned to the Critical Care Network office
- **Spend only enough time to give lifesaving interventions at the trauma unit/local emergency hospital to allow transfer of patients for definitive treatment.**

1. Staff, training, and supervision

1.1. Major trauma patients arriving in the ED of MTCs and TUs should be met by a multidisciplinary team 24/7. An anaesthetist with appropriate airway and damage control resuscitation competencies to manage trauma patients should be part of this team.[6]

1.2. A dedicated, skilled anaesthetic assistant should be available in all locations outside the operating theatre where anaesthesia is undertaken by an anaesthetist - this is best achieved by routinely including an anaesthetic practitioner as part of the trauma team.[4, 7]

1.3. In regional major trauma centres, during the hours of 0800-2000 Monday - Friday a consultant anaesthetist should be immediately available to support trainees attending major trauma patients and should ideally be part of the trauma team. In trauma units, consultant support should be made available from a pre-defined area, e.g., ICU or the emergency/CEPOD theatre.

1.4. The on-call consultant anaesthetist should be contacted at the earliest opportunity at times when they are not on site, if difficulty in airway management is predicted, if operative intervention or interventional radiology is required, and/or interhospital transfer is likely to be required.

1.5. Familiarity with the principles of ATLS and how they are adapted for use by UK trauma teams is necessary to be part of a trauma team. This may be achieved by attending national courses including ATLS, ETC, and ATACC, in addition to local training opportunities and ongoing updates.

1.6. Local arrangements for management of major trauma must be covered as part of the departmental induction for trainees, with reference to this and any other local guidelines.

1.7. Involvement in care of a major trauma patient, whether directly or indirectly supervised, should be used as a learning opportunity. This may be achieved by the use of formative assessment tools with supervising consultants, the trauma team leader, or the departmental trauma lead.

1.8. Wherever possible multidisciplinary in-situ simulation of trauma management should be undertaken on a regular basis. This enables team members to gain experience, whilst also providing the opportunity to develop and improve local practice. Learning points from such sessions should be shared locally.

2. Practice of anaesthesia

2.1. **Indications and preparation:**

2.1.1. The indications for anaesthesia in the emergency department can be summarised as follows:

- Airway compromise (actual or impending).

[6] Guidelines for the Provision of Anaesthetic Services, Chapter 16: Guidelines for the Provision of Anaesthesia Services for Trauma and Orthopaedic Surgery 2023. Royal College of Anaesthetists

[7] Guidelines for the Provision of Anaesthetic Services, Chapter 5: Guidelines for the Provision of Emergency Anaesthesia Services 2023. Royal College of Anaesthetists

- Failure of ventilation, e.g., flail chest, pulmonary contusions with refractory hypoxia.
- Reduced conscious level, including patients who are agitated following head injury and require anaesthesia to facilitate investigations.
- Anticipated clinical course, e.g., clear requirement for urgent surgery.
- Humanitarian reasons, e.g., severe burns.

2.1.2. The anaesthetist attending a trauma call should make themselves known to the trauma team leader. It is expected that the role of the anaesthetist will be assessment and management of the airway, but at times other roles may be allocated depending on staffing levels and individual patient requirements.

2.1.3. The trauma team leader should perform a team briefing before arrival of the patient so that the need for intervention can be anticipated, equipment prepared, and roles allocated.

2.1.4. Anaesthetists of all grades (including consultant) should call for help from colleagues early if required, particularly if airway management is difficult or if the patient is extremely unstable.

2.1.5. All team members, including anaesthetists, should pay close attention to the handover from pre-hospital staff so that important information is not missed. The concept of the "hands off handover" is useful to reinforce this requirement.

2.1.6. If possible, an AMPLE [8] history should be obtained from the patient, paramedics, or relatives as part of the primary survey. This, along with the ATMIST[9] handover, will form the majority of the emergency anaesthetic assessment.

2.1.7. If anaesthetic intervention is required, this should be communicated early to the trauma team leader.

2.1.8. Use of a pre-induction checklist (e.g., the B@EASE checklist) is encouraged when preparing for induction of anaesthesia in the emergency department to identify potential omissions, and to ensure all team members are fully aware of plans for the loss of ability to oxygenate the patient.

2.1.9. The following roles should be allocated before induction of anaesthesia:

- Laryngoscopy
- Manual-in line stabilisation of cervical spine
- Cricoid pressure/ external laryngeal manipulation and passing of airway equipment.
- Drug administration - may be carried out by intubating anaesthetist, TTL, second anaesthetist, or another individual with appropriate briefing.

[8] **A**llergies **M**edications **P**ast medical history **L**ast ate **E**vents leading to admission.
[9] **A**ge **T**ime of incident **M**echanism **I**njuries **S**igns/symptoms **T**reatment

2.2. **Physiology**

2.2.1. Patients may exhibit relatively normal physiology despite severe injury. A high index of suspicion should be maintained. The classic ATLS grading of shock is not supported by evidence[10] and has been removed from the most recent (10th) edition of ATLS. Patients may appear to be haemodynamically stable despite having ongoing haemorrhage.

2.2.2. Crystalloid should be withheld in trauma patients except when used to maintain patency of intravenous access or for dilution of drugs.

2.2.3. Haemorrhagic shock should be treated with blood and blood products according to local major haemorrhage protocols. Permissive hypotension should be used, targeting a systolic blood pressure of 80mmHg or presence of a radial pulse. Consideration should be given to increasing the blood pressure after approximately 1 hour of relative hypotension ("novel hybrid resuscitation").[8]

2.2.4. In patients with both traumatic brain injury and ongoing haemorrhage, the target for systolic blood pressure can be increased to 100mmHg.

2.2.5. Monitoring of physiological parameters should be according to AAGBI guidelines for minimal monitoring standards at all times.[11]

2.2.6. Early arterial blood gas analysis is recommended following intubation to enable assessment of gradient between $PaCO_2$ and $PACO_2$. This is likely to be high – recent evidence suggests average gradients of 1.7-2kPa.[12] [13]

2.3. **Pharmacology**

2.3.1. Ketamine is recommended as the most appropriate agent for induction of anaesthesia in patients who have experienced major trauma. Its main advantage is that of cardiovascular stability and maintenance of normotension. Avoidance of hypotension is especially critical in head injured patients, as hypotension has been shown to increase mortality. [14]

2.3.2. The traditional agent of choice for rapid sequence induction of anaesthesia is thiopentone. Due to its tendency to cause hypotension due to vasodilatation it is not appropriate to use in patients who may have ongoing haemorrhage.

[10] Sharrock, A, & Midwinter, M (2013). Damage control – trauma care in the first hour and beyond: a clinical review of relevant developments in the field of trauma care. Annals of the Royal College of Surgeons of England, 95 (3), 177-183

[11] http://www.aagbi.org/sites/default/files/Standards_of_monitoring_2015_0.pdf

[12] Hibberd, Owen, et al. "The PaCO2-ETCO2 gradient in pre-hospital intubations of all aetiologies from a single UK helicopter emergency medicine service 2015–2018." *Journal of the Intensive Care Society* 23.1 (2022): 11-19.

[13] Price, James, et al. "End-tidal and arterial carbon dioxide gradient in serious traumatic brain injury after prehospital emergency anaesthesia: a retrospective observational study." *Emergency Medicine Journal* 37.11 (2020): 674-679.

[14] Spaite DW, Hu C, Bobrow BJ, et al. Mortality and Prehospital Blood Pressure in Patients with Major Traumatic Brain Injury: Implications for the Hypotension Threshold. *JAMA Surg.* 2017;152(4):360–368.

2.3.3. Fears that ketamine may increase intracranial pressure have been shown to be unfounded, and evidence suggests that it is effective in maintaining or improving cerebral perfusion pressure in patients with intracranial hypertension.[15]

2.3.4. The following drugs and doses are recommended for induction of anaesthesia in trauma patients. Use of alternative agents is at the discretion of the anaesthetist, bearing in mind the risk of precipitating cardiac arrest if agents known to cause or exacerbate hypotension are used in hypovolaemic patients. A normal pulse and blood pressure does not exclude the presence of haemorrhage.

Ketamine 1-2mg kg^{-3}	Lower dosing recommended in unstable patients
Fentanyl 1-3 micrograms kg^{3}	Consider use in patients with head injury to obtund increase in intracranial pressure at laryngoscopy. Higher doses may cause or exacerbate hypotension
Rocuronium 1mg kg^{3}	

2.3.5. Use of rocuronium is recommended since there is usually not an option of waking up trauma patients who require urgent anaesthesia.
Doses of 1.5mg/kg may result in more reliable rapid onset paralysis, particularly in shock states.[16] [17]

2.3.6. Small boluses of ketamine (10 - 20mg) may be titrated to allow adequate pre-oxygenation of agitated or combative patients requiring anaesthesia.

2.3.7. In the initial management of trauma patients' vasopressors such as metaraminol should be avoided due to the risk of worsening peripheral vasoconstriction, increasing tissue hypoperfusion and exacerbating acidosis. Hypotension should be treated as haemorrhage until proven otherwise. However, following RSI it is recognised that small doses may be required to counter the effects of anaesthesia or to increase the mean arterial pressure in patients with head injuries.

2.3.8. Ongoing sedation and analgesia should be prepared before the process of anaesthesia begins or delegated to staff not involved in care of the patient being anaesthetised. Infusion of propofol and an opiate is a well understood and safe method, although careful boluses of analgesic and sedative agents may also be used until infusions can be established.

[15] Cohen, L., Athaide, V., Wickham, M.E., Doyle-Waters, M.M., Rose, N.G. and Hohl, C.M., 2015. The effect of ketamine on intracranial and cerebral perfusion pressure and health outcomes: a systematic review. *Annals of emergency medicine*, *65*(1), pp.43-51.

[16] Hayes-Bradley C, Tarrant M. Rocuronium ≤1.5 mg/kg versus >1.5 mg/kg and inadequate paralysis in prehospital and retrieval intubation: A retrospective study. Emerg Med Australas. 2022;34(6):892-897. doi:10.1111/1742-6723.14008

[17] Levin, N.M., Fix, M.L., April, M.D. *et al.* The association of rocuronium dosing and first-attempt intubation success in adult emergency department patients. *Can J Emerg Med* 23, 518–527 (2021). https://doi.org/10.1007/s43678-021-00119-6

2.3.9. 2g Tranexamic acid should be administered to people with a head injury and GCS score of 12 or less who are not thought to have active extracranial bleeding within 2 hours of injury.[18] [15 mg/kg to 30 mg/kg (up to a maximum of 2 g) intravenous bolus injection of tranexamic acid for people under 16.]

2.4. **Airway Management**

2.4.1. A difficult airway should be anticipated in all trauma patients, not least because manual in line stabilisation of the cervical spine is almost always required.

2.4.2. As per normal RSI practice, a full stomach should be assumed when anaesthetising trauma patients. Preparation should be made for the possibility of regurgitation with the immediate availability of suction and the use of a tilting trolley.

2.4.3. Use of a bougie at the first intubation attempt should be strongly considered - manual in line stabilisation and consequent restriction of laryngoscopic view is likely to mean that bougie use will increase first pass success, reduce the time to achieving a secure airway, and therefore reduce the risk of desaturation.

2.4.4. The anaesthetist's plan of action in the case of failed intubation and oxygenation should be verbalised as part of the pre-induction checklist. This is likely to include use of a supraglottic airway device followed by front of neck access as per Difficult Airway Society (DAS) guidelines.[19]

2.4.5. Use of a video laryngoscope as a first line device is strongly recommended due to the likelihood that they improve first pass success rate, reduce incidence of hypoxia, and reduce rates of poor glottic visualisation.[20] The performance of this technique may be impaired if there are large quantities of blood or other fluid in the airway, although this may be mitigated by proactive use of suction.

2.4.6. Removal of C-spine immobilisation is mandatory before anaesthetising the patient, including opening the cervical-collar (if present). Manual in line stabilisation takes the place of blocks, tape and collar, and removal of these elements will maximise the chances of successful first pass intubation.

2.4.7. Consider use of a subglottic suction endotracheal tube if the patient is likely to require ventilation on intensive care for >24 hours.

[18] Head injury: assessment and early management. NICE guideline [NG232] Published: 18 May 2023

[19] www.das.uk.com

[20] Hansel J, Rogers AM, Lewis SR, Cook TM, Smith AF. Videolaryngoscopy versus direct laryngoscopy for adults undergoing tracheal intubation. Cochrane Database of Systematic Reviews 2022, Issue 4.

2.4.8. Head injury should be assumed in all trauma patients requiring anaesthesia unless there is clear evidence to the contrary. Neuroprotective measures should be instituted following induction of anaesthesia:

- Tape ETT in situ to avoid occluding venous drainage of head
- Reverse Trendelenburg position of trolley
- Target EtCO2 to achieve a PaCO2 4.5 - 5.0kPa. Correlate gradient early but assume it may be around 2kPa. (See 2.2.6)
- Maintain c-spine immobilisation using blocks only (do not replace hard collar)

2.4.9. Documentation of the following is mandatory following induction of anaesthesia:

- Grade of intubation
- Length of ETT at the teeth/lips
- Presence of airway soiling
- Doses of drugs used

2.4.10. Depending on the service that has attended them, patients may have been anaesthetised before arrival at hospital. If this is the case the information in 2.4.9 must be handed over to the anaesthetist by the pre-hospital clinician.

3. Definitive care

3.1. The anaesthetised trauma patient may require care in a number of locations:

- Transfer from TU/LEH to MTC
- Surgical intervention in theatre
- Interventional radiology
- Intensive care for ongoing resuscitation and stabilisation

3.2. The management of critically injured patients should be consultant-delivered. Anaesthesia for the emergency control of major traumatic haemorrhage and other damage limiting interventions in the operating theatre or radiology intervention suite, should be provided by a consultant anaesthetist.[21]

3.3. Anaesthetists delivering care to patients in theatre and interventional radiology should be familiar with the concepts of damage control resuscitation.

3.4. Where appropriate the principles of damage control surgery should be followed. This involves haemorrhage control by temporary clamping, packing, shunting, or ligation. Hollow viscus injuries are either closed or resected without anastomosis. On completion of the procedure, the abdomen is temporarily closed using an improvised or commercially available topical negative pressure dressing.

