Birmingham, Black Country, Hereford & Worcester Trauma Network

A Guide for Clinicians

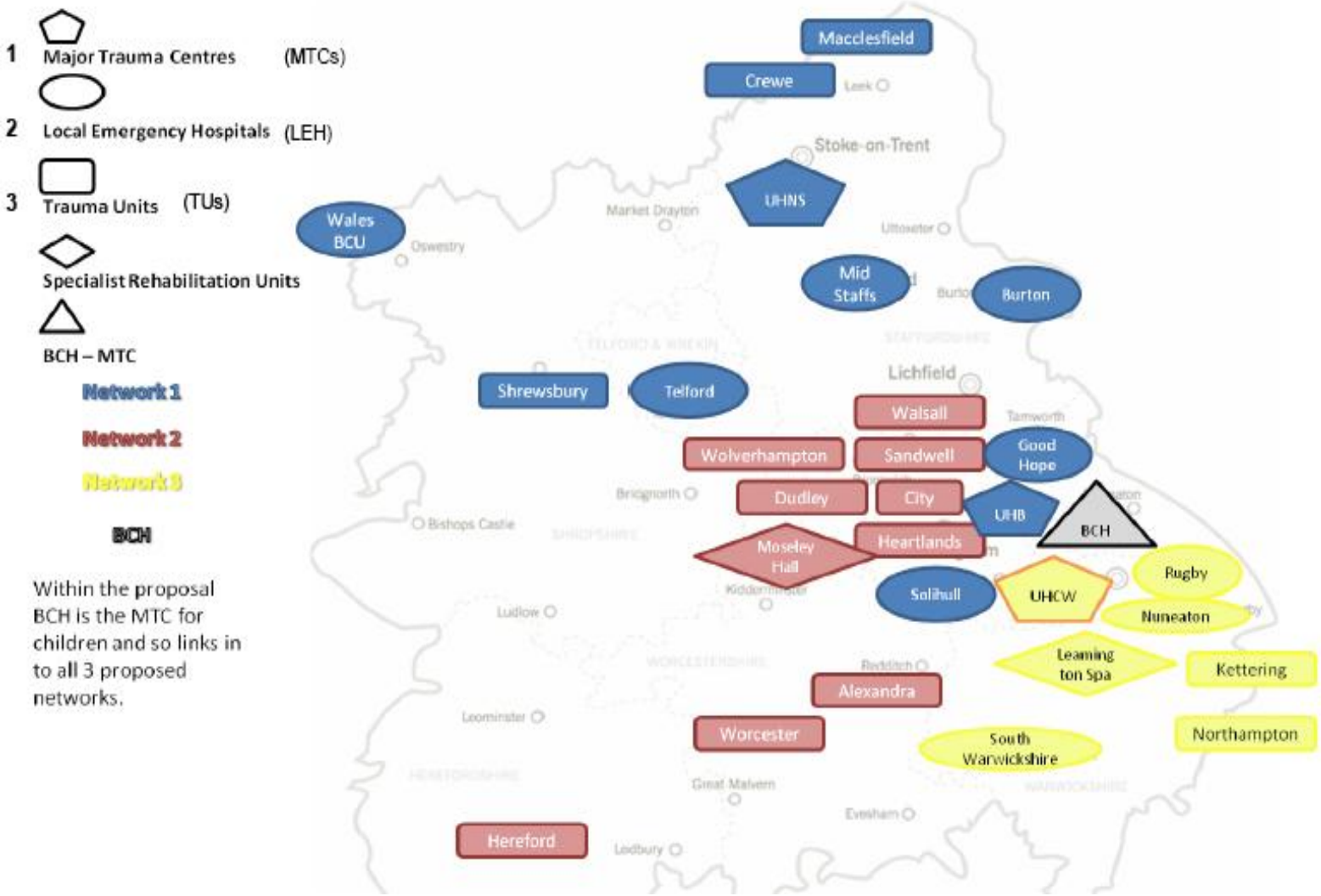
Introduction

The Birmingham, Black Country, Hereford & Worcester Trauma Network will go live at 9am on 26th March 2012. The 2007 *NCEPOD Trauma: Who Cares?* report recommended regional planning for the effective delivery of trauma service in light of a relatively low incidence of trauma. This would mean patients being transferred to specialist centres who are better equipped at dealing with the severely injured patient.

The Queen Elizabeth Hospital at the University Hospitals Birmingham NHS Trust will act as the specialist Major Trauma Centre for Adults, (age > 16 years), and the Birmingham Childrens' Hospital for Children, (age < 16 years).

Birmingham Heartlands Hospital has been designated as a Trauma Unit so will occasionally receive patients close to the site who are deemed too unstable for transfer, or who have injuries not needing immediate Major Trauma Centre-level care.

Other Trusts forming part of this Network are demonstrated on the map below.


1 Major Trauma Centres (MTCs)
2 Local Emergency Hospitals (LEH)
3 Trauma Units (TUs)
Specialist Rehabilitation Units
BCH – MTC
Network 1
Network 2
Network 3
BCH
Within the proposal BCH is the MTC for children and so links in to all 3 proposed networks.
Macclesfield
Crewe
Stoke-on-Trent
UHNS
Wales BCU
Mid Staffs
Burton
Shrewsbury
Telford
Lichfield
Walsall
Wolverhampton
Sandwell
Good Hope
Dudley
City
UHB
BCH
Moseley Hall
Heartlands
Solihull
UHCW
Rugby
Nuneaton
Leamington Spa
Kettering
Alexandra
Worcester
South Warwickshire
Northampton
Hereford

Pre-Hospital Management & Trauma Team Activation

Approach to Trauma Care

From the moment a patient is injured, the Trauma Network has developed an approach to optimise their care and ensure that the right person gets the right treatment, at the right place and at the right time.

The key developments in the delivery of this approach are as follows:

1. Pre-Hospital Triage Tool in place to ensure patients are transferred directly to the Major Trauma Centre if required

2. Support to crews on scene by West Midlands Ambulance Service Trauma Desk, staffed 24:7

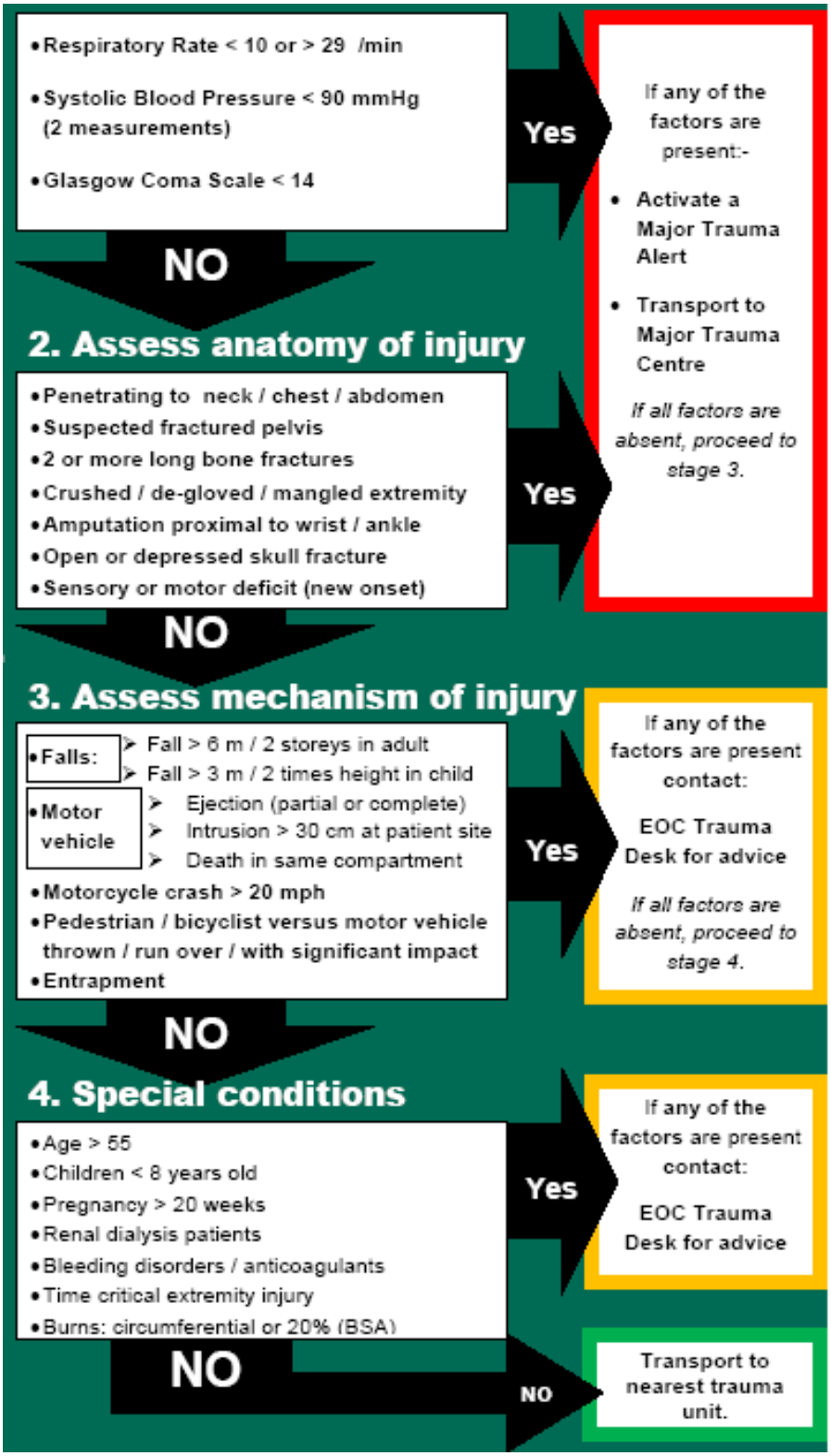
3. Direct pathways between Trauma Units and the Major Trauma Centres via the WMAS Trauma Desk

4. New pathways for Neurosurgical referrals

5. Rehabilitation Pathways with the development of Rehabilitation Prescriptions to accompany patients on their transfer back from the Major Trauma Centre to their local Trust.

The Pre-Hospital Triage Tool

When a patient is injured and an ambulance is called, all crews will use the following tool to determine where the patient should be transferred to:



If the patient is brought to Birmingham Heartlands Hospital and pre-alerted by the West Midlands Ambulance Service, the Trauma Team should be activated.

On the occasion when a patient has been brought in by private transport, or has been under-triaged by the ambulance service, the following criteria should be used to determine whether the Trauma Team should be activated:

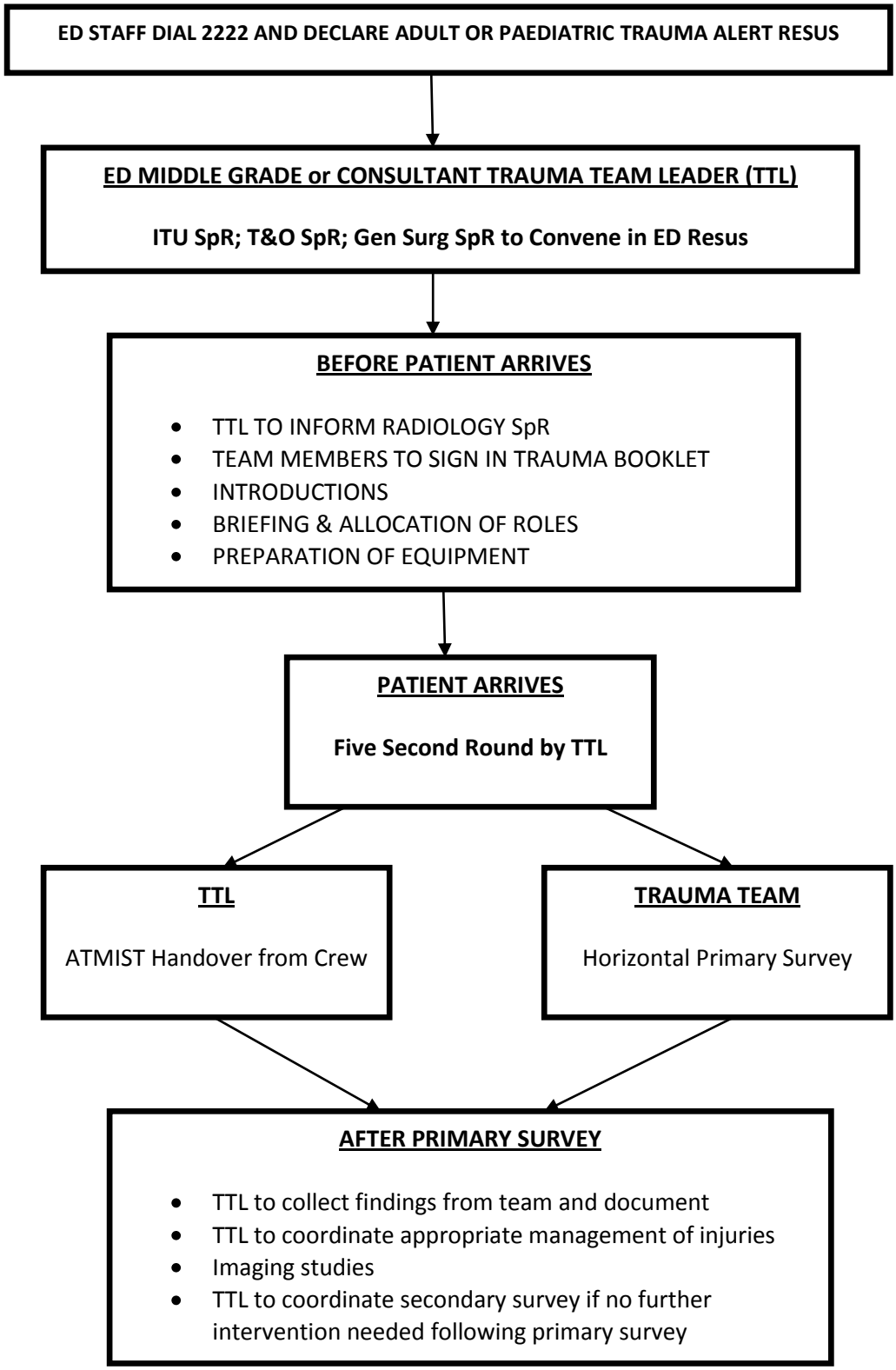
TRAUMA TEAM ACTIVATION CRITERIA ***(Activate Trauma Team via 2222 if pt meets any of the criteria with history of trauma)***

MECHANISM	PHYSIOLOGY	ANATOMY
Penetrating	SBP <90mmHg	Amputation
Gunshot Wound	HR >120	Airway Burns
Stab Wound Trunk	GCS < 12 or Fitting	Burns >10% (Child)
Blast injury/Explosion	Airway Obstruction	Burns >15% (Adult)
Blunt	RR <10 or >30	Spinal Cord Injury
Pedestrian Hit By Car	O2 sats <90%	
High Speed RTC		
Entrapment >20mins		
Fatality Same Vehicle		
Ejection		
Fall > 5m		
Crush Injury		

The Trauma Team

The Trauma Team

The Trauma Team should be led by the ED Consultant or ED Middle Grade / Registrar with ST4-level competencies in trauma management.



Role of the Trauma Team Leader

The Trauma Team Leader should adopt a "hands-free" approach to the patient and only intervene if specific skills / expertise are beyond the competencies of the individual trauma team members.

The Trauma Team Leader should perform the following:

1. **Five Second Round**

2. **ATMIST handover from Paramedic Crew**

3. **Collect Findings of Primary Survey and Coordinate Appropriate Management**

<u>The "Five Second Round"</u>

As the patient arrives in the ED Resuscitation Room, the TTL should quickly assess the patient's responsive level, feel for a distal pulse and look for any obvious signs of external haemorrhage or deformity. This should take approximately five seconds to perform and aims to answer the following questions:

- Is the patient in cardiac arrest?
- Are there signs of massive external haemorrhage or severe hypovolaemic shock?
- Is the airway clear or obstructed?
- Is ventilation compromised?
- Are there any major deformities to the trunk or limbs?

Depending on the findings, the TTL may direct the team immediately to take the following actions:

- Start cardiopulmonary resuscitation
- Control external haemorrhage
- Secure the airway and support ventilation
- Request massive transfusion protocol

If the Five second round does not cause concern, the TTL can "Release" the Trauma Team to complete a horizontal primary survey whilst they take handover from the Paramedic Crew.

ATMIST Handover

Whilst the Trauma Team perform the primary survey, the Team Leader should take handover from the Paramedic crew using an "ATMIST" approach. This is a standard handover tool which will be required at all points of patient handover, including all referrals from Trauma Unit to major Trauma Centre.

A.T.M.I.S.T. Handover tool

AGE	Age and sex of casualty (demographic).	5 Seconds
TIME	Estimated Time of Arrival and the time of incident.	10 Seconds
M.O.I.	Mechanism of incident. This should include: ○ The gross mechanism of injury (e.g. motor vehicle crash or stab wound to the chest) and, ○ Details of other factors known to be associated with major injuries e.g. entrapment, vehicle rollover, occupant ejected from vehicle.	20 Seconds
Injuries	Seen or suspected.	25 Seconds
Signs	○ Vital signs including heart rate, blood pressure, respiratory rate, oxygen saturation and Glasgow Coma Score. ○ An indication as to whether the physiological state of the patient has improved or deteriorated since first seen.	35 Seconds
Treatment	Treatment given.	45 Seconds

Having taken handover, the Team leader should collect all information obtained from the Primary Survey and coordinate appropriate management.

For patients requiring CT scanning, the aim should be to perform this within 30 minutes of the patient's arrival, and have a report within 30 minutes of the scan being performed.

Radiological Investigations

Polytrauma & The Severely Injured Patient

The care provided to the trauma patient in the first few hours can be absolutely critical in terms of predicting their long term recovery. Diagnostic and therapeutic radiology plays a pivotal role in this management process and timely access to adequate imaging modalities is key to obtaining early diagnosis and instituting early definitive care.

The acute trauma setting is not the place for disagreements about the patient pathway and immediate management decisions should be made by the Trauma Team Leader, (see separate guideline). The TTL should inform the Radiology Registrar On Call or Radiology Consultant (during working hours) as soon as the Trauma Team is activated.

Digital Radiography (DR) & FAST Scanning

- If there is a decision to request MDCT (Multi-detected computer tomography), Chest X-Ray (CXR) would still be of use if there is doubt about the side or presence of a pneumothorax. As routine, Chest X-Ray and Pelvis X-Ray in the resuscitation room should be considered for Trauma Team activations.

- Focussed abdominal sonography in trauma (FAST) does not offer any additional information to that obtained with a CT scan and should not be performed if it would cause a delay to CT

- In experience hands, FAST is a useful adjunct to clinical examination and may have a role in the diagnosis of pericardial effusion and when managing multiple casualties at once

Polytrauma Protocol MDCT

CT-scan has become the gold standard for the secondary survey of the head, neck and trunk. A polytrauma protocol MDCT is indicated where:

1. **The mechanism of injury or presentation suggests that there may be occult severe injuries that cannot be excluded by clinical examination or plain films**
2. **FAST has demonstrated intra-abdominal fluid**
3. **Obvious severe injury on clinical assessement (e.g. >2 long limb fractures, amputation)**
4. **If plain films suggest significant injury (e.g. pneumothorax, pelvic fractures)**

Trauma CT should be from vertex to symphysis with iv contrast unless there are absolute contra-indications.

Any CT request must comply with Ionising Radiation (Medical Exposure) Regulations (IR(ME)R) and contain justification regulations, (e.g. mechanism, findings, suspected injury).

Haemodynamic Instability

If a patient with a systolic blood pressure **< 90mmHg** is to go to CT, this must be discussed with the anaesthetist and the trauma team leader.

Patients with a **SBP < 70mmHg** should probably go to theatre immediately for damage control surgery.

Patients with a **SBP 70-90mmHg** may benefit from the diagnostic accuracy of a scan but it is essential that the following must be made aware: the Consultant Anaesthetist, Consultant Radiologist, Consultant Surgeon and TTL and Emergency Medicine Consultant.

Mechanism of Injury and Polytrauma CT Requesting

Whereas there is no absolute indication to perform a polytrauma CT based on mechanism, the following findings / presentations should alert the TTL to seriously consider requesting a polytrauma CT.

1. **Injury to >1 Body region**
2. **Fatality at Scene**
3. **Fall from > 3m**
4. **Gunshot wound**
5. **High speed RTC, (Pedestrian vs Car; Ejection; Rollover; Entrapment > 30mins)**

Simple penetrating injuries, (e.g. stab wounds), may be more suited to having focussed, regional imaging.

If any doubt remains from the TTL as to whether to request a polytrauma CT, this should be escalated to the Emergency Department consultant on call.

CT Reporting and Transfer of Images

All CT-scans should be reported by an appropriately trained on call radiologist. A primary survey report giving an indication of the major life-threatening injuries should be provided immediately followed by a definitive report within an hour of MDCT acquisition.

Where active contrast extravasation is seen, the on-call interventional radiologist should be informed immediately, along with the trauma team leader.