[21] Guidelines for the Provision of Anaesthetic Services, Chapter 16: Guidelines for the Provision of Anaesthesia Services for Trauma and Orthopaedic Surgery 2023. Royal College of Anaesthetists

3.5. The need for damage control surgery is based on the presence of ongoing deranged physiology. The decision to continue with surgery is made by all team members, and is guided by regular communication between the anaesthetist and surgeon, incorporating the following points:

- Patient temperature
- Base deficit
- Lactate
- Haemoglobin
- Presence of ongoing haemorrhage

3.6. Regular point of care testing should be carried out to judge the adequacy of ongoing resuscitation: this includes blood gas analysis and rotational thromboelastometry/thromboelastography as required.

3.7. Following any operative intervention there should be a consultant-to-consultant handover between the anaesthetist and critical care consultant. This should be backed up with a written summary of events and comprehensive anaesthetic chart.

Emergency Surgical Airway

Emergency Surgical Airway (Cricothyroidotomy)

- This procedure provides a temporary emergency airway in situations where there is obstruction at or above the level of the larynx, such that oral/nasal endotracheal intubation is impossible.

- Compared with an emergency tracheostomy, it is quicker and easier to perform and associated with fewer complications. Compared with needle cricothyroidotomy, it is more likely to be successful and results in the ability to ventilate, rather than just oxygenate.

- A cricothyroidotomy is an incision made through the skin and cricothyroid membrane to establish a patent airway.

- It may be performed as a primary technique during certain life-threatening situations, such as impassable airway obstruction by a foreign body or massive facial trauma.

- A cricothyrotomy should be performed as a rescue technique in *'can't intubate, can't oxygenate'* situations, according to the briefed airway management plan.

- Clinicians involved in the delivery of emergency anaesthesia to trauma patients should practice and maintain their skills in the performance of surgical cricothyroidotomy on a regular basis.

Indications for Emergency Surgical Airway Placement

Indications include the inability to intubate and oxygenate the paralysed, anaesthetised patient, which may result from:

- Severe maxillo-facial trauma.
- Inflammation of the soft tissues including oedema that prevent visualisation of the cords (caused by smoke/chemical inhalation)
- Severe oropharyngeal/tracheo-bronchial haemorrhage
- Foreign body in upper airway that can't be safely removed or bypassed.
- A pre-existing anatomically difficult airway

For difficult intubation guidelines and guidance on how to perform a surgical cricothyroidotomy follow the Difficult Airway Society link: Difficult Airway Society Difficult Intubation guidelines (2015)

Resuscitative Thoracotomy – Overview

If time permits, please read full resuscitative thoracotomy guidelines.

Markers to suggest resuscitative thoracotomy MAY BE SUCCESSFUL:

- **Short downtime** – the chance of survival, regardless of pathology, drops significantly from zero to ten minutes. Recognition of the point of arrest can be challenging, i.e., determining when in true cardiac arrest versus low flow state, and this should therefore be considered in the decision making around proceeding to thoracotomy.
- **Witnessed arrest** – cardiac arrest in the presence of a team who are able to deliver a resuscitative thoracotomy rapidly will have higher chances of success.
- **Single injury** – a patient with a single injury with associated pathology has a higher chance of survival i.e., penetrating injury.
- **Presence of ECG activity** – patients deemed to be in cardiac arrest who still have evidence of electrical activity. The highest chance of success comes with sinus rhythm with the chances decreasing as the patient progresses through bradycardia, agonal states and into asystole.

Markers to suggest resuscitative thoracotomy SHOULD NOT BE PERFORMED:

- Indications of significant/unsurviveable head injury
- Prolonged or unwitnessed downtime with no ECG activity

Procedure

1. **Undertake Zero Point Survey**. Ensure roles are allocated, major haemorrhage resources are available (including large volume blood products), and thoracotomy equipment prepared.
2. **Utilise shared decision making** and shared mental modelling to decide and communicate the decision to proceed to resuscitative thoracotomy.
3. **Ensure concomitant activities** are underway to secure airway, secure large bore vascular access, administer blood products and undertake resuscitative thoracotomy.
4. **Perform bilateral thoracostomies.**
5. **Reassess** for return of circulation particularly if a clear tension pneumothorax has been released.
6. **Connect the thoracostomies** and open the chest.
7. **Extend the thoracostomies** posteriorly if required.
8. **Open the pericardium** and lift out to inspect the heart.
9. **Close any cardiac wounds** identified - ensure vigilance for posterior wounds.
10. **Commence internal cardiac massage** and defibrillate if indicated.
11. **Compress the descending aorta**.
12. **Optimise filling** and administer adrenaline and calcium.
13. **Assess and treat any other injuries** including lung or vascular.

If ROSC is achieved:

1. **Ensure adequate anaesthesia** and paralysis.
2. **Seek early specialist input.**
3. **Identify optimal approach** to undertake any required damage control surgery.
4. **Arrange ongoing care** on Intensive Care and contact cardiothoracic team at MRI.
5. **Optimise physiology** and plan definitive treatment in coming days.
6. Once it is felt the patient is stable enough then consideration can be given to transfer to the relevant MTC following discussions with all necessary specialties. Post procedure ensure immediate welfare of those involved and plan subsequent debriefing.

Resuscitative Thoracotomy

Aims

- Define the patient population in which the procedure may prove lifesaving.
- Describe patients whom thoracotomy may be successful.
- Describe the operative process.

Background

Patients who suffer penetrating trauma and lose cardiac output have a generally poor prognosis. To maximise the chance of surviving neurologically intact early perfusion to the brain must be restored and this can best be achieved by reversing the underlying pathology rapidly and appropriate resuscitation.

Traditional thinking around the indications for thoracotomy focused on the mechanism i.e., penetrating versus blunt. It may be more beneficial to consider the underlying pathology and specific treatments that a patient requires. Cardiac arrest secondary to cardiac tamponade has been shown to have the highest chance of survival when a thoracotomy has been performed whereas neurologically intact survival following an arrest due to hypovolaemia is considerably less likely.

This SOP largely describes patients who have already arrested; however, this should be extended to those patients who are in extremis with indicators that arrest is imminent and that there is reversible pathology that can only be addressed by resuscitative thoracotomy. In patients who have not arrested yet and who are hypovolaemic then an early focus on large bore access and large volume resuscitation should be prioritised prior to resuscitative thoracotomy.

Markers to suggest resuscitative thoracotomy may be successful:

- Short downtime – the chance of survival, regardless of pathology, drops significantly from zero to ten minutes. Recognition of the point of arrest can be challenging, i.e., determining when in true cardiac arrest versus low flow state, and this should therefore be considered in the decision making around proceeding to thoracotomy.
- Witnessed arrest – cardiac arrest in the presence of a team who are able to deliver a resuscitative thoracotomy rapidly will have higher chances of success.
- Single injury – a patient with a single injury with associated pathology has a higher chance of survival i.e., penetrating injury.

Presence of ECG activity – patients deemed to be in cardiac arrest who still have evidence of electrical activity. The highest chance of success comes with sinus rhythm with the chances decreasing as the patient progresses through bradycardia, agonal states and into asystole.

Markers to suggest resuscitative thoracotomy should not be performed:

- Indications of significant/unsurviveable head injury
- Prolonged or unwitnessed downtime with no ECG activity

Process

Preparation and decision making prior to arrival.

Consider undertaking a Zero Point Survey encapsulating the following:

- Preparations for surgical intervention should be immediate, following notification of the patient's imminent arrival.
- Prepare the environment to ensure there is plenty of space with 360-degree patient access and that the patient can be placed into a cruciform position to enable access to the arms and chest.
- All surgical equipment should be readily available, and all necessary on-site specialities informed and present prior to the patient's arrival when possible.
- Roles should be assigned, and responsibilities clearly communicated to all staff involved. Additional nursing staff trained to use a Rapid Infuser (and additional staff to check blood products) should also be made available if possible.
- Blood products should be available and Massive Haemorrhage protocol activated as per local policy. Consider use of a "code red" or equivalent local procedure, if in place, to ensure adequate resources are in place and the early presence of skilled senior decision makers.
- Ideally the decision to undertake an open thoracotomy should be made within 10–15 seconds of arrival and establishing that the patient has no signs of life. For patients where the decision making is challenging then ultrasound can be considered – this may help to identify cardiac contractility, cardiac tamponade, persisting pneumothorax and large haemothorax.
- Begin opening the chest immediately whilst the team undertake intubation and IV cannulation if required.

Equipment

Two sets of key equipment components are listed for simultaneous bilateral thoracotomies:

- Skin cleansing Chloraprep 1% or 2%
- Protective clothing (sterile gloves, apron, and eye protection)
- 2 x Size 22 scalpels
- 2 x large scissors (sometimes referred to as *'Trauma* or *Tuff-cut Shears'*)
- 2 x Spencer wells straight forceps
- 2 x mosquito forceps
- Gigli Saw/Lebske knife *(or tuff-cut shears*)
- Finichietto rib spreader (optional)
- Skin stapler
- Foley catheter
- 2 x 2/0 silk sutures on a curved needle
- 2 x 2/0 vicryl ties

How to Perform a Resuscitative Thoracotomy

1. Bilateral thoracostomy

- Undertake bilateral thoracostomies in the mid-axillary to anterior line in the 5th intercostal space using a No 22 scalpel and a pair of Spencer Wells. The thoracostomies should be around 4cm in length and breach the intercostal muscles and parietal pleura and use the same technique and landmarks as for conventional chest drains.

- Two clinicians working simultaneously can achieve this quickly.

Note – the procedure is stopped at this point if tension pneumothorax is decompressed and cardiac output returns. A final, rapid pulse check should confirm this or palpation through the left thoracostomy may also detect cardiac contractility.

2. Join the thoracostomies

- Make a skin incision between the thoracostomies with a deep skin incision following the 5th intercostal space.

- Insert two fingers into a thoracostomy to hold the lung out of the way while cutting through all layers of the intercostal muscles and pleura using heavy scissors (also known as *'Tuff Cut shears'*).

- The first incision should aim to get through all skin layers to fat / chest wall.

- Using the Tuff Cut shears extend the thoracostomy wounds on both sides through the sternum.

- It may be possible to cut through the sternum with the shears – small bites taken with the tips of the shears may be required.

- If unable to divide the sternum with the shears use the Gigli saw. Pass the Spencer Wells behind the sternum grab the Gigli wire and pull it behind the sternum.

- Attach the wire to Gigli handles and saw. Long sweeping motions utilising the full length of the saw should be made. Ensure not to create a sharp angle in the wire by keeping the handles wide and the wire relatively flat. This can be achieved with a single person or two-person technique. Blood splatter may be encountered so eye protection is critical. Spencer Wells or equivalent should be placed above the sternum before the Gigli saw completes the cut to prevent the wire pinging free.

3. Extend the incision posteriorly

- Before opening the chest up extend the incision in the intercostal space posteriorly to the posterior axillary line. This will allow you to open the chest fully in a 'clamshell', maximising the exposure and identification of anatomy.

4. Open the chest and undertake cardiac procedures

- Lift the chest open wide and open the 'clamshell' using one or two self-retaining retractors/rib spreaders from the full thoracotomy set. Alternatively, a staff member can retract the upper chest wall from the head end – large gauze pads can protect hands from injury from the sharp cut edges of the sternum and any ribs that have been cut. As the sternum is lifted, dissect the sternopericardial ligament on the posterior aspect of the sternum.

- The retractor should be opened to its full extent to allow full access to the chest cavity with access to all areas. If exposure is inadequate, then the incisions need to be extended posteriorly

- Use suction if necessary to help clear the field and help identify anatomy. Suctioning to dry in all areas will help to identify ongoing bleeding points as resuscitation progresses.

- Identify the heart and assess for tamponade is present the pericardium will look tense. Regardless of whether there is a clear tamponade present open the pericardium. Using two clips/forceps raise a tent of pericardium on the anterior surface of the heart and cut a midline longitudinal incision using scissors. If tamponade makes the pericardium too tense to elevate, then carefully dissect with a scalpel.

- This approach minimises the risk of damage to the phrenic nerves, which run in the lateral walls of the pericardial sac. Making the incision too short will prevent full access to the heart.

- Remove blood clots with your hands and suction.

- The heart may fibrillate or beat spontaneously as this happens. See below.

- Inspect the heart rapidly but systematically for the site of bleeding. Posterior wounds can be the hardest to identify and treat – elevation of the heart needs to be minimised to prevent occlusion of the great vessels which can be further minimised by trying to keep the vessels straight. For wound closure see below.

- The filling status of the heart should be established and fed back to the team leader. This will aid transfusion requirements i.e., an empty heart will indicate the need for further rapid transfusion.

- One of three scenarios is now likely:

  a) The heart will begin to beat spontaneously with a return of cardiac output. In this situation any cardiac wounds should be closed as described below.

  b) The heart begins to beat slowly with a considerably reduced cardiac output. In this situation wounds should be closed quickly, then attempt to improve cardiac output wit supplementary internal cardiac massage and inotropic support.

  c) The heart remains in asystole. In this case wounds should be quickly closed and then attempts made to restart the heart as in step (b). Simply flicking the heart may produce a return of contractions.

Cardiac Wounds

- The quickest and easiest route of closure of cardiac wound is with a skin stapler – even the largest wounds can be stapled closed within seconds.
- Small wounds (less than 1cm) can be *occluded* temporarily using a finger or gauze swab. Be careful not plug the hole with a finger as this may simply extend the wound, simply occluding it should be adequate.
- Wounds adjacent to coronary arteries should be treated with caution. If the artery is distal then it (and the distal myocardium) can be sacrificed, if necessary, otherwise either a vertical mattress suture should be used, or the wound occluded with a finger. Any closure that occludes a coronary artery can be addressed as a priority post ROSC or after perfusion has been restored.

Ventricular Fibrillation

- Should this occur use internal paddles with an initial energy level of 10 joules *or levels appropriate to your defibrillator (some can be as low as 5j on some models).* 5J is suitable for paediatric patients.

- Ensure there are no blood pools / fluids that may arc.
- If internal defibrillation paddles are not available, then close the clamshell and externally defibrillate as required. Ideally compression of the chest needs to be performed at the same time to eliminate air pockets between the pads and the myocardium – precautions need to be taken to ensure there is no risk of the person undertaking compression from being defibrillated.

Other Injuries

In addition to cardiac wounds a number of other injuries may become apparent once in the chest:

- Wounds to the lung can present as either an air leak or haemorrhage. Unfortunately, lung tissue cannot be sutured. Minor air leaks can be ignored, and the patient ventilated to accommodate. Larger leaks and haemorrhaging wounds may require control. Non-specialist options may include single lung ventilation, collapse of the lung and direct pressure to the hilum or isolation of the effected lung via hilar control i.e., by application of a tie/Foley catheter or Rummel tourniquet. More specialised techniques may include a tractotomy, resection of lung tissue utilising linear cutters or even lobe resection, but these will be limited by clinicians present and the timeframe to complete if the patient remains in cardiac arrest. Definitive treatment of lung injuries will require a specialist surgeon and treatment in theatre.

- Vascular wounds (potentially in the mediastinum, apex of the lung or aortic) can be controlled by direct pressure or application of haemostatic dressing and pressure. If the skills are available and the location accessible, then clamping may be possible. Definitive repair should be arranged with the vascular surgeons.

- As perfusion is restored the internal mammary/thoracic arteries will start to bleed – control is quickest and easiest with the use of arterial forceps.

5. How to perform internal cardiac massage

If the heart makes no spontaneous movement try flicking it with your finger.

- If no movement occurs begin massage.

- When internal cardiac massage is required, it must be of optimal quality. And the two-handed technique is recommended.

- One flat hand is applied to the posterior surface of the heart; the other is placed on the anterior surface. The posterior hand should **remain flat on the back at all times** – the heart should not be elevated as this will obstruct cardiac filling.

- Blood is 'milked' from the apex upwards. The rate should be guided by the filling of the heart – compressing an empty heart will prove counterproductive. Once adequately filled aim for a rate of 80-100 bpm.

- Take great care to do this properly. Do not let anyone else perform the massage at this stage, it is essential to get blood moving through the coronary arteries and for the myocardium to be perfused – focus on the quality of massage you are providing.

Get an assistant to compress the descending aorta on the spinal column. This will raise root pressure and enhance coronary blood flow, maximising coronary and cerebral perfusion

6. Continue ALS

By this time vascular access should have been established (intravenous or intraosseous).

- Transfuse blood products to load the heart with volume; you will feel whether it feels empty or not. If myocardial activity is sluggish despite adequate filling, then 1 mg of adrenaline and calcium (dose dependent on presentation being used) can be administered.
- Massage and repeat doses should be continued until myocardial activity is good. If the procedure is successful, the internal mammary arteries may now bleed and require clipping.

7. Ensure anaesthesia

Anaesthetise the patient as required. If return of spontaneous cardiac contractility is achieved, then be prepared to provide immediate anaesthesia. Ketamine is recommended as the most appropriate agent in this setting.

8. Damage control surgery

Patients who have undergone a prehospital thoracotomy should be triaged by the enhanced care team to the most suitable destination.

If perfusion is restored, then specialist advice should be sought to plan damage control surgery (DCS) or if appropriate definitive repair. This is likely best achieved in theatres if the patient can be stabilised sufficiently. Early involvement of specialist teams should be sought. In hospitals without the required specialist surgeons support may be available from other surgical teams.

If the patient requires transfer to theatre, then temporary closure of the thoracotomy should be considered, for example, utilising chest seals, cling film or other suitable dressing to help minimise heat loss. Other heat loss prevention strategies should also be utilised.

9. Ongoing Care following the procedure

Following initial DCS it is likely the patient will need a Level 3 bed on Intensive Care. If DCS has been conducted at a remote site, then discussions should be undertaken with the relevant MTC to establish a plan for further treatment, management, and potential transfer at a suitable time (if this can be safely conducted and is in the patient's interests).

10. Post procedure

Ensure timely and comprehensive notes are completed. Resuscitative thoracotomy cases are usually subject to criminal and coronial processes, and these should be supported as required.

Ensure the immediate welfare of those involved and try and ensure ongoing support is available especially to those who may become isolated after the procedure, for example, students, clinicians from specialties out with the Emergency Department, police etc.

Plan and undertake hot and cold debriefs to help identify learning and improvements in addition to wellbeing aspects.

Consider religious beliefs and potentially organ & tissue donation, however, in view of the context this is usually not possible.

11. Definitive Treatment

Once perfusion has been restored the patient should be moved to a theatre for definitive repair.
All patients who have undergone thoracotomy should be subsequently discussed with the cardiothoracic team at Manchester Royal Infirmary to agree a forward plan.

Cardio-thoracic Registrar
via MFT (MRI) switchboard
(0161) 276 1234

Management of Blunt Chest Wall Injuries

This guideline covers the management of blunt chest trauma and rib fractures and includes advice about investigations, referral processes, chest drains and stepped analgesia.

As with all trauma patients, the evaluation of a patient with thoracic trauma begins with a determination of airway patency, adequacy of breathing, haemodynamic stability, and neurological status.

Chest wall injury is extremely common following blunt trauma. It varies in severity from minor bruising or an isolated rib fracture to severe crush injuries of both hemi thoraces leading to respiratory compromise.

Rib fractures are often associated with an underlying pulmonary injury, which may not be immediately apparent on an initial chest X-ray. Fractures of the lower ribs may be associated with diaphragmatic tears and spleen or liver injuries. Injuries to upper ribs are associated with injuries to adjacent great vessels. This is especially true of a first rib fracture, which requires a significant amount of force to break and indicates a major energy transfer.

A fracture of the first rib should prompt a careful search for other injuries. Note that the rib cage and sternum provide a significant amount of stability to the thoracic spine. Severe disruption of this 'fourth column' may convert what would otherwise be a stable thoracic spine fracture into an unstable one.

Rib Fractures

- Rib fractures are the commonest injury in blunt trauma.
- Ribs 4 – 8 are the most common fractured ribs.
- Fractures of the 1st to 3rd ribs indicate high energy trauma: consider subclavian or brachial plexus injuries.
- Fractures to ribs 9 – 12 can be associated with intra-abdominal injury.
- Elderly patients are at increased risk of respiratory tract infection and death.
- The aim is to provide appropriate effective timely and targeted pain management to prevent deterioration in patient condition/function and optimise lung function.

Flail Segment

- Flail segment is defined as 3 or more ribs fractured in 2 or more places.
- Suspicion of flail segment can lead to a *'clinical'* diagnosis in the pre-hospital environment (by NWAS or NWAA crews) and patients can be directly conveyed to the MTC on suspicion of a flail chest.
- The clinical significance of a flail chest is the presence of an incompetent segment of chest wall large enough to impair respiration. Large flail segments will involve a much greater proportion of the chest wall and may extend bilaterally or involve the sternum. In these cases, the disruption of normal pulmonary mechanics may be large enough to require mechanical ventilation. This can be accompanied by lung injury and potential bleeding which can further impede respiration.

- Following major trauma, the pathophysiological response is usually similar to that of post-operative pain. Due of the lack of preparation, unexpected nature of the injury and associated severe psychological responses, anxiety levels are usually extremely high, and the central nervous system will initiate a pronounced response.
- The combination of flail chest and pulmonary contusion is associated with higher mortality than either isolated contusion or flail.

Pulmonary Contusions

- Blunt force trauma to the chest wall may result in pulmonary contusions. This may or may not be associated with rib fractures.
- Pulmonary contusions evolve over the first 48-72 hours. If optimal management isn't achieved this can lead to deterioration in respiratory function, decreased tidal volumes, atelectasis and pneumonia.

Haemothorax and Pneumothorax Presentations

- A patient with thoracic trauma and a clinically patent airway who has rapid, inadequate, or laboured respirations, the diagnosis of pneumothorax must be assumed until proven otherwise.
- Chest drains placement may be indicated as the initial therapeutic intervention for most patients with penetrating thoracic trauma, and often for any patient with suspected significant pneumothorax or Haemothorax.

Tension Pneumothorax

- A tension pneumothorax develops when a 'one-way valve' air leak occurs from the lung or through the chest wall. Air is forced into the thoracic cavity without any means of escape, completely collapsing the affected lung.
- The mediastinum is then displaced to the opposite side, decreasing venous return, and compressing the opposite lung. Immediate intervention is required by either finger thoracostomy (this can take place in the pre-hospital setting by an appropriately trained paramedic) or definitive chest drain placement.

Massive Haemothorax

- A massive haemothorax is a significant accumulation of blood within the pleural cavity. Sometimes defined by the need for a thoracotomy, indications include blood loss of >1500mls (around a third of all circulating volume in a trauma patient) or blood loss of >200ml/h for > 2 consecutive hours.
- Identification of a massive haemothorax will likely require surgical exploration as a matter of urgency.

Open Pneumothorax

- An open pneumothorax ('sucking' chest wound) occurs when large defects to the chest wall (such as wounds) remain open.
- If the opening in the chest wall is approximately two-thirds the diameter of the trachea, air passes preferentially through the chest wall defect with each respiratory effort, because air tends to follow the path of least resistance. Effective ventilation is impaired, leading to hypoxia and hypercarbia.

- Initial management of an open pneumothorax is to close the defect with a sterile occlusive dressing. The dressing should be large enough to overlap the wound edges and then taped securely on 3 sides to provide a flutter-type valve effect.
- As the patient inhales, the dressing occludes the wound, preventing air from entering. During exhalation, the open end of the dressing allows air to escape from the pleural space.
- A chest drain should then be placed.

Chest Drain Placement – Tube thoracostomy.

The following are potentially life-threatening presentations and are explained above. These are *clinical diagnoses* and radiological confirmation should not delay the instigation of immediate chest drain placement:

- Tension pneumothorax
- Open pneumothorax, in conjunction with closing/covering the open wound.
- Massive haemothorax

Other indications for chest drain placement following radiological confirmation include:

- 'Significant' simple pneumothorax not under clinical tension
- Any pneumothorax in a clinically unstable patient
- Bilateral pneumothoraces
- Large pleural effusions – in the context of trauma these will almost invariably be haemothoraces
- Self-ventilating patients who have undergone finger thoracostomies (which may behave like an open pneumothorax)

Consider a chest drain:

- In cases of worsening surgical emphysema
- A patient who is to be intubated and ventilated for theatre

A chest drain is not mandated in the following scenarios:

- The presence of needle decompression cannulae that have been placed prior to arrival in the Emergency Department (usually by NWAS) does not mandate the insertion of a chest drain unless clinically indicated.
- The identification of an asymptomatic pneumothorax on a Trauma CT is not an indication for a chest drain in an otherwise stable patient.

Guidance for Chest Drain Insertion

- All clinicians who are expected to be able to insert a chest drain should be trained using a combination of didactic lecture, simulated practice, and supervised practice until considered competent.
- Written consent should be gained whenever possible. Complications of the procedure include pain, intra-pleural infection, wound infection, visceral injury resulting from chest drain placement, bleeding from intercostal vessels and drain blockage. All of these possible sequelae should be detailed in the consent process.
- In a conscious alert patient, sufficient local anaesthesia should be administered.
- A 28 Fr chest drain is sufficient in most situations.
- Small bore Seldinger drains should be avoided in trauma unless there is a specific indication, and after discussion with an appropriate specialist team.
- The usual point of insertion would be in the 5th intercostal space between anterior and mid-axillary lines, as per trauma guidelines.
- All 'trauma' drains must be inserted using blunt dissection: trocars must NEVER be used.
- Having inserted the chest drain, secure it in place and connect it via the drain tubing to an underwater seal chest drain bottle.
- Take care to ensure that drains are adequately secured.
- A simple transparent dressing around the drain site is all that is required. This allows inspection of the drain insertion site.
- Obtain imaging to ensure correct positioning of the chest drain – either a chest x-ray or CT scan if the patient is en-route to the scanner.
- A second drain must not be inserted through the site of a previously dislodged drain because of the increased risk of infection (BTS 2010)

Cautions

- Patients with obvious scarring to the chest wall may have a history of previous thoracic surgery and are likely to have adhesions.
- Patients with a diagnosis of COPD. Bullous disease can be mistaken for a pneumothorax.
- If, following radiographic imaging there is concern that the chest drain is in the incorrect place, seek immediate advice from a more experienced colleague or the local cardiothoracic service.
- **NEVER** clamp a chest drain.
- Constant suction on thoracic drains should only be carried out under the guidance of experienced cardiothoracic or Intensive care personnel and requires the use of specialist equipment.
- In most trauma situations effusions are likely to be haemorrhagic. If the effusion is consistent with gastric contents, consider oesophageal rupture, ruptured diaphragm, or a misplaced (intra-gastric) drain. In these situations, seek advice from a more experienced colleague or from Thoracic Surgery/Upper GI surgery.

How to Insert a Chest Drain

Equipment

All the equipment required to insert a chest tube should be available before commencing the procedure and are listed below:

- Sterile gloves and gown
- Skin antiseptic solution, e.g., iodine or chlorhexidine
- Sterile drapes
- Gauze swabs
- A selection of syringes and needles (21–25 gauge)
- Local anaesthetic, e.g., Lignocaine (Lidocaine) 1% or 2%
- Scalpel and blade
- Suture -1/0 silk
- Instrument for blunt dissection (e.g., curved clamp)
- Chest drains tube
- Chest drain connecting tubing.
- Chest Drain bottle.
- Sterile water
- Clear Dressing

Equipment may also be available in kit form. 'Chest drains kits' may vary.

Preparation

- Consent should be taken and recorded in keeping with national guidelines. The General Medical Council (GMC) guidelines for consent state that it is the responsibility of the doctor carrying out the procedure, or an appropriately trained individual with sufficient knowledge of a procedure, to explain its nature and the risks associated with it. It is within the rights of a competent individual patient to refuse such treatment.

- In the case of an emergency, when the patient is unconscious and the treatment is lifesaving, treatment may be carried out but must be explained as soon as the patient is sufficiently recovered to understand.

- Insertion of a chest drain is a painful procedure so wherever possible (unless contraindicated) ensure analgesia +/- sedation is provided as appropriate.

Procedure

- Prepare the area with iodine/chlorhexidine.
- Position sterile drapes, avoiding the patient's face if he, or she, is conscious.
- Anaesthetise the skin (Maximum of 3mg/kg of 1% Lignocaine)
- Aspirate air or blood
- Anaesthetise pleura and chest wall.