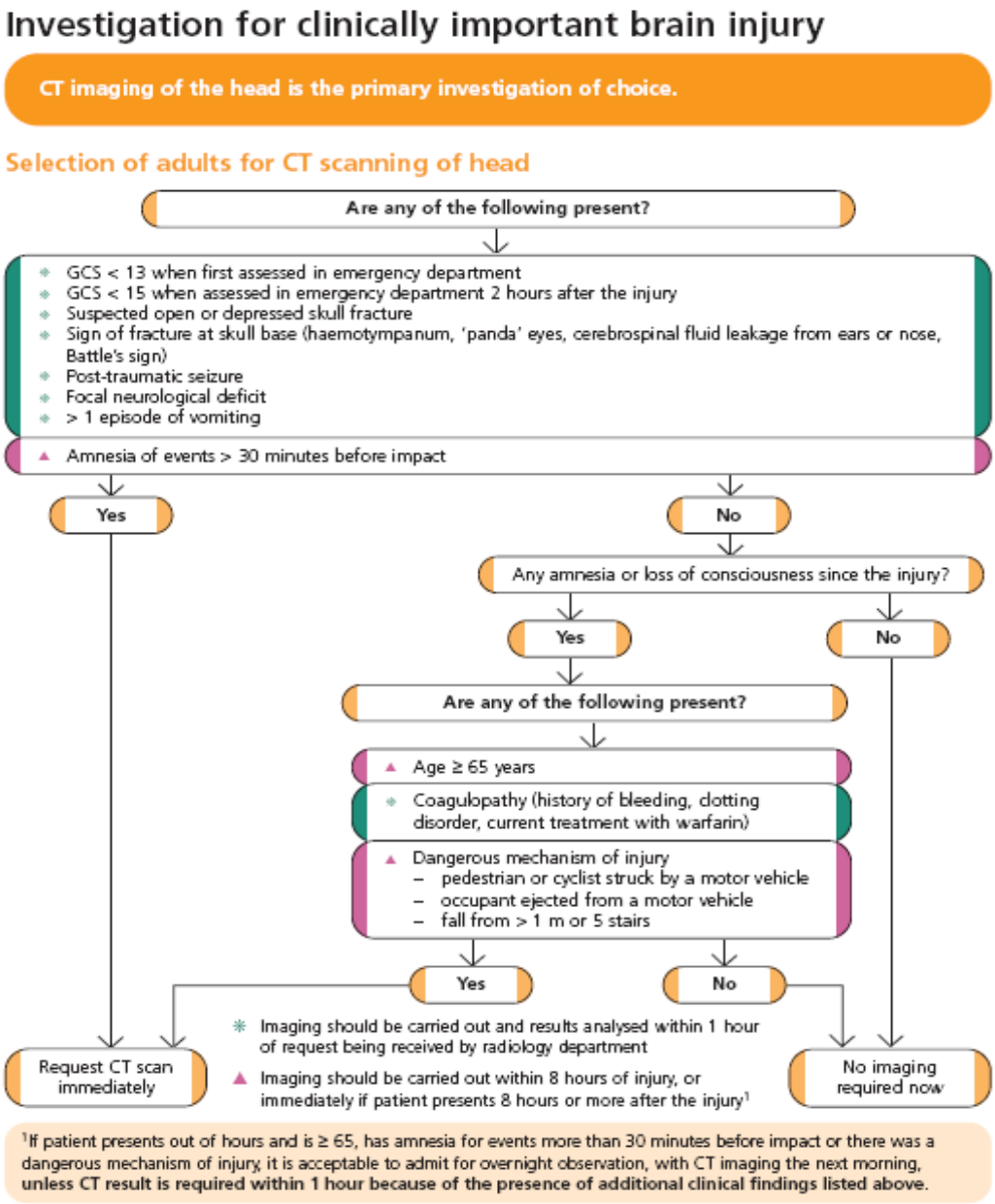
The decision on whether a patient with traumatic haemorrhage undergoes endovascular treatment, open surgery, a combination of the two, or non-operative management should be made by the Interventional Radiologist and Trauma Team Leader after consultation with other consultants involved.

Head & Neck Injuries

Head Injury in Adults (Age 16 and Over)

Skull X-Rays are only indicated to assess for retained foreign body, (e.g. glass smashed over head with associated laceration). They should all be discussed with the MG/Senior clinician on duty and all requesting should follow IRMER guidelines.

Requesting of CT Head scans should be made after prior discussion with a senior ED clinician, (Middle Grade or above), and conform to NICE Guidelines for requesting CT Head scans, (see below)



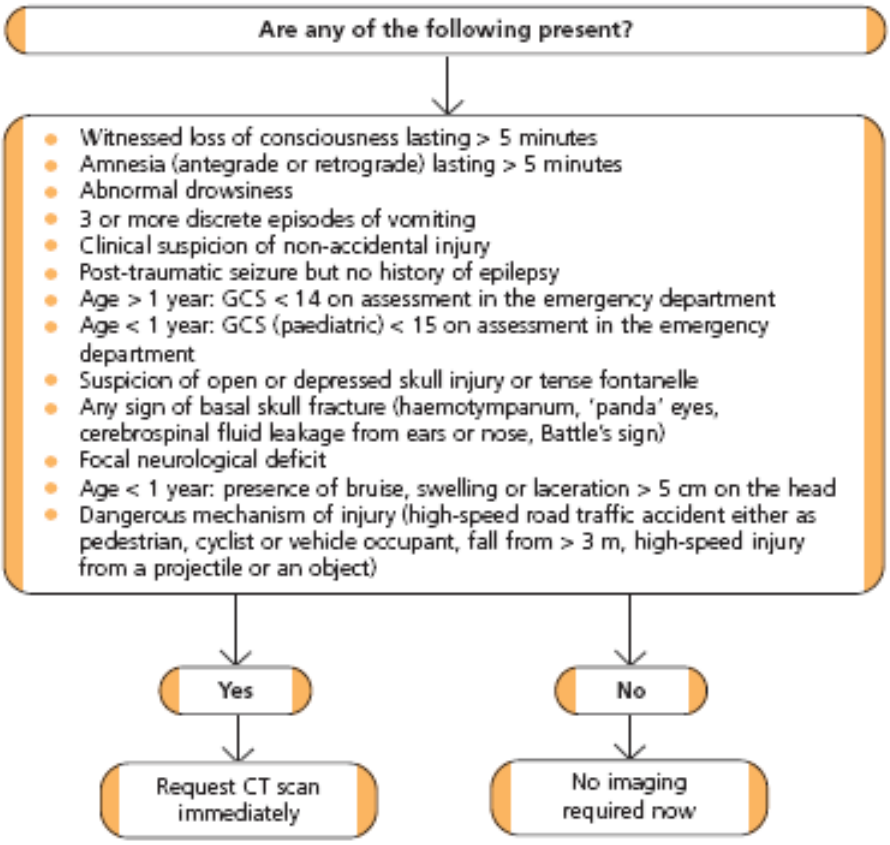
All patients with head injury who reattend with worsening headache despite regular analgesia should be discussed with a senior ED clinician (Middle Grade or above) and there should be a low threshold for requesting a CT Head Scan. If the patient reattends > 7 days after the initial injury, discuss with the Radiology Consultant On Call to determine appropriate imaging modalities

Head Injury in Children (16 years or less)

CT requests need to be made by a clinician experienced in assessing children and be of Middle Grade seniority or above.

There is little or no role for Skull X-Rays in children. Consideration of skull X-Rays should be discussed with a consultant

Selection of children (under 16) for CT scanning of head

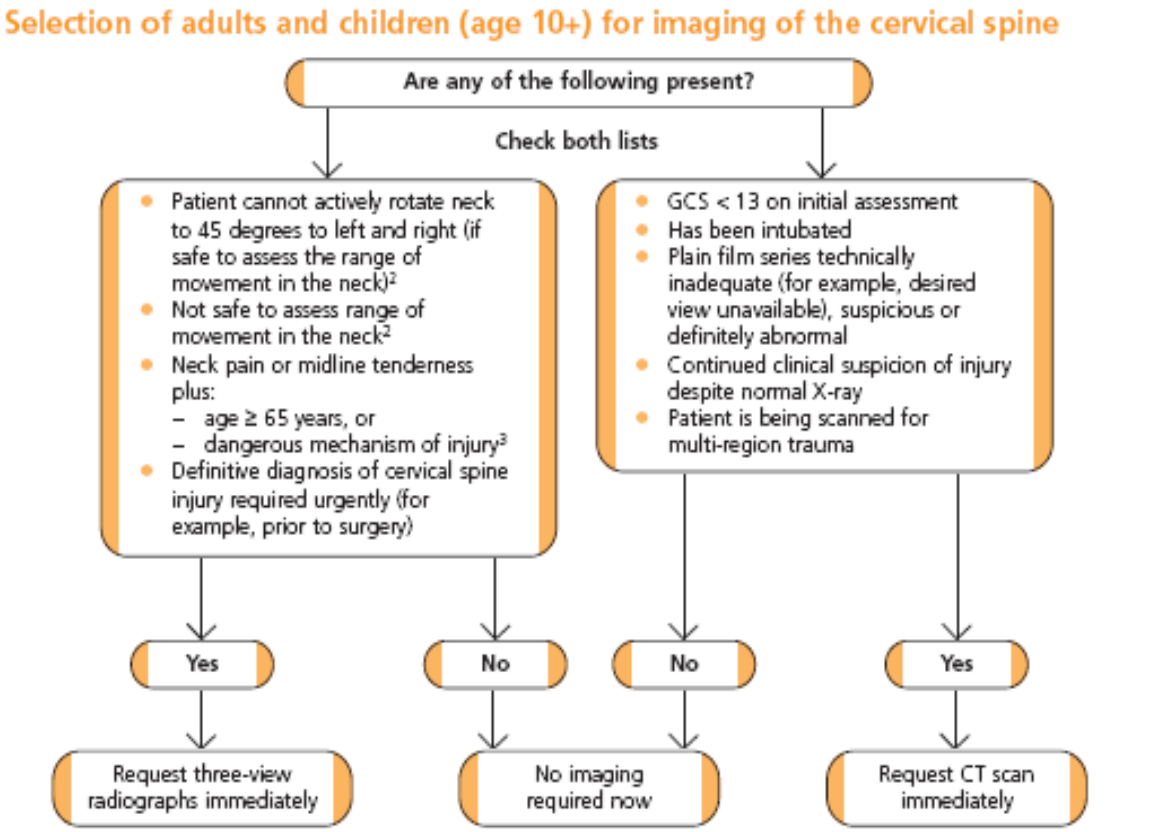


Investigation of non-accidental injury in children

A clinician with expertise in non-accidental injuries in children should be involved in any suspected case of non-accidental injury in a child. Consider: skull X-ray as part of a skeletal survey; ophthalmoscopic examination for retinal haemorrhage; examination for pallor, anaemia, tense fontanelle and other suggestive features. Imaging such as CT and magnetic resonance imaging (MRI) may be required to define injuries.

Immediate CT Imaging of the Cervical Spine

CT cervical spine is indicated as follows:



[2] Safe assessment can be carried out if patient: was involved in a simple rear-end motor vehicle collision; is comfortable in a sitting position in the emergency department; has been ambulatory at any time since injury and there is no midline cervical spine tenderness; or if the patient presents with delayed onset of neck pain.

[3] Dangerous mechanism of injury: fall from > 1 m or 5 stairs; axial load to head – for example, diving; high-speed motor vehicle collision; rollover motor accident; ejection from a motor vehicle; accident involving motorized recreational vehicles; bicycle collision.

Children under 10 years

- Use anterior/posterior and lateral radiographs without an anterior/posterior peg view.
- Use CT imaging to clarify abnormalities or uncertainties.

Investigation for injuries to the cervical spine

Which Investigations?