- When the anaesthesia has taken effect, make the incision.
- Incise the skin.
- Blunt dissection with curved clamp
- Pierce the pleura
- Widen the pleural breach.
- Perform a 360-degree finger sweep being mindful of foreign bodies or fracture fragments.
- Mount the tip of the chest drain on a clamp and guide it into the pleural cavity.
- Insert chest drain.
- Ensure most proximal drain hole lies within chest cavity.
- Attach connecting tube to the underwater seal.
- Check for fogging of the tube (this will confirm the position of the tube in the chest wall cavity)
- Secure the drain with a 1/0 Silk suture. Now add a horizontal mattress suture around the drain, leaving the ends long, tie a knot in the 2 ends and wrap it around the chest drain. This will be used for closing the hole when the chest drain is removed.
- A Chest X-ray will confirm the placement of the chest drain and any changing pathology. As a final check ensure the chest drain is 'swinging' with respiration

Analgesia for Chest Trauma with Rib Fractures

Key messages:

- Multiple rib fractures are often associated with an underlying pulmonary contusion.
- Patients with multiple fractured ribs are at risk of respiratory compromise if they are unable to cough and clear due to pain.
- Respiratory compromise may not be seen for 2-3 days after trauma.
- The risk of harm increases with increasing numbers of fractured ribs.
- More than 3 fractured ribs are high risk.
- Effective pain management is necessary to reduce the risk of respiratory complications and facilitate rehabilitation and recovery.
- Clinicians should be mindful of complications of analgesia. Some medications have side effects which may contribute to delirium. The on-site pain team can advise.

Background

Chest wall injury is extremely common following blunt trauma. It varies in severity from minor bruising or an isolated rib fracture to severe crush injuries of both hemi thoraces leading to respiratory compromise.

Multiple rib fractures are often associated with an underlying pulmonary contusion, which may not be immediately apparent on an initial chest X-ray. Fractures of the lower ribs may be associated with diaphragmatic tears and spleen or liver injuries. Injuries to upper ribs are associated with injuries to adjacent great vessels. This is especially true of a first rib fracture, which requires a significant amount of force to break and indicates a major energy transfer. A fracture of the first rib should prompt a careful search for other injuries. Note that the rib cage and sternum provide a significant amount of stability to the thoracic spine. Severe disruption of this 'fourth column' may convert what would otherwise be a stable thoracic spine fracture into an unstable one.

Pain following major trauma poses many challenges for clinicians. Timely repeated thorough assessment and a multidisciplinary approach to pain management are essential. Evidence suggests a failure to effectively manage acute pain in the early stages increases the incidence of chronic persistent pain, including problematic post-traumatic pain.

It has been estimated that up to two thirds of major trauma patients continue to experience severe pain affecting their quality of life for several years after their injury.

Pain from fractured ribs may worsen 2-3 days post injury and lead to respiratory compromise. It is therefore vital that patients with thoracic injuries especially fractured ribs be monitored closely; any deterioration requires rapid escalation of treatment.

Aims of treating fractured ribs

To provide appropriate effective timely and targeted pain management to prevent deterioration in patient condition/function and optimise lung function.

Surgical Fixation

The indications for rib fixation extend beyond producing structural fixation of the thoracic cage to enhance sputum expectoration and effectiveness of respiratory interventions to minimise respiratory morbidity. Experience in GM has demonstrated benefit also to elderly patients in whom the injury per se may be relatively small, but the physiological compromise is extreme. It is our experience that such patients should be considered on an individual basis and discussed with the clinical teams undertaking rib fixation in MRI or SRH.

Developments in Care for Patients with a Chest Injury

Following examination of regional data on chest injuries from 2017-2018 the Network has produced the *'Greater Manchester Chest Injury Pathway'*.

The Pathway addresses issues from initial management, diagnostics and definitive care and was developed in collaboration with colleagues from ED, surgery, orthopaedics, anaesthetics, radiology, specialist pain management teams and physiotherapy.

Greater Manchester Chest Injury Pathway

Clinical Course

Thorough assessment and aggressive, early management should help to reduce the mortality and morbidity of these patients.

Important Interventions

Administration of timely tranexamic acid (TXA) and reversal of anticoagulants in appropriate cases.

Identification and management of all other injuries using timely and appropriate diagnostics.

Effective early analgesia – both PRN and regular analgesia are optimal. Analgesia requirements should be stratified according to severity of pain. The *'Chest Injury Pathway – Analgesia'* document provides some guidance on this; local policy should be followed. Effect of medications should be regularly measured, and consideration should be given to preventing delirium and constipation in vulnerable groups.

For the purpose of this document:

- *'Non-invasive analgesia'* refers to simple analgesia, various methods of opiate administration (PO/SC/IM/IV) and the utilisation of patient-controlled analgesia (PCA).
- *'Invasive analgesia'* refers to intervention likely to be delivered within a Critical Care setting such as Serratus Anterior (SA) blocks or Paravertebral/Epidural blocks.

P/F (Pa02/Fi02) ratio refers to arterial blood gas measurement and reflects how well the lungs absorb oxygen from expired air. P/F ratio less than 27 (kPa) is a reasonable descriptor of significantly poor oxygenation.

Chest fixation is an urgent, but not emergency procedure following clinical and radiological assessment. Rib fixation candidates will not be for immediate transfer and should be discussed within the agreed operational timeframe. It is anticipated the majority of cases will be referrals from the critical care environment. However operative management may be considered for ward patients.

Manchester Royal Infirmary offer video-assisted thoracoscopic surgery (VATS) for patients with haemothoraces that have not adequately drained with a large bore chest drain. Patients should be discussed during operational hours with the Major Trauma Consultant on **0161 701 4451**

Process

- All Sites have the capability to admit to a critical care setting for enhanced interventions.
- The local acute pain service should be contacted regarding specific management of pain issues.
- MTC Chest Injury services are available for clinical management advice/discussion during the operational hours stated below.
- Consider other injuries, locality, and social issues.
- Chest injury patients (if deemed suitable for rib fixation) are not *'immediate transfer to MTC'* patients.
- All transfers should be planned.
- It is anticipated that in the case of isolated chest injury only those patients who require surgical fixation will be transferred through the pathway as all other interventions should be delivered and escalated locally prior to discussion. There will be exceptions to this, and these should be discussed during operational hours.
- Contact with SRH is via a MT Consultant of the day (MTCOD).
- Contact with MRI is via the Major Trauma Consultant.

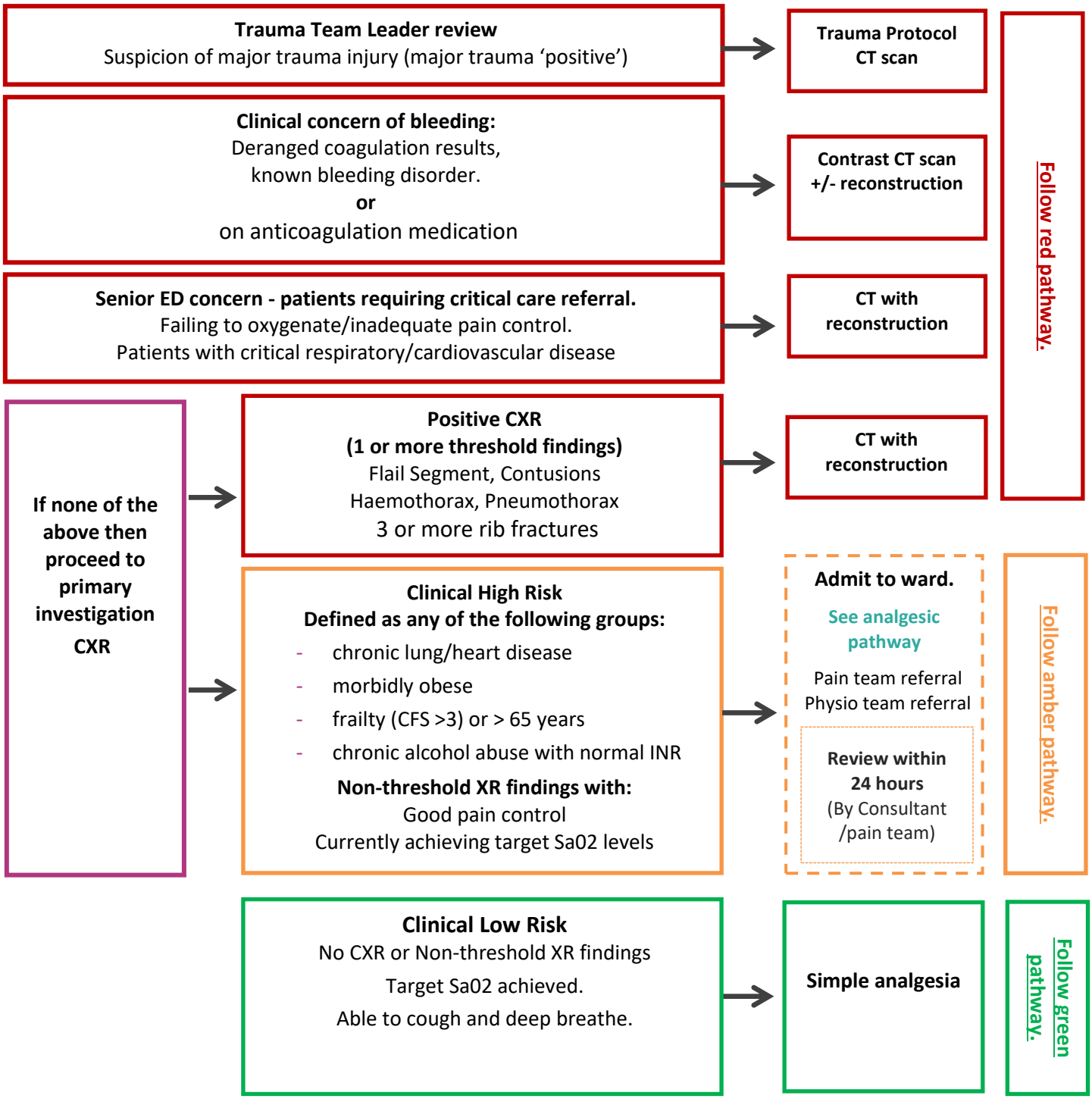
Contact Details

SRH – (0161) 206 7138
9am - 4pm Monday – Sunday

MRI - (0161) 701 4451
9am – 4pm Monday – Sunday

A suitable time should be agreed between both the sending and receiving sites and arrangements made for local admission to manage prior to transfer.

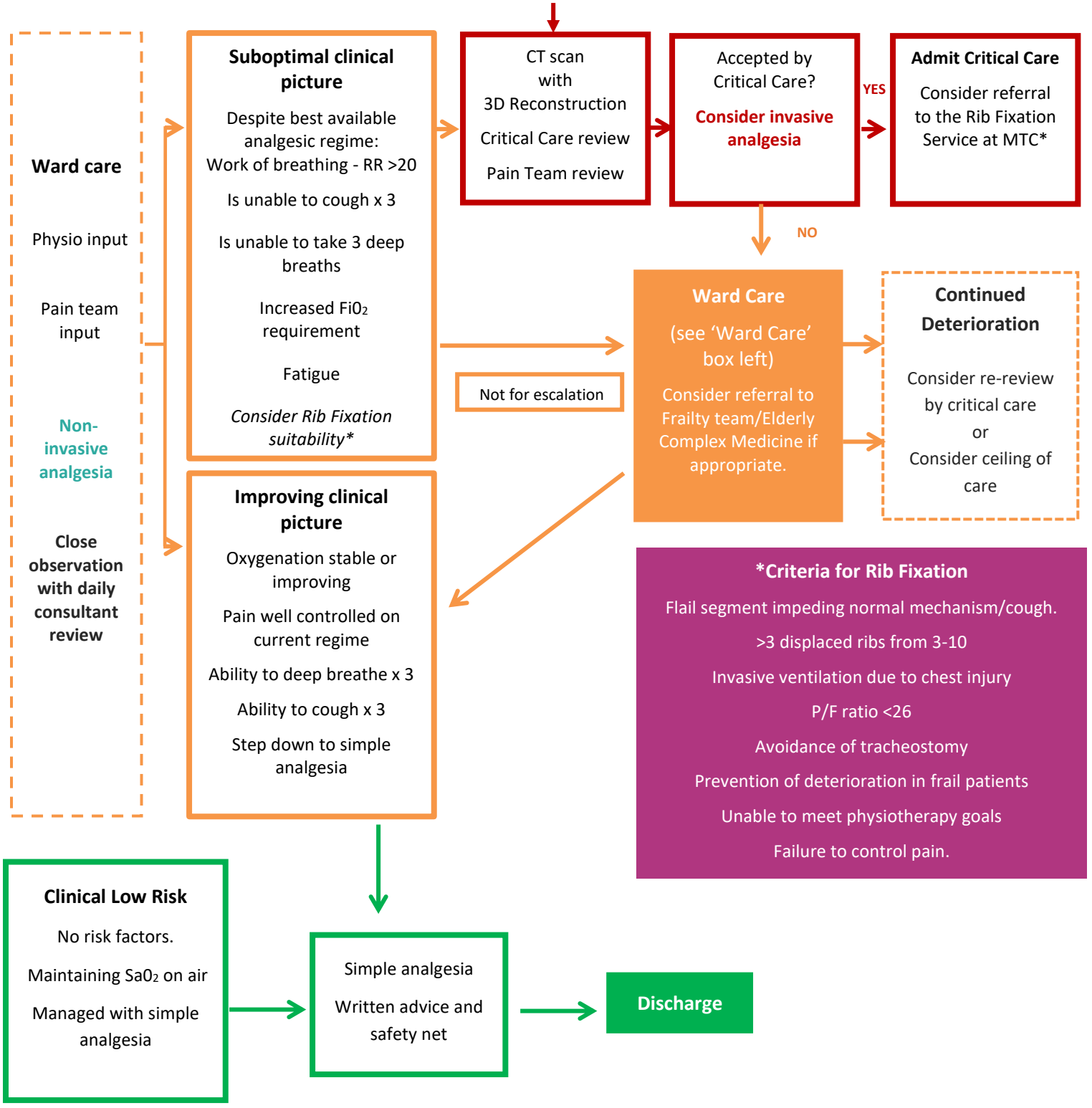
Chest Injury Pathway – Stratification Process



Non-MTC sites: Positive radiological findings for **MAJOR trauma** should be discussed with MTC TTL

MRI: 0161 276 4012 **SRH: 0161 206 2226**

Chest Injury Pathway – Treatment



Chest Injury Pathway – Analgesia

Non-invasive analgesia

Simple Analgesia

Consider hydration, laxatives, and prevention of delirium in vulnerable groups

Opiates

With regular simple analgesia

PO/IV/IM/SC routes

Consider hydration, laxatives, and prevention of delirium in vulnerable groups.