- **In most circumstances, plain radiographs are the initial investigation of choice to detect cervical spine injuries – three views of sufficient quality for reliable interpretation (two views for children under 10 years of age)**
- CT imaging is recommended in some circumstances
- Children under 10 have increased risk from irradiation, so restrict CT imaging of cervical spine to children with indicators of more serious injury, in circumstances such as:
    - severe head injury (GCS <= 8)
    - strong suspicion of injury despite normal plain films
    - plain films are inadequate.

As a minimum, CT imaging should cover any areas of concern or uncertainty on plain films or clinical grounds.

Timing of cervical spine imaging

- Imaging indicated: imaging within 1 hour of request being received by the radiology department or when patient sufficiently stable.
- Children under 10 with GCS <= 8: CT imaging of the cervical spine within 1 hour of presentation or when sufficiently stable.

Fits/coma in children

Children who present with acute encephalopathy with an abnormal GCS (with or without localising signs) require an urgent CT scan. Children who fail to consistently improve their conscious level after prolonged fits also require an urgent CT scan. Children who require emergency general anaesthetic for status epilepticus require an urgent CT scan. Most children with febrile convulsions (even if prolonged) do not require a CT scan.

CERVICAL SPINE CT in Adults & Children (10 years of age & over)

For obtunded patients with isolated head injuries (for whom a CT head is indicated) and when the cervical spine needs to be cleared, a CT examination of the cervical spine should be undertaken in preference over plain radiographs of the neck.

In children aged less than 10 the opinion of a senior clinician should be sought on the appropriateness of scanning.

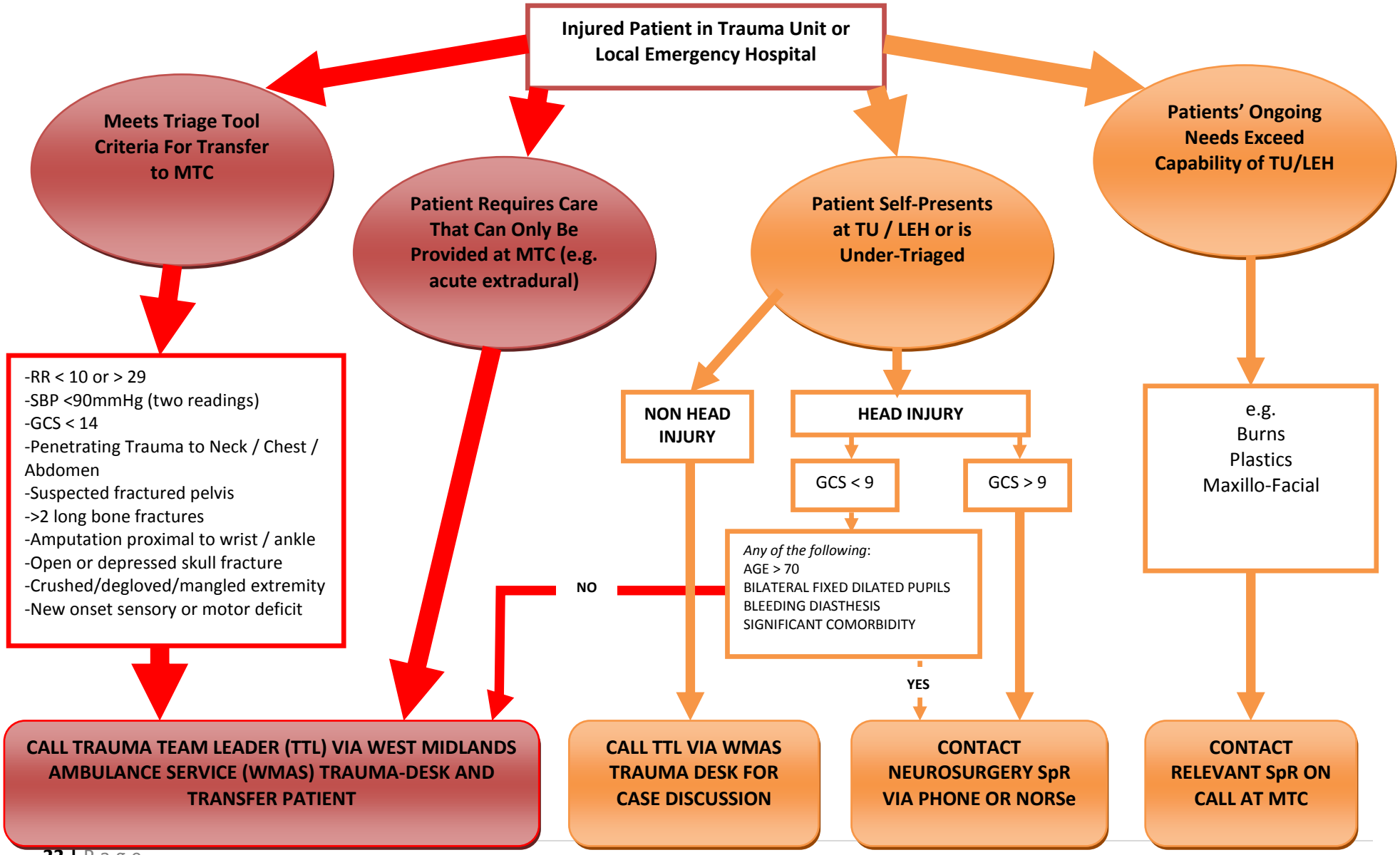
Transfer of Patients to the Major Trauma Centres

Introduction

In the context of the Trauma Network, there will be four general categories of patient presenting to the Trauma Unit or Local Emergency Hospital:

a. Patients meeting criteria for immediate transfer to the Major Trauma Centre (MTC)
b. Patients with injuries whose immediate care can only be provided at the Major Trauma Centre
c. Self-presenting or under-triaged patients with significant injuries detected on CT or Examination
d. Patients whose ongoing needs exceed the capability of the Trauma Unit or Local Emergency Hospital.

These groups of patients will be managed differently within the Network and the pathways are illustrated below.


Injured Patient in Trauma Unit or Local Emergency Hospital
Meets Triage Tool Criteria For Transfer to MTC
Patient Requires Care That Can Only Be Provided at MTC (e.g. acute extradural)
Patient Self-Presents at TU / LEH or is Under-Triaged
Patients' Ongoing Needs Exceed Capability of TU/LEH
-RR < 10 or > 29
-SBP <90mmHg (two readings)
-GCS < 14
-Penetrating Trauma to Neck / Chest / Abdomen
-Suspected fractured pelvis
->2 long bone fractures
-Amputation proximal to wrist / ankle
-Open or depressed skull fracture
-Crushed/degloved/mangled extremity
-New onset sensory or motor deficit
NON HEAD INJURY
HEAD INJURY
GCS < 9
GCS > 9
Any of the following:
AGE > 70
BILATERAL FIXED DILATED PUPILS
BLEEDING DIASTHESIS
SIGNIFICANT COMORBIDITY
NO
YES
e.g.
Burns
Plastics
Maxillo-Facial
CALL TRAUMA TEAM LEADER (TTL) VIA WEST MIDLANDS AMBULANCE SERVICE (WMAS) TRAUMA-DESK AND TRANSFER PATIENT
CALL TTL VIA WMAS TRAUMA DESK FOR CASE DISCUSSION
CONTACT NEUROSURGERY SpR VIA PHONE OR NORSe
CONTACT RELEVANT SpR ON CALL AT MTC

Contact Telephone Numbers for West Midlands Ambulance Service Trauma Desk

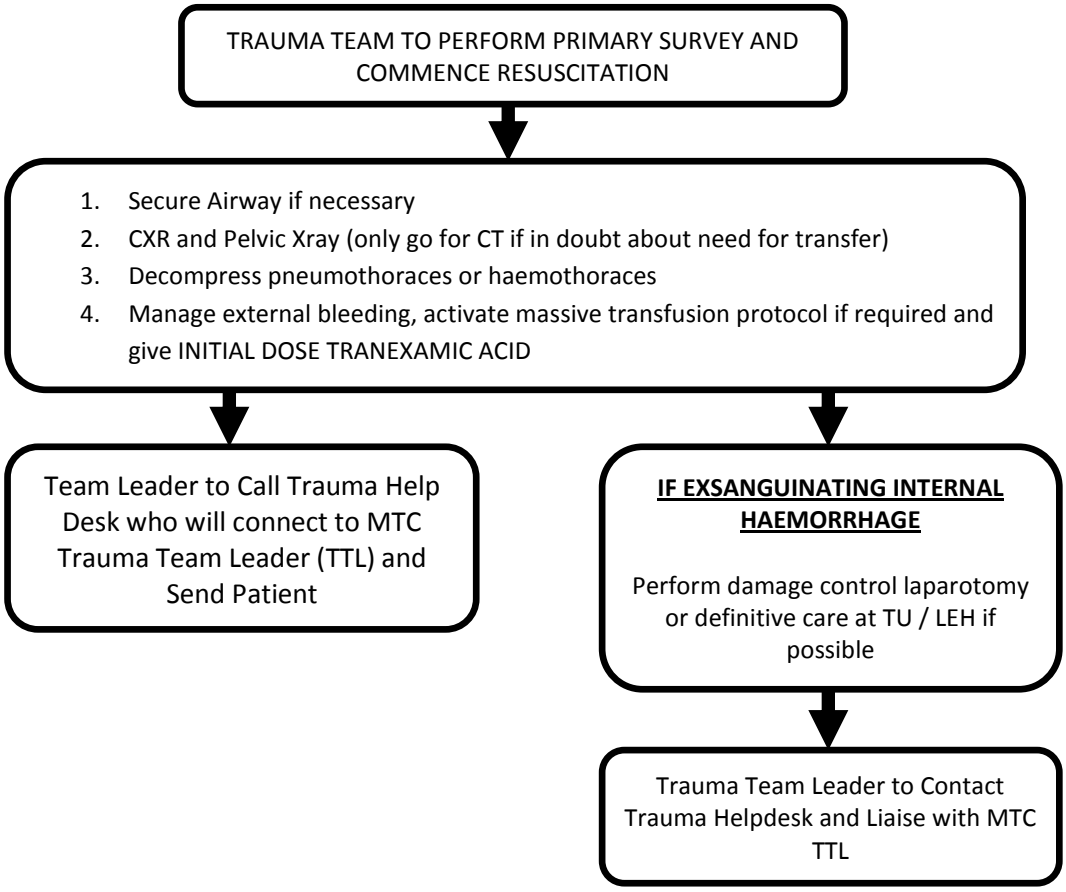
01384 215695 MTD Emergency Contact

01384 215696 MTD General Enquiries

01384 215697 MTD Desk Admin Line

Patients Meeting Criteria for Immediate Transfer to the MTC

If a patient is injured and fulfils the pre-hospital criteria for immediate transfer to a Major Trauma Centre, the WMAS Trauma Help Desk will inform the Trauma Team Leader at the MTC if the patient is brought to Birmingham Heartlands or Good Hope Hospital. Once the patient arrives in the Emergency Department, the Trauma Team should commence resuscitation, perform a thorough primary survey and ensure the patient is safe for transfer to the MTC.



The Trauma Team Leader should contact the Trauma Helpdesk via 01384 215695 who will connect them to the Team Leader at the MTC to coordinate immediate transfer.

Patients for Whose Care Can Only Be Provided at the Major Trauma Centre

If a patient presents to the TU / LEH with complex injury patterns that can only be dealt with at a specialist centre, these patients should be transferred to the Major Trauma Centre.

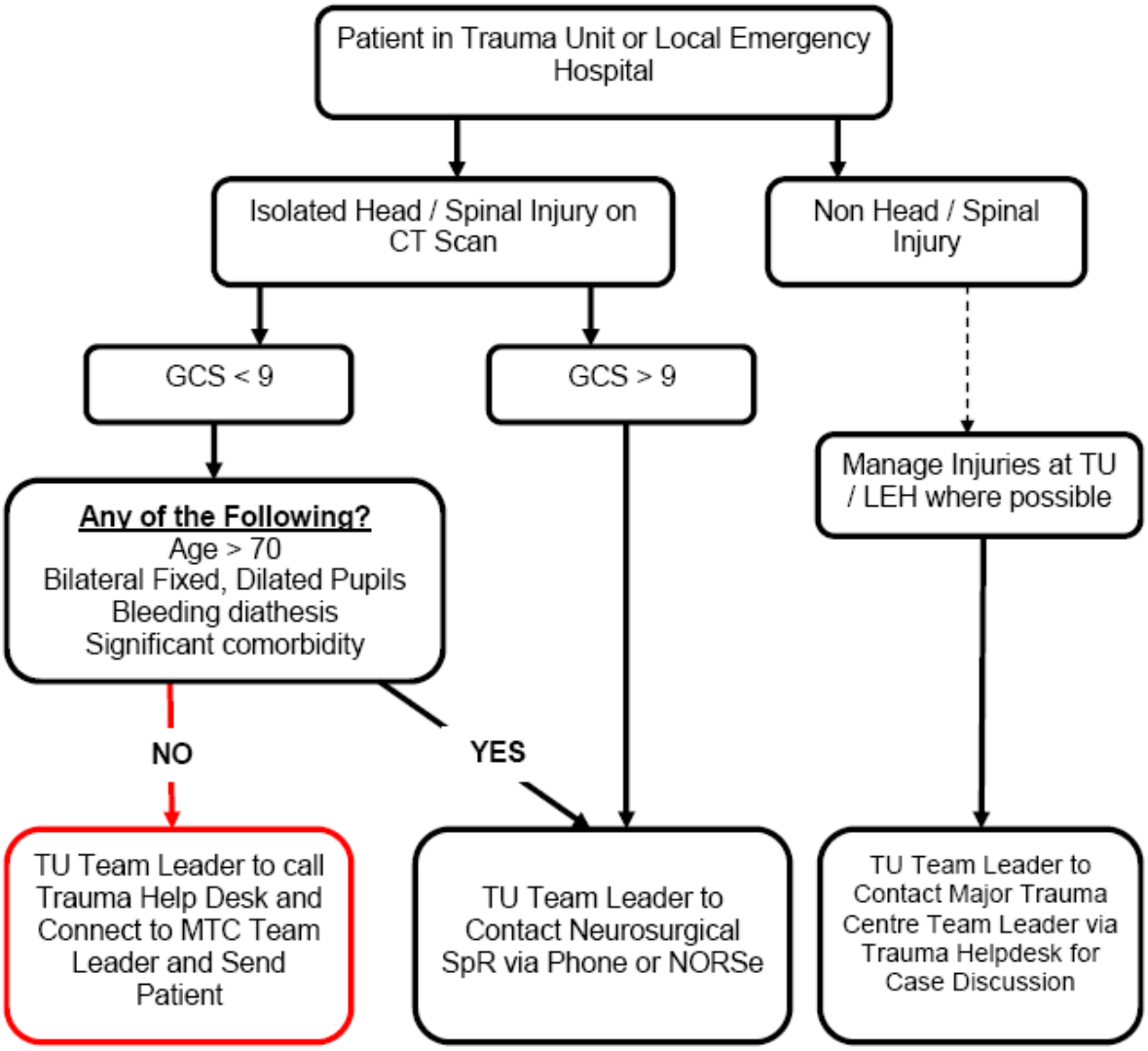
Examples of such injuries include acute extradural haematomas. Guidelines from the Brain Trauma Foundation suggest that all patients with an acute extradural haematoma be managed in a "neurosciences centre". Therefore, if a patient is identified as having such an injury on CT scan, the Trauma Team Leader should call the West Midlands Ambulance Service Trauma Desk to connect with the Major Trauma Centre and arrange to transfer the patient.

Patients with other isolated or combined head / spinal injuries are covered by a separate pathway related to neurosurgical referrals.

Self-Presenting or Under-Triaged Patients

Occasionally patients will self-present to the TU / LEH, bypassing the Pre-Hospital Network activation system. In other instances, patients may be under-triaged and not trigger the Trauma Network. A standard approach should be used by the Trauma Team whereby a rapid, thorough primary survey is performed at the same time as ongoing resuscitation. **Emergency Department consultants should be informed of ALL Trauma Team Activations**

For the purposes of the Trauma Network, further transfer decisions are based upon whether the patient has a head / spinal injury or alternative injuries.



Patients for Whose Needs Exceed the Capability of the TU / LEH

As per existing arrangements, patients with Maxillo-Facial Injuries, Burns, and Injuries requiring specialist Plastic Surgery input should be referred to the relevant SHO / Registrar at the Major Trauma Centre.

Neurosurgical Referrals

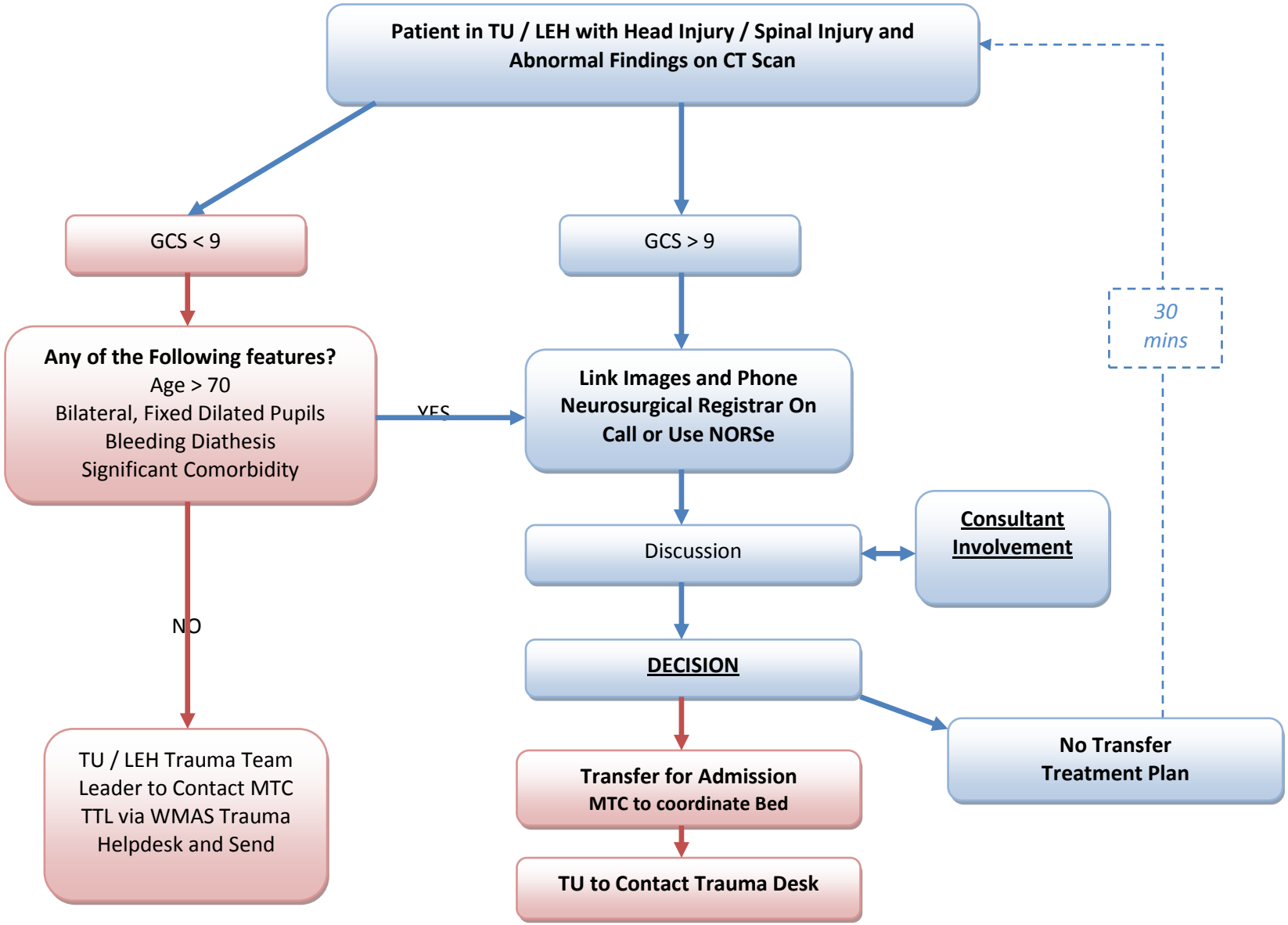
Introduction

Having presented to Birmingham Heartlands Hospital (TU) or Good Hope Hospital (LEH) Emergency Department, patients with a head and / or spinal injury with abnormal CT findings should be discussed with Senior ED staff, (Middle Grade or above).

All abnormal images should be linked immediately to the Neurosurgical Team at the Queen Elizabeth Hospital Birmingham and the patients referred to either the Trauma Team Leader via the WMAS Trauma Desk or directly with the Neurosurgical Registrar on Call, (see pathway).

Referral and transfer pathways to the Neurosurgical teams at UHB Major Trauma Centre take one of two routes, according to the patient's GCS and comorbidities.

EYE		MOVEMENT		VERBAL	
Open spontaneously	4	Obeys commands	6	Orientated	5
Opens to voice	3	Localises to Pain	5	Confused	4
Opens to pain	2	Withdraws	4	Inappropriate	3
No response	1	Abnormal Flexion	3	Incomprehensible	2
		Abnormal Extension	2	No response	1
		No movement	1		


Patient in TU / LEH with Head Injury / Spinal Injury and Abnormal Findings on CT Scan
GCS < 9
GCS > 9
Any of the Following features?
Age > 70
Bilateral, Fixed Dilated Pupils
Bleeding Diathesis
Significant Comorbidity
YES
Link Images and Phone Neurosurgical Registrar On Call or Use NORSe
30 mins
Discussion
Consultant Involvement
NO
DECISION
TU / LEH Trauma Team Leader to Contact MTC TTL via WMAS Trauma Helpdesk and Send
Transfer for Admission
MTC to coordinate Bed
No Transfer Treatment Plan
TU to Contact Trauma Desk

Direct Referral to MTC Trauma Team Leader

All patients with a GCS < 9 who don't have any of the features listed below should be referred to the MTC TTL. The Team Leader should contact the West Midlands Ambulance Trauma Desk on 01384 215695 who will put them through to the MTC TTL.