Patient Controlled Analgesia (PCA)

With regular simple analgesia

Consider hydration, laxatives, and prevention of delirium in vulnerable groups.

Invasive analgesia options

Intercostal/Serratus Anterior blocks*

Consider environment – Critical Care review.

Paravertebral/Epidural blocks*

Consider environment – Critical Care review.

*Refer to local policy

Penetrating Cardiothoracic Injury

The NWAS GM pathfinder aims to direct all penetrating injury trauma to MRI.

SRH receives cover from MFT via the MRI Cardiothoracic team (0161 276 1234).

At MRI, if penetrating chest injury has occurred, the following actions should occur:

1. Activate appropriate tier of trauma call. For exsanguinating chest trauma or a penetrating cardiac injury, this should be a **code red**. Do not forget to call:

    a. Resident cardiothoracic middle grade
    b. Consultant cardiothoracic surgeon on-call (via switch board)
    c. Cardiothoracic anaesthetist on-call
    d. Bleep emergency theatre bleep holder

2. Emergency thoracotomy to be performed in A&E only if patient in cardiac arrest or in extremis. Decision to be made by trauma team leader and most senior surgeon present.

3. Transfer to theatre immediately. Resuscitation should continue there.

4. Earliest cardiac team member to decide if a perfusionist is required on site and emergency theatre bleep holder to summon perfusionist and specialist cardiac scrub nurse, if such a decision made.

5. Unless the patient requires immediate thoracotomy, the patient should not be anaesthetised until the cardiothoracic surgeon arrives, assuming airway patent.

6. Guard against un-necessary X-rays which may add nothing and endanger the patient by delaying surgery and sending a very ill patient to an area not set up for such patients. Both a chest XR and FAST scan can be performed in ED, if there is diagnostic uncertainty, but this should not delay time to theatre.

Cardiothoracic Trauma

The NWAS GM pathfinder aims to direct all penetrating injury trauma to MRI.

SRH receives cover from MFT via the MRI Cardiothoracic team (0161 276 1234).

General Principles

- All patients to have assessment along ATLS guidelines.
- Initial management of life-threatening injuries identified during primary survey to be dealt with according to ATLS guidelines with further support / advice from the cardiothoracic services.
- Majority of thoracic trauma is managed conservatively and may require chest drain, resuscitation and very good analgesia.
- Cardio-Thoracic services (MRI) provides initial contact and cover for SRH.
- Any suspicion of cardiac tamponade should be referred via cardiothoracic registrar for cardiac surgery advice/intervention.

Equipment Requirements

- At least 2 thoracotomy sets should be available in A&E and theatres.
- Appropriate staplers / vascular clamps should be available in theatre.
- Sternal saw should be available in theatre.
- Appropriate senior anaesthetic input with skills of double lumen tube insertion should be available in cases of patients requiring thoracic surgery at SRH.

Blunt Abdominal Injury (adults)

Assessment

Clinical abdominal assessment will often not yield much in a polytrauma patient with distracting injuries. A seatbelt sign is significant and associated with intra-abdominal injuries in adults. All haemodynamically unstable patients should be assessed by a surgical registrar and, preferably, by a consultant surgeon. Those in class 3 or 4 shock (PR >120, anxious or confused, reduced systolic BP) should be assessed by a consultant surgeon as these patients require damage control surgery. They have a much higher chance of developing hypothermia/coagulopathy/acidosis and consequently, have a higher mortality rate if not managed optimally and expeditiously.

Investigation

CT is the main adjunct for the evaluation of blunt torso trauma in adults. A Focused Assessment with Sonography in Trauma (FAST) scan can be performed and is particularly useful for patients who are too unwell to go to a CT scanner to look for intrabdominal bleeding.

FAST

a. Should only be performed by an individual with appropriate certification and who is performing the assessment regularly.

b. Focused assessment with sonography for trauma is a **rule in** investigation only and cannot be used to rule out an injury.

c. A negative FAST means nothing.

d. FAST only looks for fluid in the perihepatic, peri splenic, pericardiac, and pelvic region.

e. FAST does not identify retroperitoneal haemorrhage.

CT

a. ADULT polytrauma patients should undergo whole body CT (head to knees) utilising a Bastion protocol, unless there is good reason not to CT a part of the body e.g., isolated crush to the torso in a conscious patient.

b. Haemodynamically unstable patients who are not responding to resuscitation with blood and blood products should not be taken to a CT scanner and should proceed straight to theatre.

c. The lack of free air on an abdominal CT does NOT rule out hollow viscus injury and repeat scanning in 24 to 48 hours may be needed to identify devascularised bowel or perforation.

d. If occult hollow viscus injury (e.g., duodenum or oesophagus) is suspected, a repeat CT scan with oral contrast can be performed.

Do not forget pregnancy tests for all female patients aged between 10-50 yrs. Lack of a pregnancy test should not delay a CT scan in a haemodynamically unstable patient.

Management

a. Solid organ injury on CT may require angioembolisation if there is contrast extravasation. Angioembolisation is most commonly used in splenic injury. The precise indications for angioembolisation for solid organ injury are beyond the scope of this document.

b. All haemodynamically unstable patients at initial assessment should be managed in level 2 or 3 care, even if they have responded to resuscitation.

c. All patients with blunt abdominal trauma who are managed conservatively should have regular review by a Consultant in General Surgery and a low threshold for a further CT scan or laparotomy if there are signs of a clinical deterioration.

d. **Indications for laparotomy in blunt abdominal trauma (with or without a CT):**

1. Unstable patient with abdominal trauma
2. Clinical peritonitis
3. Unstable patient with positive FAST
4. Unstable patient with free fluid on CT
5. Evidence of hollow viscus injury on imaging
6. Evisceration
7. Free fluid (Blood) in the abdomen on a trauma CT without solid organ injury

e. All trauma laparotomies should be performed by a consultant surgeon and **in those patients who are haemodynamically unstable with multiple injuries two consultants should be present**, even if the other consultant is from a different specialty. This may necessitate calling in a colleague who is not on call from home.

Penetrating Abdominal Trauma

These cases should all be '*Trauma calls*'. Please request a call if this has not already happened. A Consultant Surgeon should be contacted immediately in patients who are haemodynamically unstable or who obviously need to go to theatre.

The principles of management are the same as for blunt abdominal trauma, with a few caveats.

- Gunshot wounds (GSW) to the abdomen almost always require a laparotomy. Occasionally they can be tangential, passing through soft tissue only; but this is rare, and a laparotomy is often the most appropriate management. CT has a role in stable patients to assess for associated fractures, foreign body retention and track of the round. Always check **THOROUGHLY** for an exit wound which may be remote from the entry wound. The track of the bullet is not necessarily straight. Consider junctional injuries and prepare for every eventuality.

- Patients who respond to fluid resuscitation or who are haemodynamically stable with penetrating injuries to the torso may undergo CT. CT facilitates surgical planning and is a good investigation for identifying retroperitoneal injuries.

- Thoracoabdominal injuries are common. If a patient has been stabbed in the chest, consideration should be given to infra-diaphragmatic injuries. When in doubt, a diagnostic laparoscopy with diaphragmatic repair should be performed.

- When there is doubt as to whether a penetrating implement has breached the peritoneum, wound exploration in theatre or diagnostic laparoscopy should be performed. There is no role for wound exploration in ED.

- Evisceration or omental herniation requires a laparotomy.

- Do **NOT** remove retained weapons in ED. They need to be removed in theatre.

- Bullets do **NOT** necessarily need removal. A bullet is lodged in soft tissue and not easily accessible it can be safely left. Bullets just under the skin will often cause symptoms and should be removed. Any ballistic removed from the body should NOT be handled with a metal instrument. Where possible, remove with your fingers or plastic instrument to preserve the forensic information.

- Do not forget to perform a THOROUGH secondary survey to ensure no other penetrating wounds have been missed, that includes the back, buttocks, and axillae.

Liver Trauma

The GM trauma pathfinder is designed to place patients in the correct GM MTC partner collaborative organisation from the outset.

All suspected isolated hepatic trauma within Greater Manchester should be triaged to MRI.

However, liver trauma is often a component of multiple injuries, and it is therefore necessary to provide guidance for non-liver trauma surgeons for the initial management of liver trauma at partner organisations.

For all cases of suspected or confirmed liver trauma, 24hrs a day and 365 days per year, contact the **on-call liver trauma surgeon via MFT switchboard.**

GM MTC collaborative – how to contact a liver surgeon:

Dial: MRI

0161 276 1234

and ask for the on-call HPB surgeon

Guide to Management of Liver Trauma

Aetiologies

Liver injury can occur in blunt trauma – either due to blunt force trauma or commonly secondary to deceleration injury in motor vehicle accidents.

In civilian practice, penetrating liver injury commonly occurs due to either knife or gunshot wounds.

Initial management

Penetrating or blunt injury of liver

Haemodynamically **stable**

Resuscitation

CT of thorax, abdomen and pelvis

Discuss case with collaborative hepatobiliary (HPB) surgery service at MRI and agree a management plan

Haemodynamically **unstable**

Resuscitation

CT of thorax, abdomen and pelvis **if at all possible**

Discuss case with collaborative hepatobiliary (HPB) surgery service at MRI and agree a management plan

Scenario A

Clinical suspicion of liver injury or confirmed injury on imaging, patient **unstable** and urgent laparotomy indicated:

After discussion with HPB at MRI, proceed to laparotomy pack liver and wait for specialist

Scenario B

Unexpected finding of liver injury on laparotomy:

Contact HPB at MRI, pack liver and wait for specialist

Spinal Injury Management

Spinal Injury: assessment and initial management (NICE guideline [NG41]):

Overview | Spinal injury: assessment and initial management | Guidance | NICE

Spinal Clearance in the Trauma Patient – see BOAST guidance (January 2015):

BOAST - Spinal Clearance in the Trauma Patient

Cervical Spine Clearance in the Trauma Patient – see BOAST guidance (May 2021):

BOAST - Cervical Spine Clearance in the Trauma Patient

The Management of Traumatic Spinal Cord Injury – see BOAST guidance (November 2022):

BOAST - The Management of Traumatic Spinal Cord Injury

Traumatic Spinal Cord Injury – Referral Process

Any patient with a new onset of hard motor neurology should be transferred to Salford Royal ED under the fast-track automatic acceptance criteria

A 'send and call' approach should be taken

Non-Fast Track Patients

Confirmed/diagnosed spinal cord injury (SCI)

Patient Pass referral completed

Instruction to contact the Greater Manchester Spinal Cord Injury service outreach team to discuss requirements.

For referrals within Greater Manchester only

Contact the Spinal Cord Injury Outreach Team to discuss patient (daytime hours Mon-Fri only)

Tel: 07759 136775/07519 617253

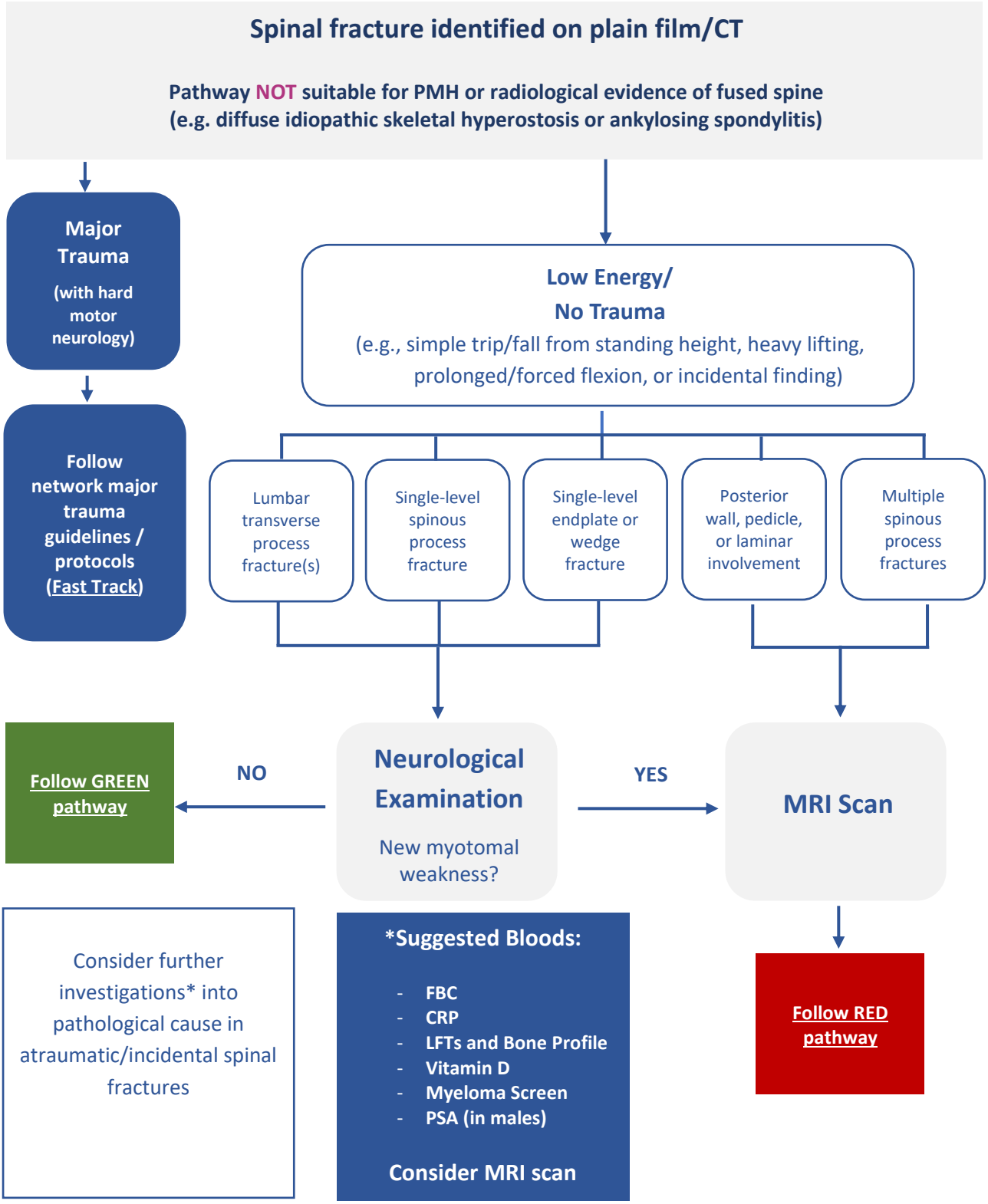
Email: gmsci.outreachteam@nca.nhs.uk

Following triage and discussion with the team a referral form can be completed.