Features Warranting Neurosurgical Discussion Despite GCS < 9

1. Age > 70 years
2. Bilateral, fixed dilated pupils
3. Bleeding diasthesis
4. Significant comorbidities

Any patient with an acute extradural haematoma on CT scan should be referred this way, as under the Network transfer policies, these injuries should be managed in a neurosciences centre.

Referral to Neurosurgical Registrar

Patients with a GCS > 9, or with positive CT findings that don't mandate immediate transfer to the MTC, should be discussed with the Neurosurgical Registrar on call at the QEH. They can be contacted by dialling #6248 and asking switchboard to put you through to the Registrar.

After initial point of contact with the Neurosurgeons, a definitive management decision should be made ***within 30 minutes of referral.*** If no plan has been forwarded to the TU / LEH TTL within 30 minutes, they should attempt to contact the Neurosurgical Registrar On-Call again. Further delay mandates escalation to the ED Consultant and discussion with the Neurosurgical Consultant at the UHB.

In accordance with Brain Trauma Foundation Guidelines as to what constitutes a "surgically significant" lesion, the following clinical characteristics and CT findings should warrant a more active pursuit of a definitive neurosurgical plan, irrespective of GCS:

Extradural Haemorrhage	Subdural Haemorrhage	Traumatic Parenchymal Lesion	Depressed Skull Fracture
EDH > 30cm^3 Midline shift > 5mm >15mm thickness *Patients with an EDH <15mm thick, <30cm^3 volume andwith <5mm midline shift can be treated conservatively at a neurosciences centre*	Thickness > 10mm Midline shift > 5mm GCS <9 + Thickness <10mm + GCS drop > 2 since injury or fixed or asymmetric pupils	Progressive neurological deterioration without extracranial cause Medically refractory intracranial hypertension Signs of mass effect on CT Lesion > 50cm^3 on CT Frontal / temporal contusion with GCS 6-8 and midline shift >5mm or cisternal compression on CT	Open fracture depressed greater than thickness of cranium Gross cosmetic deformity Gross contamination Dural penetration Significant intracranial haematoma

Spinal Cord Injury

All patients with spinal cord injury should be discussed with the Neurosurgical Registrar On Call at the MTC. Further input may be required from the Midland Spinal Cord Injury Centre at Oswestry after discussion with the Neurosurgeons. In general, they have the following admission criteria but very rarely accept patients in a hyperacute setting:

1. Spinal trauma and new onset neurological deficit
2. Spinal trauma and an unstable vertebral column fracture which the TU / LEH aren't able to manage
3. Non-traumatic, progressive spinal paralysis, (e.g. epidural haematoma secondary to over anti-coagulation)

No patient should be kept in the Emergency Department whilst waiting for an MCSI spinal bed. These patients should be admitted under the relevant speciality and transferred when appropriate.

Outcome of Neurosurgical Referral

With the definitive management decision, the Neurosurgical Registrar should provide a detailed management strategy including length of neurological observation, use of anti-epileptic medication or other agents, and appropriate management for any unexpected patient deterioration. The referring clinician should document the name of the Neurosurgical Registrar and time of discussion.

Patients Not Being Transferred

Patients with multiple injuries should be admitted under the care of the team that is trained to deal with their most severe and urgent problem. When admitted, observations should be recorded half hourly until the GCS is 15.

Once the GCS is 15, observations should be recorded half-hourly for two hours, hourly for four hours and two-hourly thereafter. Any neurological deterioration should prompt immediate reassessment by the supervising clinician. To reduce inter-observer variability, a second member of staff capable of performing observation and confirming deterioration should be involved before referral to the supervising clinician.

The following features are examples of such deterioration:

-Development of agitation or abnormal behaviour
-Sustained drop in GCS of 1 point for more than 30 minutes duration (greater attention paid to drops in motor score)
-Development of severe or increasing headache and / or persistent vomiting
-New or evolving neurological symptoms / signs, such as pupil inequality, limb or facial asymmetry
-Any drop of three or more points in eye or verbal score, or a drop of two or more points in motor score

An immediate CT scan should be considered if a patient develops any of the above features, or, if a patient has not achieved GCS 15 after 24 hours observation, a further CT scan or MRI should be performed.

Patients Being Transferred to the MTC

Guidance taken from the Brain Trauma Foundation and NICE mandates the following management strategy, although this may be altered on the advice of the MTC TTL or Neurosurgical Registrar On Call:

1. Monitoring of Blood Pressure and avoiding SBP <90mmHg
2. Aim for PaO2 > 13kPa
3. Aim for PaCO2 4 - 4.5kPa
4. Restrict mannitol use prior to ICP monitoring to patients with signs of tentorial herniation or progressive neurological herniation not attributable to extra-cranial causes.
5. Anticonvulsants are indicated to prevent the development of early post-traumatic seizure
6. In moderate / severe traumatic brain injury, high dose methylprednisolone is contra-indicated and associated with higher mortality

The following are indications for endotracheal intubation at any point, or prior to transfer of patients with a head injury:

- GCS < 8
- Loss of protective laryngeal reflexes
- Irregular respirations
- PaO2 < 13kPa or PaCO2 > 6 kPa
- Spontaneous hyperventilation causing PaCO2 < 4kPa
- Significantly deteriorating conscious score, (especially 1 or more points on motor score)
- Unstable fractures of the facial skeleton
- Copious bleeding into mouth
- Seizures

Hyperacute Transfers

PATIENT IDENTIFIED AS NEEDING TRANSFER TO MAJOR TRAUMA CENTRE

PRE-TRANSFER ACTIONS:

1. Undertake Full Primary Survey
2. Secure airway if necessary
3. CXR and Pelvic X-Ray (only perform CT if any doubt about the need for transfer or at request of MTC TTL)
4. Decompress pneumothoraces and haemothoraces (use transport type drains, not underwater seal)
5. Control haemorrhage
   a. Stop external bleeding
   b. Activate massive transfusion protocol if required
   c. Give initial dose tranexamic acid
6. Apply pelvic binder if required
7. Splint femoral fractures with traction splint / immobilise other fractures with splints or plaster

CLINICAL CONSIDERATIONS

The TU TTL should be satisfied that:
-Airway is safe for the duration of transfer
-Life-threatening chest injuries treated / excluded
-Appropriate haemorrhage control achieved
-C-spine immobilisation is maintained

EXSANGUINATING INTERNAL HAEMORRHAGE

Perform damage control laparotomy or definitive care before transfer if this is possible in a timely fashion and does not exceed capability of TU / LEH

All relevant imaging is transferred electronically to the receiving MTC

Escort is provided who is clinically capable of dealing with patient's condition

Standard of monitoring reflects patient's condition ($ETCO_2$ for all ventilated patients)

Equipment checks completed – battery power for infusion pumps and monitors

NO

YES

DO NOT TRANSFER UNTIL SATISFIED WITH ALL THE ABOVE

INFORM MTC TTL IMMEDIATELY BEFORE DEPARTURE AND CONFIRM EXACT DESTINATION AND ESTIMATED JOURNEY TIME

Clinical Considerations

Once a patient has been identified who warrants transfer to the Major Trauma Centre, the TU Trauma Team Leader should ensure that the following steps are taken as a minimum before transfer:

A. FULL PRIMARY SURVEY HAS BEEN PERFORMED AND DOCUMENTED

B. AIRWAY IS SECURE

C. CHEST X-RAY AND PELVIS X-RAY HAVE BEEN PERFORMED, (CT should be undertaken if there is any doubt over the need for transfer, or at the request of the MTC trauma Team Leader)

D. PNEUMOTHORACES AND HAEMOTHORACES HAVE BEEN DRAINED AS APPROPRIATE (use transport drains as opposed to underwater seals)

E. CONTROL EXTERNAL HAEMORRHAGE
- i. Stop external bleeding
- ii. Activate massive transfusion protocol as required
- iii. Give initial dose of tranexamic acid

F. APPLY PELVIC BINDER IF REQUIRED

G. SPLINT FEMORAL FRACTURES WITH TRACTION SPLINT (and apply splints or plaster casts to other fractures)

In addition to this, the Team Leader should ensure that:

the airway will be safe for the duration of the transfer;
cervical spine immobilisation is maintained;
any life-threatening chest injuries are treated or excluded;.

Patients with Exsanguinating Internal Haemorrhage

If a patient remains unstable despite adequate resuscitation with blood products and efforts to control any haemorrhage, all members of the Trauma Team should escalate this to their relevant consultants. Damage control laparotomy or definitive care should be provided at the TU / LEH where possible as a matter of priority.

In certain circumstances, it may not be possible to ensure that all patients are completely stable as the intervention to achieve stability may also be the reason for the transfer. For such cases, the TU Trauma Team Leader should contact the WMAS Trauma Desk and liaise with the MTC pending immediate transfer.

Preparation for Transfer

Imaging and Documentation

The Trauma Team Leader should ensure that all X-ray and CT images have been linked to the MTC via the Imaging Exchange Portal and that the MTC Trauma Team Leader is in receipt of these. Delays in this process should not hinder the transfer of the critically unstable patients and if necessary, CD-based images should be transferred with the patient.

The TU TTL should ensure that all documentation is completed and scanned onto the internal MSS system prior to patient transfer and original copies, or adequate photocopies sent with the patient. Finally, the TTL should inform the patient's family members of the transfer.

Escort

The appropriate escort should be determined by the TU Trauma Team Leader. For intubated and ventilated patients this will normally be an anaesthetist or ITU doctor. For non-intubated patients, the escort must be capable of dealing with any anticipated complications en route.

The ambulance service will not routinely return escorts to the referring TU / LEH but the MTC will arrange taxi transfers to return the escort and their equipment. Escort staff should wear suitable clothing and take mobile phones and money in case of emergency. They should know the **exact destination and have a named contact** at the receiving MTC.

The transfer personnel should fully familiarise themselves with the patient's history, present condition and treatment up to the point of departure. Prior to departure, they should perform a full clinical assessment to ensure that the patient is ready for transfer.

Monitoring During Transfer

During transfer, the standard of monitoring should reflect the patient's condition and for critically ill patients this should remain as high as in the Resuscitation room or Critical Care Unit. Non-invasive blood pressure measurement suffers from motion artefact and invasive blood pressure monitoring is preferable. End tidal CO_2 monitoring should be used for all ventilated patients.

Equipment

There should be a dedicated set of equipment available for transfer which should be stored near the Emergency Department or Critical Care Unit. The staff accompanying the patient are responsible for checking the correct functioning of this equipment prior to departure. In particular, there should be sufficient battery power in any monitors and infusion pumps. Back-up equipment should be taken on longer journeys. A basic box of emergency drugs

should be available. The accompanying doctor should decide what other drugs and fluids (e.g. sedation and inotropes), should be taken in addition.

Final Actions Before Departure

Just before the patient is ready to leave the Emergency Department, the TU/LEH TTL must contact the receiving MTC to confirm:

1. The exact destination of the patient
2. The named contact who will be receiving the patient
3. That a bed / theatre place is still available if outlined in previous discussions

Specific Clinical Guidance

Emergency Management of Traumatic Cardiac Arrest

Traumatic cardiac arrest caused by trauma has a very high mortality, with an overall survival of 5.6% (range 0-17%). The subgroup of patients who arrest after hypoxic insults, (e.g. hanging, drowning, c-spine injury), have a slightly increased chance of survival.

The following guidance aims to maximise the chances of survival in this critically injured cohort and should proceed in a horizontal fashion according to the <C>ABC paradigm.

<C> Catastrophic Haemorrhage	-Activate Massive Transfusion Protocol -Give 2 units O neg blood stat -Catastrophic limb haemorrhage should be treated witha CAT tourniquet or fully inflated manual BP cuff until the bleeding stops -Haemostatic agents are indicated when catastrophic haemorrhage is uncontrollable by any other means and the patient needs emergency surgery for their injuries
<A> Airway	-Secure the airway and ventilate with 100% O_2 -Consider a suxamethonium only intubation if the patient has just arrested -Look for airway obstruction / disruption
<B> Breathing	-Perform bilateral thoracostomies -Perform an emergency thoracotomy in penetrating trauma if there were vital signs <10mins prior to cardiac arrest and no return of spontaneous circulation -Exclude life-threatening chest injuries (e.g. cardiac tamponade, massive haemothorax etc.)
<C> Circulation	-Insert two wide-bore IV cannula -Use IO access if unable to secure iv access -Apply pelvic splint and realign limb fractures -Check the heart for shockable VT or VF

CPR and chest compressions are unlikely to be effective in hypovolaemic cardiac arrest but most survivors do not have hypovolaemia-related arrest so a standard ALS approach can be life-saving. Standard CPR should not delay the treatment of reversible causes (e.g. thoracotomy for cardiac tamponade). Adrenaline should be used cautiously as it can worsen intracellular hypoxia and increase bleeding.

Termination of Resuscitation

If there is no response within 20 minutes despite the above measures, the patient should be pronounced dead.

Commotio Cordis

This rare condition is actual or near cardiac arrest caused by a blunt impact to the chest wall over the heart. A blow to the chest during the vulnerable phase of the cardiac cycle may cause malignant arrhythmias, (usually VF).

Commotio cordis occurs mostly during sports and victims are young males, (mean age 14 years). The overall survival rate from commotion cordis is 15%, but 25% if resuscitation is started within 3 minutes.

Compound Fractures

Included Patients

All patients with high energy compound fractures as manifest by the following injury patterns:

Fracture Pattern: Comminuted tibial fracture and fibular fracture at the same level;
Segmental fractures;
Fractures with bone loss, either from extrusion or after debridement.

Soft Tissue Injury: Swelling or skin loss such that tension-free closure is impossible;
Degloving;
Injury to one or more main arteries in leg;
Muscle Injury that requires excision of devitalised muscle;
Contamination with marine, agricultural or sewage material.

Wound Management

1. Photograph wound if possible, (not on mobile phone)
2. Remove gross contamination (e.g. leaves)
3. Do NOT wash out wound at this stage
4. Cover wound with saline soaked gauze
5. Leave wound and dressing undisturbed
6. Check tetanus status
7. Give IV Antibiotics:

Grade I or II	AUGMENTIN 1.2g IV
Grade III	AUGMENTIN 1.2g IV + GENTAMICIN 5mg/kg IV
Farm/Aquatic	ADD METRONIDAZOLE 500mg IV

Fracture Management

1. Neurovascular examination and documentation
2. Align and splint fracture
3. Repeat neurovascular examination
4. X-Ray
5. Document all findings

N.B. Severely contaminated injuries, farm, and aquatic remain a surgical emergency and should be debrided ASAP.

Gustilo Classification of Compound Fractures

GRADE I	• Wound <1cm with minimal soft tissue injury • Simple bone injury with minimal comminution • Wound bed is clean
GRADE II	• Wound >1cm with moderate soft tissue injury • Moderate contamination • Moderate comminution
GRADE III	• Segmental fracture with displacement • Fracture with diaphyseal segmental loss • Associated vascular injury • Farmyard injuries or highly contaminated wounds • High velocity gunshot wound or severe crush injury Grade IIIa • Wound less than 10cm with crushed tissue and contamination • Soft tissue coverage of bone is usually possible Grade IIIb • Wound greater than 10cm with crushed tissue and contamination • Soft tissue is inadequate and requires regional or free flap Grade IIIc • Major vascular injury requiring repair for limb salvage

Penetrating Cardiac Injury

If a penetrating cardiac injury is suspected, the following actions should be taken:

1. Call Trauma Team

2. Immediately Contact:
   - Consultant Thoracic Surgeon on Call
   - Thoracic Registrar on Call
   - ED Consultant on Call
   - Anaesthesia Consultant on Call

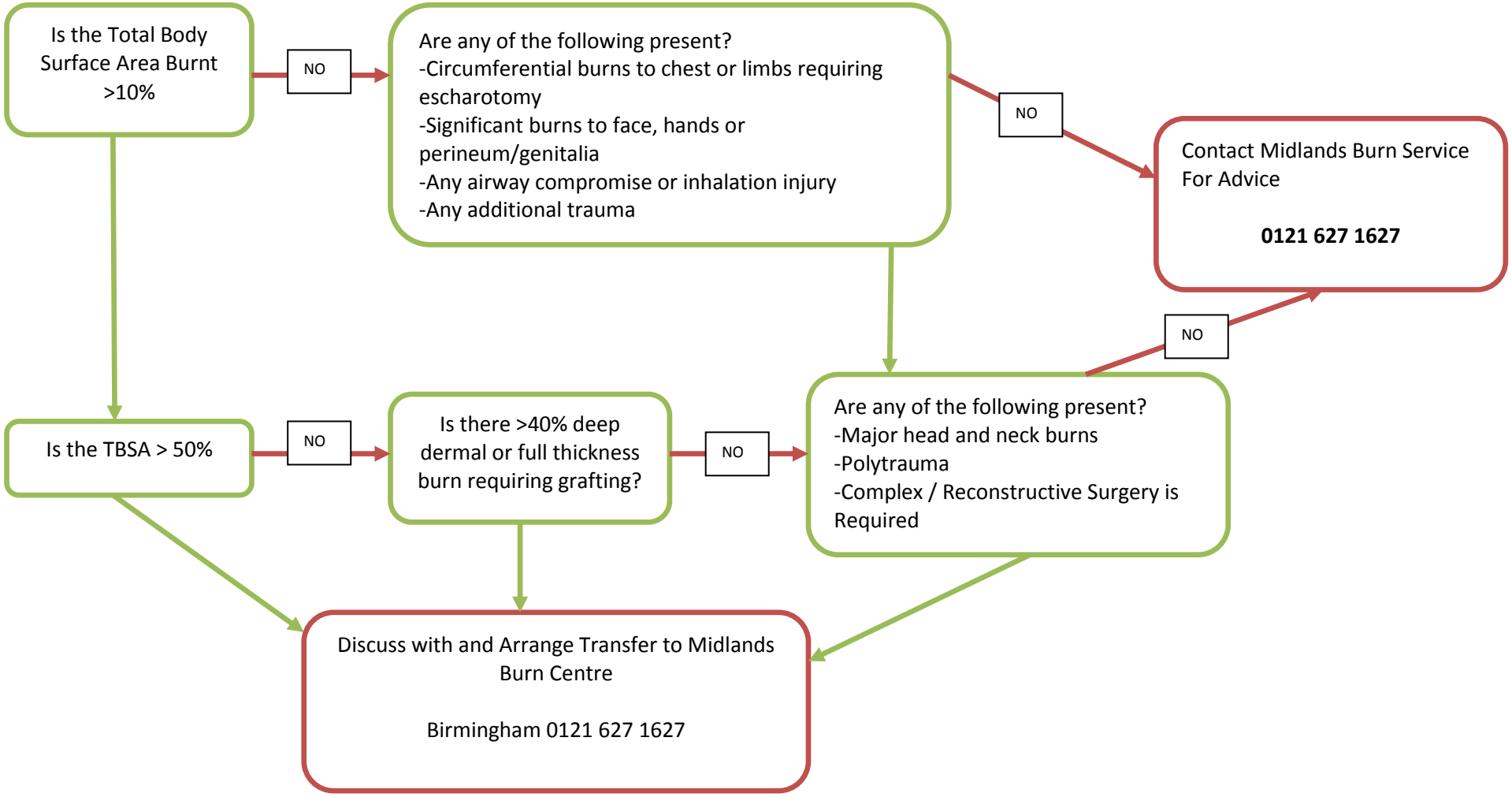
3. Emergency Thoracotomy in Emergency Department to be performed only if the patient is in cardiac arrest or extremis. Decision will need to be made by the Trauma Team Leader and most senior surgeon present

4. If safe, transfer patient to main theatre and continue resuscitation

5. Unless the patient requires immediate thoracotomy, the patient should not be anaesthetised until the Thoracic Surgeon arrives

6. The Thoracic Surgeon will go directly to the ED or Theatres to evaluate the patient

Adult Burns Pathway



Emergency Management of Severe Pelvic Fractures

Introduction

Approximately 90% of patients with severe pelvic fractures will have multiple injuries elsewhere. Any patient with a pelvic fracture, (excluding neck of femur fractures age >65 years), should be assumed to have additional injuries until proven otherwise. Up to 60% of patients with such fractures will be in hypovolaemic shock and are eight times more likely to have aortic transection.

Pelvic injury with signs of shock should be treated in the same way as vascular injury. Moving the patient can provoke intra-peritoneal and extra-peritoneal bleeding and the mortality rate for patients with pelvic fractures presenting with haemorrhagic shock is 30-50%.

Mechanism of Injury

Pelvic fracture should be suspected in the following patients:

A. MOTORCYCLIST RTC
B. PEDESTRIAN RTC
C. CRUSH INJURY TO PELVIC REGION
D. FALL FROM HEIGHT
E. FRONT-SEAT OCCUPANT IN HIGH SPEED RTC or PATIENTS SITTING ON SIDE OF IMPACT WITH CABIN INTRUSION

Signs of Pelvic Fracture on Inspection

- Obvious deformity or asymmetry
- Bruising and swelling of bony prominences, pubis, perineum or scrotum
- Leg length discrepancy or rotational deformity
- Wounds over the pelvis suggesting an open fracture
- Bleeding from the vagina, rectum or urethra

Initial Management

1. Blunt trauma + Systolic BP < 110mmHg: APPLY PELVIC BINDER. This can be applied even if lateral compression injury is suspected
2. Consider activation of Massive Transfusion Protocol in shocked patients
3. Pelvic binder can be applied even if lateral compression injury is suspected.
4. If the binder is applied pre-hospital, leave it, check position and X-Ray.
5. Do NOT examine the pelvis for mechanical instability.
6. Do NOT logroll the patient until the pelvis is cleared.
7. Do NOT pass a urinary catheter until the pelvis is cleared.