The team can currently offer support from:

- Consultant in SCI Rehab Medicine
- Occupational Therapist
- Physiotherapist
- Spinal Cord Injury Nurse
- Speech and Language Therapy

Lumbar and Thoracic Fracture Management



Any clinical concern not specifically covered by this pathway, please refer for advice via:

https://patientpass.srft.nhs.uk

GREEN pathway

Management

Specialist spinal input not required

- Analgesia
- Mobilise
- Avoid bracing if possible – brace only as an adjunct for pain control

Patient Advice

- Postural advice**
- No restrictions to mobility
- Graded return to work
- Pain for 6-12 weeks
- Avoid heavy lifting for 3 months in wedge/endplate fractures
- Avoid contact sports for 3 months.
- If provided with brace, give advice including skin care, removal at night and weaning after 6 weeks

Advice for GP

- Address bone health/FLS referral as per local guidelines
- Physiotherapy locally only if persistent

RED pathway

Management

- Analgesia
- Spinal precautions with pressure area care
- **Spinal referral via Patient Pass**

https://patientpass.srft.nhs.uk

**Postural Advice

- Maintaining a good posture and avoiding 'slouching' – in standing, walking, and sitting.
- Avoid activities in a flexed (bent forward) posture
- Avoid sitting in one position for more than 30-60 minutes. Take breaks to stand up, walk around, and change position.

Further advice available:

https://theros.org.uk/information-and-support/osteoporosis/spinal-fractures/

Considerations

1. Pain prevention: through appropriate analgesia, in occasional cases a brace can be used for pain relief for 6 weeks, but this not required for stability or prevention of kyphosis. The use of brace depends on pain. If a brace is used, this is not followed up by the spinal team and will require local orthotic input/follow-up.
2. Rehabilitation: through physiotherapy by providing early mobilisation to prevent bone and muscle loss as well as risks associated with immobilisation, though a short period of rest may be required. The aim of physiotherapy is for early posture management to prevent hyperkyphosis of thoracic and loss of lordosis in the lumbar spine, as well as prevention of falls, improving axial strength and rehabilitation to help maintain the correct posture/spinal alignment. This does not require specific or special spinal physiotherapy; Lifting and bending excessively should be avoided for 6-12 weeks.
3. Investigation: to rule out other causes that may cause pathological fracture where appropriate. This may include blood tests such as myeloma screen, bone profile, blood count etc as well as MRI if local team suspect underlying malignancy. A specific MRI is not required for the spinal team to determine stability and the need for MRI scan is based on your local suspicion of an underlying malignancy or pathological process. If you do not suspect malignancy or other non-osteoporotic/traumatic process, then there is no absolute indication for this.
4. Prevention: of future fractures by following the advice from the National Osteoporosis Guideline Group or local policy.

Spinal Low Trauma Fracture Pathway v2.4 (2023). T Watt, D van Popta, M Smith, C Choi, N Yasin, M Angus

Clinical Guidance for Head Injury

Context

According to NICE (2021) head injury is the commonest cause of death and disability in people aged 1-40 in the UK. Initial management of the head injured patient is similar to the management of all major trauma patients.

Definitions:

Severity of head injury	GCS
Mild	13-15
Moderate	9-12
Severe	8 or less

Pre-hospital assessment

Adult patients with cranial trauma and GCS <12 should be transferred directly from the scene to Salford Royal via the GM supplementary major trauma Pathfinder. **Exclusions to this include where the patient has:**

- Unmanageable airway
- Unmanageable breathing
- Unmanageable catastrophic haemorrhage

In this instance NWAS should follow the **Pit Stop** pathway and convey the patient to the **nearest** MTC or Trauma Unit (TU).

- Pregnant patients (over 20 weeks) with head injuries should be conveyed directly to MRI.

Assessment in the emergency department

From the point of view of the head injury there are two main aims:

1. Prevent secondary brain injury.
2. Rapid diagnosis of a surgically amenable lesion.

Primary brain injury

The injury that occurs at the time of impact due to the mechanical forces applied.

Secondary brain injury

Secondary brain injury results from a cascade of events initiated by the primary trauma. It can result in ongoing brain injury that can continue hours or even days after the event.

Simple, early interventions may reduce secondary brain injury and avoidance of hypotension and hypoxia are fundamental and includes:

Management principles for head injured patients.

A	**Airway obstruction** • Aggressive basic airway management in accordance with GCS • Consider early intubation, especially GCS <8 or deteriorating conscious level (see also table 1).
B	**Oxygenation** • Maintain SpO2 >95%, PaO2 > 13kPa. • Even short periods of hypoxia should be avoided. • If ventilated PEEP of 5-10cm H20 should be used (1) **Carbon dioxide** • In the intubated patient maintain PaCO2 4.5-5kPa • Titrate end tidal CO2 to arterial values
C	**Blood pressure** • Maintain systolic BP > 110 (MAP >90) • SBP <150 • In multiply injured patient (TBI plus non compressible bleeding) maintain MAP >70. Stop the bleeding. • Avoid hypotension to maintain cerebral blood flow
D	**GCS and pupils** • The GCS should regularly be assessed along with pupillary response to light (or pupils alone in the intubated patient) **Improve venous outflow.** • Remove all cervical collars and maintain a neutral C-spine position using blocks or sandbags. • Endotracheal tube ties not too tight • Aim for 20-30 degree head up tilt. **Potential spinal injury** • All patients with moderate – severe TBI should be managed as if they have a spinal injury until this is excluded radiologically. **Seizures** • Seizures should be aggressively managed, but prophylactic anticonvulsants are not routinely used

Indications for tracheal intubation in head injured patients

- GCS < 8
- Significantly deteriorating conscious level (e.g., a fall in GCS of two points or more, or a fall in motor score of one point or more)
- Loss of protective laryngeal reflexes
- Failure to achieve PaO_2 > 13kPa; but a lower target can be accepted in patients with AIS (aim for peripheral oxygen saturation > 95%)
- Hypercarbia ($PaCO_2$ > 6 kPa)
- Spontaneous hyperventilation (Pa CO2 < 4.0 kPa)
- Bilateral fractured mandible
- Copious bleeding into the mouth (e.g., from skull base fracture)
- Seizures

Raised intracranial pressure (ICP)

Vigilance for signs of intracranial pressure should be maintained. Signs of raised ICP include:

- Asymmetric pupils
- Bradycardia
- Hypertension (active reduction of ICP should occur and should be treated as a symptom of raised ICP)
- Fixed dilated pupils (though prognostication should not occur with initial scan)

Mannitol (and hypertonic saline) for raised ICP.

Hyperosmolar solutions are widely used to treat raised intracranial pressure (ICP) following severe traumatic brain injury (TBI). Mannitol has historically been the most frequently administered but in some centres hypertonic saline (HTS) solutions are being used. There are studies currently assessing the effectiveness of HTS vs Mannitol but currently there is equipoise.

In GM we use Mannitol 10% solution if required. This can be given if there are clinical signs of raised ICP or if requested by the neurosurgical team.

Adult patients should be given a dose of Mannitol 1g/kg over 10 minutes.

Clinical signs of raised ICP:

- Asymmetric pupils
- Bradycardia
- Hypertension
- Fixed dilated pupils

Other Interventions should include:

Tranexamic Acid (TXA) administration for brain injury

Following the CRASH 3 trial there is now good evidence that TXA reduces deaths in mild – moderate head injury. TXA needs to be given within 3 hours of the injury, and the sooner it is given the greater the effect.

For patients who are self-presenters, or have not had TXA pre-hospital:

- **Has the patient had a head injury?**
- **Has the injury occurred within the last 3 hours?**
- **Is the GCS 12 or less?**

↓

If yes to all three questions – give TXA 2g IV over 10 minutes ASAP.

Following CT brain, GCS 13-15:

- **Does the CT show a TBI?**
- **Is it less than 3 hours since the injury?**

↓

If yes to both questions – give TXA 2g IV over 10 minutes ASAP.

Anti-coagulation reversal

Patients with intracranial bleeding should have anti-coagulation reversed whenever possible. For warfarin use prothrombin complex concentrate (e.g., Beriplex). For Novel Oral Anticoagulants (NOACs) liaise with a haematologist. Local guidelines should be followed.

Antibiotics & Immunisation

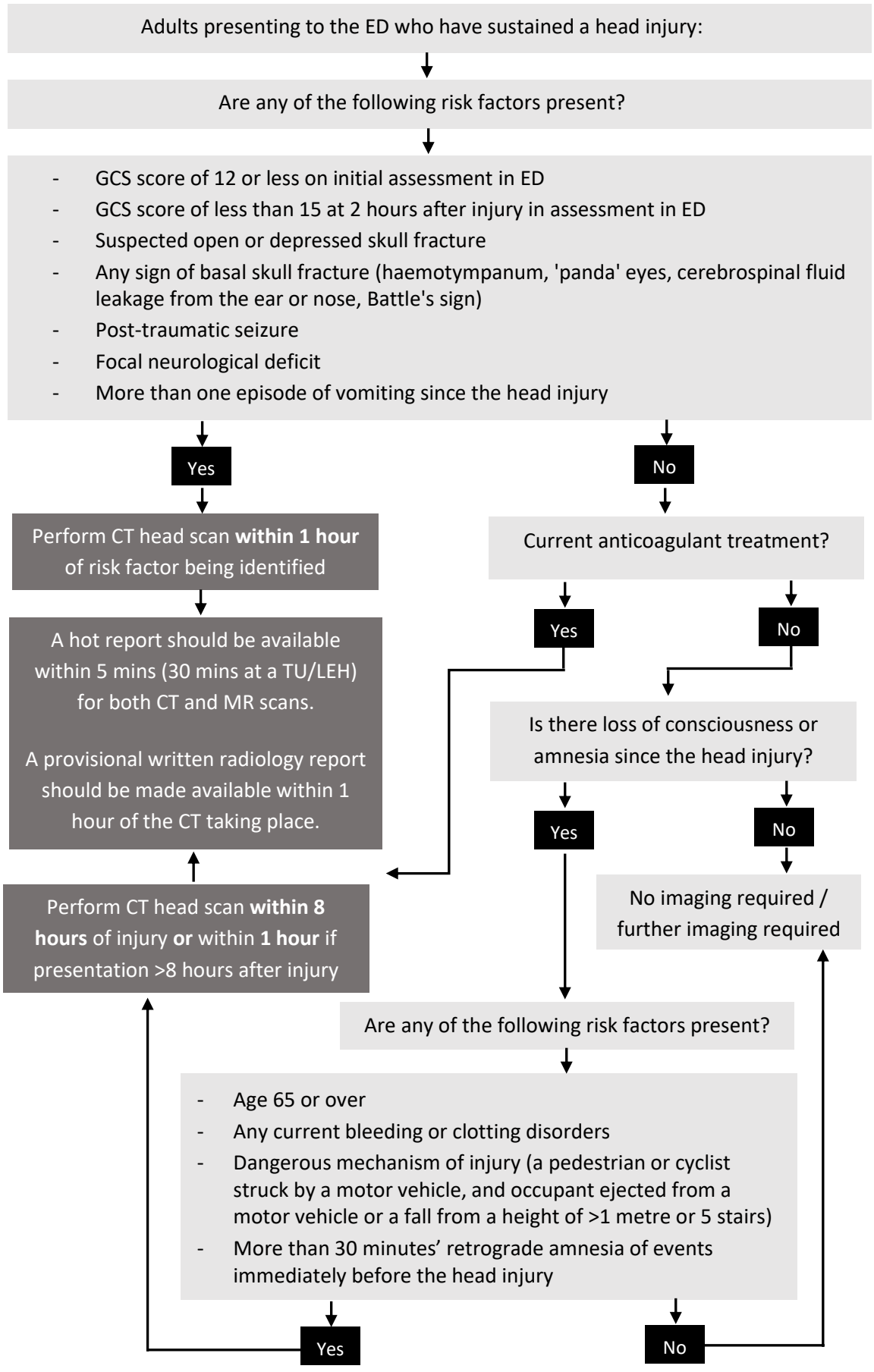
- Antibiotics are not indicated for base of skull fractures or CSF leaks.
- All patients with penetrating brain injury should receive IV antibiotics – discuss with microbiology team.
- All patients with penetrating brain injury, base of skull fractures or CSF leaks should be given Pneumovax II vaccination if not already covered.

Wounds

Should be covered with saline soaked gauze.

Selection of adult patients for CT following a head injury

CT Imaging of the head is the primary investigation of choice



Severe Traumatic Brain Injury – TTL Transfer Criteria

For patients who have self-presented in ED or who have been taken to an ED other than Salford, some will meet the inclusion criteria to be transferred to Salford via TTL – TTL transfer, **without discussion by the referring team with neurosurgery**. This is to minimise potential delays in the transfer of patients with a potentially surgically amenable lesion. The neurosurgical team will then be informed of the incoming patient by the TTL at Salford prior to arrival.

INCLUSION criteria for TTL-to-TTL transfer:

70 years or under:	**Over 70 years:**
- Intubated **AND** abnormal scan, **OR** - Extra-dural haematoma: >15mm thickness or > 5mm midline shift, **OR** - **Acute** subdural haematoma: >10mm thickness or >5mm midline shift	- GCS > 8 **AND** - Living independently, **AND** - One of the following: • Extradural haematoma >15mm thickness or >5mm midline shift • **Acute** subdural haematoma > 10mm thickness or >5mm midline shift

EXCLUSION criteria for TTL-to-TTL transfer:

Patients with any of the following MUST be discussed with the receiving neurosurgical service before transfer:

- Patients with head injury NOT meeting the inclusion criteria
- Fixed dilated pupils
- Primacy of injury other than to head e.g., haemodynamic instability

Primacy of injury - Patients that could potentially require bleeding control/IR should be discussed with MRI Interventional Radiology.

Any patient with actual/potential signs of instability should be discussed with the TTL at the receiving site prior to transfer to ensure safe transfer

Neurosurgical support to MRI can be considered for patients too unstable to transfer

Referring hospital will:

Call SRH TTL on 0161 206 2226/5354

- Upload scans to SECTRA
- Transfer patient to SRH ED (with appropriate escort)

On arrival at ED the patient will be met and assessed at SRH by:

TTL / Anaesthetist / Neurosurgeon / Theatre Team

When transfer to SRH is not possible

Pregnant patients >20 weeks

Pregnant patients >20 weeks gestation, including those that have sustained a head injury should be directly conveyed to MRI from the scene.

On arrival at MRI pregnant patients with a surgically remediable intracranial mass lesion (i.e., extradural or subdural haemorrhage with mass effect) should be placed on CTG monitoring and receive care from a registered midwife. The neurosurgical consultant on call should be contacted to attend within 30 minutes via SRH switchboard 0161 789 7373.

MDT discussions led by the TTL should agree an immediate plan following CT scan.

For patients with a head injury who self-present or are conveyed to sites other than MRI with known pregnancy / pregnancy becomes apparent, the decision-making process regarding transfer should be made on a case-by-case basis, ensuring that the needs of the patient can be met. This should involve TTLs at both MTC sites and may necessitate transfer out of GM.

Haemodynamically unstable polytrauma patients at MRI

Polytrauma patients at MRI with cardiovascular instability (precluding safe transfer to SRH) who have a surgically remediable intracranial mass lesion (i.e., extradural or subdural haemorrhage with mass effect) should remain at MRI.

The Neurosurgery Consultant on call should be contacted to attend with the 'grab box' of equipment. A Neurosurgical consultant will be available to attend at MFT within 30 minutes.

The Neurosurgical registrar on call can be contacted via SRH SWITCHBOARD- 0161 789 7373

Patients who require discussion with Neurosurgery

Many head injured patients may benefit from transfer to the neuroscience centre (SRH) even if they do not require neurosurgery. For those patients who do not meet the criteria for TTL-TTL transfer the following injuries warrant discussion with the neurosurgical on call team:

- Acute SDH
- Extradural haematoma
- Cerebral contusions
- Open skull fractures
- Depressed skull fractures
- Penetrating cranial injuries
- Traumatic CSF leaks
- Skull base fractures

Even in the presence of normal imaging, other reasons for discussing a patient with a neurosurgeon include:

- Persisting coma (GCS 8 or less) after initial resuscitation
- Unexplained confusion which persists for more than 4 hours
- Deterioration in GCS after admission
- Focal neurological signs
- A seizure without full recovery

Discharge from the Emergency Department

Any patient who discharged home from the ED must be given appropriate written head injury advice, backed up by verbal instructions on when to seek review. Patients should be accompanied for 24 hours following discharge.

NICE guidance for head injury

The link below updates and replaces NICE guideline CG176:

Head Injury: assessment and early management [NG232] Published: 18 May 2023:

Head injury: assessment and early management (nice.org.uk)

Open Lower Limb Fracture Pathway

Version 4.1 August 2024

All open lower limb fractures to be conveyed to an MTC site

At receiving site, initial management as per BOAST - Open Fractures (Dec 2017)

open fractures.pdf (boa.ac.uk)

Patients at a non-MTC site:

Refer for MTC care:
Local Trauma Team Leader (TTL) to MTC TTL

MRI TTL (0161 276 4012) **SRH TTL (0161 206 2226)**

- For **catastrophic injuries** (unmanageable: airway, breathing, or catastrophic haemorrhage): Go to **'PIT STOP'** guidance
- For all patients, arrange an **Emergency Category 2** transfer to the MTC
- For patients with **other injuries**, consider primacy of injury and follow existing GM Network major trauma pathways (e.g. vascular injuries to MRI, head injuries to SRH)
- While awaiting transfer, follow BOAST guidelines for assessment (photographs), splintage, antibiotic administration, and imaging

MTC Care

Orthopaedic registrar (to assess in person):

- Assesses wound
- Takes photos, x-rays (for upload to GM SECTRA PACS) and medical microbiology swabs
- Initiates referral to **MTC Ortho-Plastic team**
    - **For MRI Submit e-referral** https://referrals.mdsas.com

Primary Surgery (Gustilo classification refined by orthopaedics)	**Immediate Surgery:**	For **highly contaminated wounds** (agricultural, aquatic, sewage) or when there is an associated **vascular compromise** (compartment syndrome or arterial disruption producing ischaemia).
	Within 12 hours of injury:	For other solitary **high energy** open fractures
	Within 24 hours of injury:	For all other **low energy** open fractures
Definitive Surgery	**Within 72 hours of injury:**	**Definitive soft tissue closure** or coverage should be achieved within 72 hours of injury if it cannot be performed at the time of debridement. *In cases where delay to wound cover is deemed clinically beneficial, an exception report should be documented and audited*

Compartment Syndrome Management

Follow BOAST guidelines:

BOAST - Diagnosis and Management of Compartment Syndrome of the Limbs (July 2014)

BOAST - Diagnosis and Management of Compartment Syndrome of the Limbs

Pelvic Fractures

Investigation in the ED

Beware! – Patients are not always tachycardic at presentation. Apply in children if suspicion of potential injury as in adults.

The initial management aims to:

1. Splint the pelvis to provide tamponade and prevent movement.
2. Detect the presence of a pelvic fracture with an early CT scan if stable enough to transfer to radiology.
3. Differentiate between pelvic and intra-abdominal bleeding.

The following is the Standard Operating Procedure:

4. Splint - A pelvic binder can provide tamponade of haemorrhage and splintage in pelvic fractures. This should be applied at the earliest opportunity (pre-hospital or on arrival to ED) in patients with a suspected pelvic fracture. Do not wait for imaging.
5. Pelvic binder can be applied even if lateral compression injury is suspected.
6. The binder should be placed around the trochanters not the iliac crests.
7. In haemodynamically unstable patients confirm presence of the trauma team, activate massive transfusion protocol/Code Red response. Urgent escalation to Consultant in ED and Orthopaedic Consultant.

Greater Manchester Pelvic Injury Pathway

ED Management

This guidance should be read in conjunction with: The British Orthopaedic Association Standards for Trauma **BOAST: Management of Patients with Pelvic Fractures** and the NICE major trauma guidelines **Fractures (complex): assessment and management (updated 2022)**

Initial management aims to:

1. Maintain a low threshold of suspicion for the presence of a pelvic fracture. This is particularly important when the patient is elderly.

2. Splint - A pelvic binder can provide tamponade of haemorrhage and splintage in pelvic fractures. This should be applied at the earliest opportunity (pre-hospital or on arrival to ED) in patients with a suspected pelvic fracture. Do not wait for imaging.

3. Investigate - As per NICE NG37, all adult patients with blunt major trauma and suspected multiple injuries should have a whole-body contrast CT (WBCT). This should be completed as soon as practically possible (within 30 mins of arrival at an MTC or 60 mins of arrival at a Trauma Unit)[22]

4. Differentiate between pelvic, intra-abdominal bleeding and other sources of bleeding.

The following is the Standard Operating Procedure:

1. In haemodynamically unstable patients confirm presence of the trauma team, activate massive transfusion protocol/Code Red response.

   Urgent escalation to Consultant in ED and Orthopaedic Consultant

2. Ensure timely administration of Tranexamic Acid (TXA) and where appropriate, reversal of anticoagulants.

3. If the pelvic binder has been applied pre-hospital, check the position, adjust if needed and image.

4. The pelvic binder should be placed around the trochanters not the iliac crests.

5. The pelvic binder can be applied even if lateral compression injury is suspected.

6. Do NOT examine the pelvis for mechanical stability.

7. In **non-responding, unstable patients**, early resus plain films (pelvis) can identify candidates (vertical shear) for whom traction could be an immediate life-saving intervention when early definitive pelvic surgery is not possible.

[22] NHSE Service Specification Major-trauma-all-ages.pdf (england.nhs.uk)

Pelvic Fracture Management

1. The pelvic binder CAN be left in place for up to 24 hours unless the patient has severe neurological deficit or a major soft tissue injury.

2. Examine carefully for open wounds, especially perineum. Wounds should be covered and managed in accordance with **BOAST Open Fracture Guidelines.** Local antibiotic guidelines should be followed.

3. If unilateral pelvic injury: log-roll to opposite side
   If bilateral pelvic injury: avoid log-roll, if possible, use a scoop stretcher

4. Discussion with Interventional Radiology (IR) may be appropriate to guide management.

5. Identify and manage any other injuries as appropriate.

6. All suspected pelvic fractures should be reviewed by the local on-call orthopaedic team, who will consider referral to the GM Pelvic Service as per the guidance below.

7. All polytraumatised patients require a post-binder X-ray after resuscitation, even in the presence of a 'negative' CT scan because a well-applied pelvic binder can mask a pelvic ring injury. If there is haemodynamic instability, reapply the binder. For binder removal, follow local trust guidance.

8. Injury to the bladder or urethra should be diagnosed and managed according to BOAST - The Management of Urological Trauma Associated with Pelvic Fractures

9. Regarding VTE, apply mechanical prophylaxis.
   Check coagulation, consider bleeding risk and seek senior clinical opinion before starting chemical prophylaxis.

10. Open pelvic fractures associated with wounds to the lower abdomen, groin, buttocks, perineum, anus (including sphincters) and rectum require urgent assessment by a consultant general or colorectal surgeon and wound debridement as per the Open Fractures BOAST.

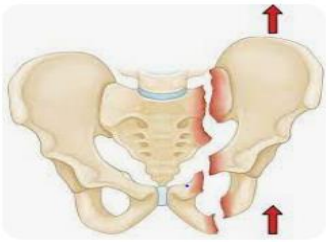
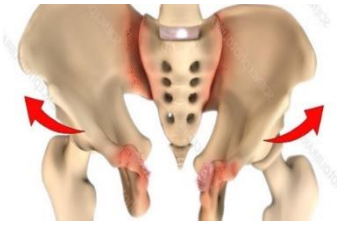
    Clinically and/or radiologically proven or suspected injuries to the anus and/or rectum may initially require construction of a de-functioning stoma. Nursing care of wounds to the perineum or buttocks may also require a de-functioning stoma, although this is unlikely to be necessary for open pelvic fractures associated with wounds to the groin or lower abdomen alone[23].

    Further information can be found in the British Orthopaedic Association guidance BOAST - The Management of Patients with Pelvic Fractures (January 2018) including guidance from the Association of Surgeons of Great Britain and Ireland (ASGBI) and The Association of Coloproctology of Great Britain and Ireland (ACPGBI) for stoma formation with open pelvic fractures.

[23] BOA Guidance: The Management of Patients with a Pelvic Fracture (2018)

Stratification of pelvic injury severity post orthopaedic review

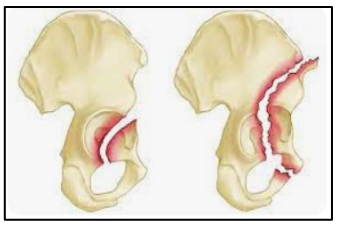
RED STREAM
These patients require TTL to TTL discussion and in some cases, discussion with Interventional Radiology may be necessary.
Discussions with the TTL can take place 24/7 via the following contact numbers. **MRI: 0161 276 4012** **SRH: 0161 206 2226/ 206 5354** **All pregnant patients refer to MRI.** **All paediatric patients refer to RMCH.**
In cases of haemodynamic instability, patients may be identified as *'surgeon waiting'* and immediate emergency transfer should be arranged.

Vertical Shear Fractures	
	- Follow BOAST guidelines for management. - Check binder is correctly applied. - Consider vaginal, rectal, and perineal injuries. - Follow local antibiotic guidelines for timely administration. - Clinical input by senior ED and Orthopaedic on call on suspicion or diagnosis of fracture. - Consider traction when early definitive surgery or temporary surgical stabilisation (emergency screws or external fixation) cannot be performed. - TTL - TTL and refer to pelvic trauma surgeon.
Open Book Pelvis Fractures	
	- Manage haemodynamic instability - Apply pelvic binder at trochanters level - Massive Haemorrhage Protocol (MHP) activation - Early administration of TXA - Consider other injuries (bladder, bowel, perinium, vessels) - Clinical input by senior ED and Orthopaedic on call on suspicion or diagnosis of fracture. - TTL- TTL and refer to pelvic trauma surgeons.

AMBER STREAM

The following classification of patients may require MTC input, but do not require immediate, blue light transfer to the MTC. Interventions such as wound assessment, antibiotic administration and splinting should take place at the initial receiving site.

Acetabular Fractures



- Review by senior ED and orthopaedic in call team who will consider urgent referral to the GM Pelvic Service
- If haemodynamically unstable, consider IR
- Consider TTL – TTL referral in very unstable fractures or associated injuries

If haemodynamically stable:

- Consider other injuries
- Consider need to transfer in discussion with GM Pelvic Team
- Relax binder, observe haemodynamic stability, and post binder x-ray

Lateral Compression Fractures

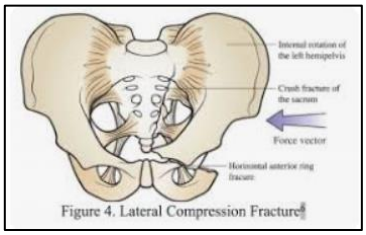


Figure 4. Lateral Compression Fracture[4]

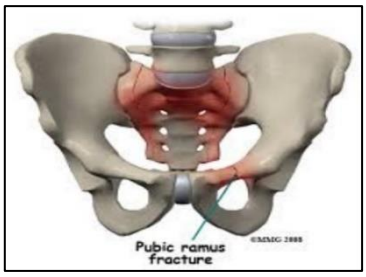
- Review by senior ED and orthopaedic in call team who will consider urgent referral to the GM Pelvic Service
- If haemodynamically unstable, consider IR
- Consider TTL – TTL referral in very unstable fractures or associated injuries

If haemodynamically stable:

- Consider other injuries
- Consider need to transfer in discussion with GM Pelvic Team
- Relax binder, observe haemodynamic stability, and post binder x-ray

GREEN STREAM
The following classification of patients should be managed locally and may be treated conservatively. Consider hydration and bowel care to prevent delirium.
Local orthopaedic on call team to review and refer to GM Pelvic Service for management decision.

Stable Lateral Compression (LC1) and Pubic Ramus Fractures



Low energy injury: A pelvic or sacral insufficiency fracture which commonly accompanies a simple pubic ramus fracture will at least cause back pain and may result in an unstable pelvis.

In high energy injury or in younger patients; pubic rami fracture may be associated with pelvic ring injury, lateral. compression type 1 (LC1) or type 2 (LC2).

In cases where Urgent CT has not already been performed. CT should be requested in:

- Symptomatic older patients (pain and reduced mobility)
- High energy injury in older patients
- All younger patients with pubic rami or suspected pelvic ring injuries

Local orthopaedic on call team to review and refer to GM Pelvic Service for management decision.

Urethrogram /Cystogram

Investigation in the ED after pelvic fracture

- In the absence of any concerning features, in particular blood at the meatus, or any history of haematuria since accident, **a single, gentle attempt** at passing a urinary catheter may be undertaken. ANTT should be observed, and the procedure performed **by an experienced surgeon**: this is not the time to teach the technique.

    i. If clear urine drains, then all good

    ii. If there is any element of blood staining in the fluid draining from the catheter, then a contrast study (retrograde cystogram) is **mandated.**

    iii. Retrograde cystogram: inject 100ml diluted (50% saline, 50% contrast) IV contrast medium into the catheter. Clamp catheter and then take AP pelvis x-ray (or CT if the patient is having one).

- If there is any blood at the meatus prior to catheterisation, or any history of haematuria since accident, then a retrograde urethrogram is indicated before attempts at catheterisation.
- Retrograde urethrogram: use 50ml diluted (50% saline, 50% contrast) IV contrast medium in bladder syringe. Insert size 10 Foley catheter so that balloon is just past the meatus then gently inflate balloon with 5mls saline. Hold in place whilst assistant injects contrast into catheter and take AP pelvis x-ray.
- Urethrogram positive: call Consultant Urologist. Decisions now very difficult. If a suprapubic catheter is needed suggest discussion with the pelvic and acetabular surgeons as this will have major implications for any internal fixation.
- Retrograde urethrogram negative: Catheterise. If haematuria is present, perform retrograde cystogram.

**Principles apply for children but always consult Consultant Paediatric Surgeon

Management of Frail, Older Patients

The age group 65 and over is the fastest growing age group, and the Office for National Statistics (ONS) estimates that by 2050 one in four people in the UK will be aged 65 or over[24]. The ageing of the population has meant that the incidence of traumatic injury in the elderly is rising in both absolute numbers and as a percentage of national trauma admissions annually.

The Trauma Audit Research Network (TARN) report, 'Major trauma in older people' (2017) also highlighted the fact that the proportion of older trauma patients in England and Wales was increasing, with falls from less than 2m remaining a leading cause of severe injury in this group[25].

For many patients, advancing in age is accompanied by an increased incidence of frailty. Frailty is a better predictor than age alone in determining complications and mortality after major trauma. Very frail patients have a shorter life expectancy and may need different priorities when planning treatment.

A frailty assessment (such as Rockwood) can be used for guidance and should form part of a holistic patient assessment.

All staff working with older trauma patients should be trained to understand the effect of altered. physiological reserve, frequently used medications, and increased comorbid disease that exist within this population subset.

Prospective recognition of potentially serious injuries should occur in the pre-hospital phase, but this. group are less likely to be identified, pre-alerted as major trauma and are less likely to be conveyed to major trauma centres. They often see more junior doctors, wait longer to be seen and are more likely to have X-Rays rather than CT scans [26].

Many older patients present as ill as well as injured and are a complex patient group to assess. They may have acute illnesses or co morbidities that can make traumatic injuries harder to detect.

All sites will receive frail, injured patients. Major Trauma Centres are also local hospital sites and receive pre-alerts for frail injured patients as outlined in the pre-hospital version of the Frail Injured Patient (FrIP) pathway.

The FrIP guidance can also be used in ED and has been adjusted as below:

[24] Overview of the UK population - Office for National Statistics (ons.gov.uk)

[25] Major-Trauma-in-Older-People-2017-1.pdf (gmccmt.org.uk)

THE FRAIL INJURED PATIENT PATHWAY (FrIP)

Guidance in ED for self-presenting patients or those not conveyed with a FrIP Amber Pre-alert

Mechanism of Injury

Low Impact Mechanisms

Falls <2m are the largest injury group in major trauma

Consider -

Collapse from Standing

Medical presentations

'Found on floor' presentations

Roll out of bed presentations

Impact Zone

Lack of peripheral injuries should elicit a high index of suspicion

Injury to 2 or more body systems

Pharmacology

Anticoagulants

Consider visible haemorrhage and occult bleeding to head, chest, abdomen, pelvis or long bones.

Consider -

Beta Blockers

Will mask tachycardia in the major trauma patient

Steroids

History of steroid use in chronic disease means fractures are more likely

Other medications

Consider polypharmacy and antiplatelet use (e.g. aspirin). Anticoagulants include warfarin, LMWH and DOACs (apixaban, rivaroxaban, dabigatran and edoxaban).

LMWH: low molecular weight heparin, DOAC: direct oral anticoagulants

Physiology

SBP <110mmHg

***Worried? What is the patient's normal blood pressure?**

Consider -

Existing Disease Process

Note any changes in physiology of the chest wall. Chest wall injuries are common and difficult to diagnose and require careful examination.

Previous Recent Injury History

Consider acute on chronic injury to the brain and other regions

- **Consider previous recent collapses**
- **Consider potential for undiagnosed injury with previous, recent hospital attendances**

Older people may sustain serious injury from low mechanisms. Illness may be present as well as injury. Consider early TXA. Be aware of anticoagulant use and potential for reversal. Recognise potential for occult injury.

The ***'Meet Harry'*** aide memoire captures the complexities of assessing older patients in the Emergency Department. Many present following injury with little or no change in their physiological observations. The tool can be used in pre-hospital and ED triage and has been adapted for use on in-patient wards.

Key messages in caring for older, frail patients

Initial assessment

- A high index of suspicion should be maintained to seek injuries in all older patients who present following low energy mechanisms of injury (such as a slip, trip or fall from standing or seated height)

- Be aware that physiological changes with age can affect the response to trauma, and alter the way that BP and heart rate, for example, after the development of hypovolaemia.

- Be alert for injuries in patients who are taking drugs that increase the risk of bleeding, e.g., anticoagulants. These may need reversing as a priority.

- Patients can be ill as well as injured. Patients may have an acute illness, e.g., pneumonia, which resulted in the fall or may have developed illnesses as a result of the fall.

- Particular care should be taken in assessing patients who have spent significant time lying on the floor.

- Frailty should be assessed as soon as possible, using a recognised scale, e.g., Clinical Frailty Scale. This requires information as to how the person was functioning 2 weeks prior to presentation, and a collateral history may be required.

- Consider early CT scan rather than X-Rays, particularly in assessment of the C spine and rib fractures.

Ongoing care

- Patients should have an accurate documentation of their co morbidities and usual medications as soon as possible.

- Clinicians specialising in the care of older patients should be involved in the care of frail patients wherever possible.

- The patient should be treated holistically – 'treat the person, not their injuries' – when considering management plans. Their degree of frailty should be considered, rather than age alone.

- Suitability for escalation of care and resuscitation should be considered in all cases.

- The patient and/or next of kin should be involved as much as possible with treatment decisions.

- Assistance should be given to help the patient to communicate and understand.

- Palliation should be considered when a patient is not going to recover from their injuries.

- Bed rest should be avoided, and patients assisted to mobilise as soon as it is safe to do so.

Expectation of receiving sites

- All sites should maintain a high index of suspicion when assessing older patients for signs of major trauma injuries.

- Older patients will mostly be 'pathfinder negative' and may not show signs of serious injury (reduced GCS, tachycardia, hypotension etc.). In cases where major trauma is suspected, the GM Injured Patient Pathway should be followed.

- Older patients should be assessed utilising a clinical frailty score. This should inform decision making and guide management to ensure holistic person-centred (not injury-centred) care is delivered.

- In the Emergency Department all nursing staff should have an awareness of the physiological changes in the older, frail patient, the influences of polypharmacy and relevant co-morbidities, and how this impacts major trauma presentations.[26]

- Nursing staff in the emergency department undertaking completion of National Major Trauma Nursing Group Level 2 competencies should be able to calculate a clinical frailty score.[27]

- Prolonged flat bed rest should be avoided. Ward nursing/AHP staff should be aware of the risks in older patients.[28]

- Where possible, older patients with major trauma injuries should have access to both trauma clinicians and geriatric medicine clinicians.

- All patients with a CFS of 5 or more should receive a Comprehensive Geriatric Assessment (CGA) within 72 hours of injury as in-patients in the hospital setting.[29]

- All older patients with a CFS of 5 or more should be routinely assessed using a validated delirium assessment tool (such as the 4AT) and have a delirium policy which describes preventative measures, ensures rapid identification of potentially reversible causes, and delivers individualised interventions in line with NICE CG103.[30]

- All older patients that have sustained orthopaedic injury should have a multifactorial risk assessment, bone health review and should be investigated and provided with appropriate medication where indicated.[30]

- Where possible, patients should be repatriated to their local hospital once the episode of MTC care is completed utilising the Greater Manchester Major Trauma Network Transfer Policy (updated 2024).

Further information:

Clinical Frailty Scale information and training: **https://www.scfn.org.uk/clinical-frailty-scale-training**
London Major Trauma System guidelines **Management of Older Major Trauma Patients (2021)**

[26] National Major Trauma Nursing Group Emergency Department Level 1 Competencies (2022),
[27] National Major Trauma Nursing Group Emergency Department Level 2 Competencies (2022)
[28] National Major Trauma Nursing Group Ward Competencies (2018)
[29] BOA Standard 'The care of the older or frail orthopaedic trauma patient' (2019) **https://www.boa.ac.uk/static/a30f1f4c-210e-4ee2-98fd14a8a04093fe/boast-frail-and-older-care-final.pdf**

Guidelines on Requesting an Oral & Maxillofacial Surgery Opinion

Facial Fracture

Oral / Facial Soft Tissue Injury

- If facial fracture present or suspected and head / neck CT imaging required, consider imaging face at same time (if patient stable).

Oral & Maxillofacial Surgery Emergency Cover Arrangements

Emergencies with primary facial trauma:

Contact MFT switchboard (0161) 276 1234.

Contact 1st on call.

Ask to Vocera Max Fax core trainee on call.

(Escalated as necessary to registrar)

Guidelines on Requesting an Ophthalmic Surgery Opinion

Ophthalmic Injury in Major Trauma Patient

08:00-21:00

Contact the Emergency Eye Department (EED) via MFT Switchboard (0161) 276 1234

Direct line: (0161) 701 4999 (EDD reception)
Emergency Eye Department: (0161) 701 4163/4164

21:00 – 08:00
Out-of-hours

Contact MFT switchboard (0161) 276 1234.
Ask for Ophthalmology 2nd on call.

Abbreviations

ALS	Advanced Life Support
AMPLE	Allergies, Medications, Past medical history, Last meal, Events relating to injury
APTT	Activated Partial Thromboplastin Time
ATLS	Advanced Trauma Life Support
ATMIST	Age, Time of incident, Mechanism, Injuries sustained, Treatment and trends
BOAST	British Orthopaedic Association Standard
CEC	Clinical Effectiveness Committee
CFS	Clinical Frailty Score
CIH	Complex Incident Hub
COPD	Chronic Obstructive Pulmonary Disease
CSF	Cerebrospinal Fluid
CT	Computed Tomography
CXR	Chest x-ray
DAS	Difficult Airway
DCS	Damage Control Surgery
DOAC	Direct Oral Anticoagulants
ECG	Electrocardiogram
ED	Emergency Department
EMAS	East Midlands Ambulance Service
ETC	European Trauma Course
FAST	Focused Assessment with Sonography for Trauma
FFP	Fresh Frozen Plasma
FrIP	Frail Injured Patient (Pathway)
GCS	Glasgow Coma Scale
GM	Greater Manchester
Hb	Haemoglobin
HEMS	Helicopter Emergency Medical Service
HPB	Hepatobiliary
ICP	Intracranial Pressure
IV	Intravenous
ISS	Injury Severity Score
LEH	Local Emergency Hospital
LMWH	Low Molecular Weight Heparin
MHP	Massive Haemorrhage Protocol
MFT	Manchester University Hospital NHS Foundation Trust
MR(I)	Magnetic Resonance (Imaging)
MRI	Manchester Royal Infirmary
MT	Major Trauma
MTC	Major Trauma Centre
MTCC	Major Trauma Centre Collaborative
MTCOD	Major Trauma Consultant of the Day
MTN	Major Trauma Network
NCA	Northern Care Alliance NHS Foundation Trust
NHSE	NHS England
NICE	National Institute for Health and Care Excellence
NWAA	North West Air Ambulance Charity
NWAS	North West Ambulance Service
ODP	Operating Department Practitioner
OOH	Out of Hours
PCA	Patient-controlled analgesia
PERT	Pre-Hospital and emergency Department Resuscitative Thoracotomy

ROTEM	Rotational Thromboelastometry
RSI	Rapid Sequence Induction
SA	Serratus Anterior
SBP	Systolic Blood Pressure
SCI	Spinal Cord Injury
SpR	Specialist Registrar
SRH	Salford Royal Hospital
ST3	Specialty Trainee (3rd year of training)
TBI	Traumatic Brain Injury
TEG	Thromboelastography
TTL	Trauma Team Leader
TU	Trauma Unit
TXA	Tranexamic Acid
VATS	Video-assisted Thorascopic Surgery
VIR	Vascular Interventional Radiology
WBCT	Whole Body CT