8. Obtain an early Pelvic X-Ray or Immediate CT Scan
9. If X-Ray or CT is normal, remove the binder and perform a repeat X-Ray, (open book injuries can be perfectly reduced by the binder so that X-Rays / CT scans can be normal)

Application of the SAM Splint

This is a two-person technique and should be performed by people trained in the application of the splint

1. Unroll splint and place underneath the patients feet
2. Slide towards the patient's head and if necessary, elevate buttocks to facilitate correct placement
3. The splint should be at the level of the greater trochanters and no higher.
4. One person holds the orange handle and the other tightens the splint until a click is heard.
5. The splint is fastened using the Velcro.

Management of Exsanguinating Pelvic Injuries

- Apply a pelvic binder and bind knees and ankles together
- Ensure two large bore iv cannulae are in situ
- If a shocked patient does not respond to 2 units of O negative blood the Consultants for Orthopaedic and General Surgery should be contacted and a decision made as to whether the patient should proceed immediately to theatre for extra-peritoneal packing +/- damage control laparotomy
- Angio-embolisation could be considered for transient responders who are not bleeding from elsewhere and requires early discussion with an Interventional Radiologist

Pelvic Fracture Identified

The pelvic binder can remain in place for up to 24 hours unless the patient has severe neurological deficit, (e.g. paraplegia)

A. Examine carefully for open wounds, especially in the perineum
B. If there is an open wound, including vaginal lacerations, antibiotics must be administered, (augmentin 1.2g IV + gentamicin 5mg/kg iv + metronidazole 500mg iv)

C. If unilateral pelvic injury, log roll to opposite side
D. If bilateral pelvic injury, avoid log-roll and use scoop stretcher

Contrast Urethrogram / Cystogram After Pelvic Fracture

In the absence of any concerning features, (e.g. blood at the meatus, haematuria at any point since incident), a single, gentle technique at passing a urinary catheter may be undertaken. If clear urine drains then no further imaging is mandated.

If there is blood at the meatus or any history of haematuria, a retrograde urethrogram is indicated before any attempts at catheterisation.

Retrograde Urethrogram:

-Insert size 10Ch Foley catheter just past the meatus and inflate balloon with 5ml saline

-Use 50ml diluted contrast medium (50% saline; 50% contrast) and inject into catheter whilst an AP pelvis X-Ray is taken

If there are no concerning features of urethral injury and a catheter is inserted which drains blood stained fluid a retrograde cystogram is mandated.

Retrograde Cystogram:

- Inject 100ml diluted IV contrast medium into catheter (50% saline; 50% contrast)
- Clamp catheter and then take AP Pelvis X-Ray or CT

If either study is positive, discuss with the Urology Consultant On Call.

Pelvic Fracture and Persistent Hypotension

1. Call the ED CONSULTANT IMMEDIATELY if not already done – contact the Trauma Desk and consider whether the patient can be safely transferred to the MTC.
2. ANAESTHETIC / SURGICAL / ORTHIPAEDIC CONSULTANTS to be contacted
3. If < 70mmHg and not responding to blood products, take to hybrid theatre now and perform angiography in theatre.
4. If isolated pelvic haemorrhage and BP > 70mmHg this could be done in the IR suite
5. Extra-peritoneal packing of the pelvis can be used to control external haemorrhage.
6. There is little place for pelvic external fixation in these injuries

Spine and Spinal Cord Injuries

Management of Suspected Brachial Plexus Injuries

Introduction

High energy trauma to the upper extremity and neck can cause a variety of lesions in the brachial plexus. Most common are traction injuries in which the head and neck are moved away violently from the ipselateral shoulder, others include penetrating trauma.

Patients commonly present with:

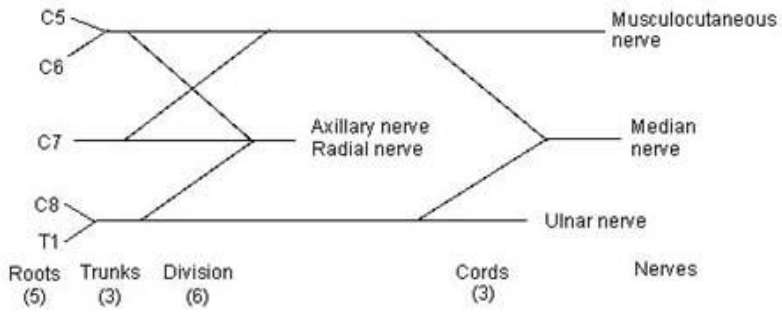
-Pain of the neck or shoulder
-Pain over a nerve
-Paraesthesias and dysesthesias
-Weakness or heaviness in the extremity
-Diminished pulses (vascular injury accompanies traction injury)

Physical Examination

The standard ATLS / ETC approach should be adopted. Any signs of shoulder abrasions, or injury above the clavicles should mandate formal neurological examination. Ptosis, enophthalmos, anhidrosis and miosis suggest Horner's syndrome and possible injury to the lower brachial plexus as the sympathetic ganglion for T1 is in close proximity to the brachial plexus.

Swelling around the shoulder can be dramatic and diminished or absent pulses suggest vascular injury and mandate immediate review by the vascular surgeons. In such circumstances, consider the role of Interventional Radiology for stenting. Examine for clavicular fractures and examine each cervical root on an individual basis.

Brachial Plexus Nerve Root Examination



The following table describes the nerve roots responsible for varying functions:

Area to Test	Nerve Root
Thumb	Median nerve supplied by C6
Middle Finger	Median nerve supplied by C7
Little Finger	Ulnar nerve supplied by C8

Nerve Root	Function
C5	Shoulder Movement in all directions, flexion of elbow
C6	Flexion of elbow, rotation of forearm, flexion of wrist
C7	Mainly a sensory trunk (generalised loss of arm movement without total paralysis in any given muscle group)
C8	Extension and flexion of fingers, flexion of wrist
T1	Instrinsic muscles of hand

When assessing sensation, apply full pinch for deep pressure testing. Deep pressure sensation may be the only clue to continuity in a nerve with no motor or other sensation function.

Imaging Techniques

Attention should be paid to the upper thoracic area on any primary survey CXR. CT scanning may be helpful in identifying additional fractures. The evidence is sparse regarding the best alternative imaging modality with MRI and MRA being useful in visualising vascular injury and the postganglionic brachial plexus.

Sensory nerve potentials are helpful in differentiating preganglionic from postganglionic injuries. EMG is not useful until 1-3 weeks after injury.

Compartment Syndrome

Introduction

This is employed in the assessment of potential compartment syndrome. Compartment syndrome may be defined as increased pressure within a non-expansile space that results in compromised tissue perfusion and dysfunction of neural and muscular structures contained within that space.

Suspecting Compartment Syndrome

Reliance on the presence or absence of the classic 5 Ps (Pain, Pallor, Pulselessness, Paraesthesias and Paralysis) may lead to a delay in diagnosis. Patients with a burning quality of pain, delayed onset or increasing severity on passive stretch must be evaluated for compartment syndrome.

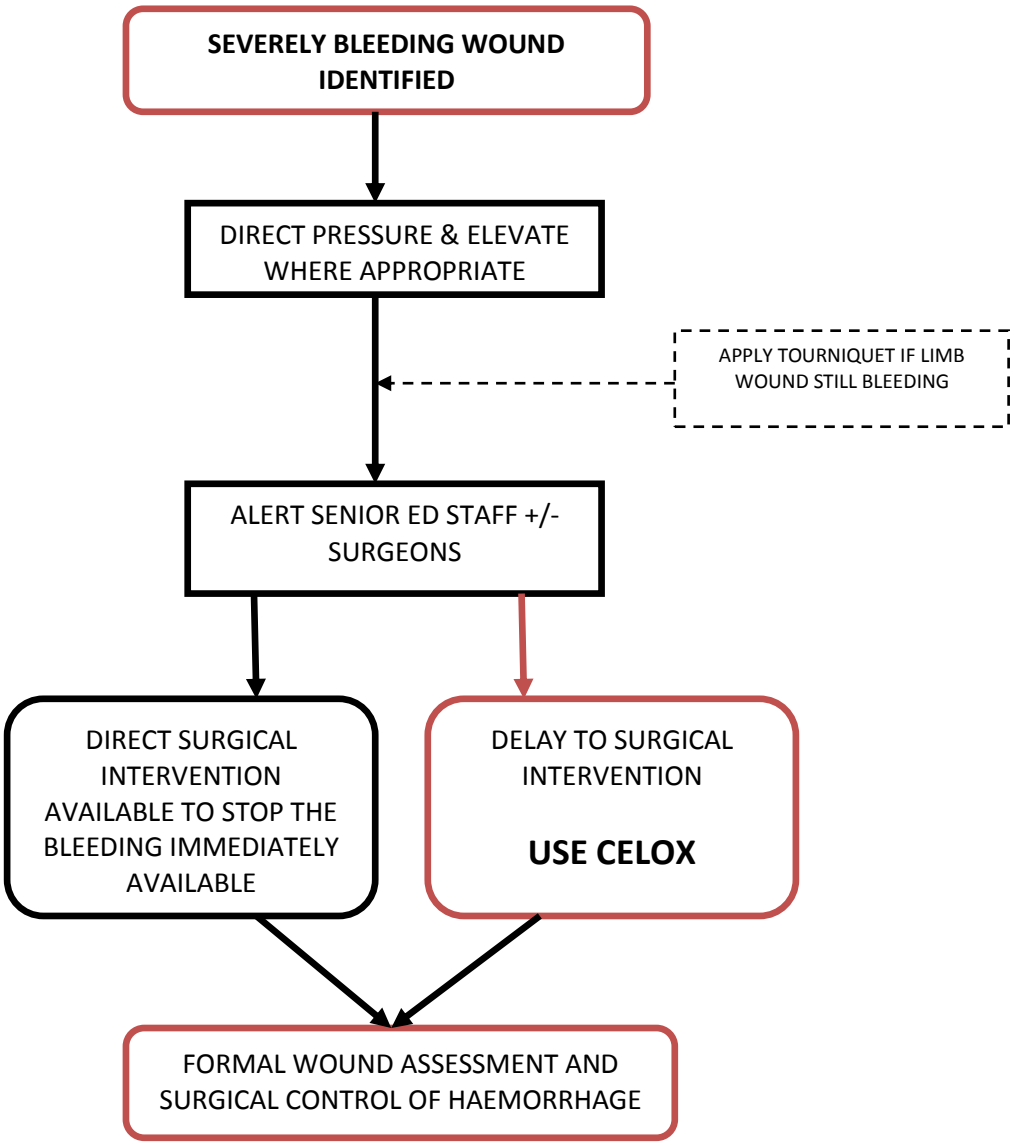
Other features such as unremitting pain or pain disproportionate to the injury should raise suspicions of compartment syndrome. Compartmental release is the treatment of choice and monitoring is only indicated where there is significant clinical doubt or the patient is unable to communicate reliable information regarding pain.

Celox Granules and Prefilled Syringe
(Used to Stop Potentially Lethal Bleeding)

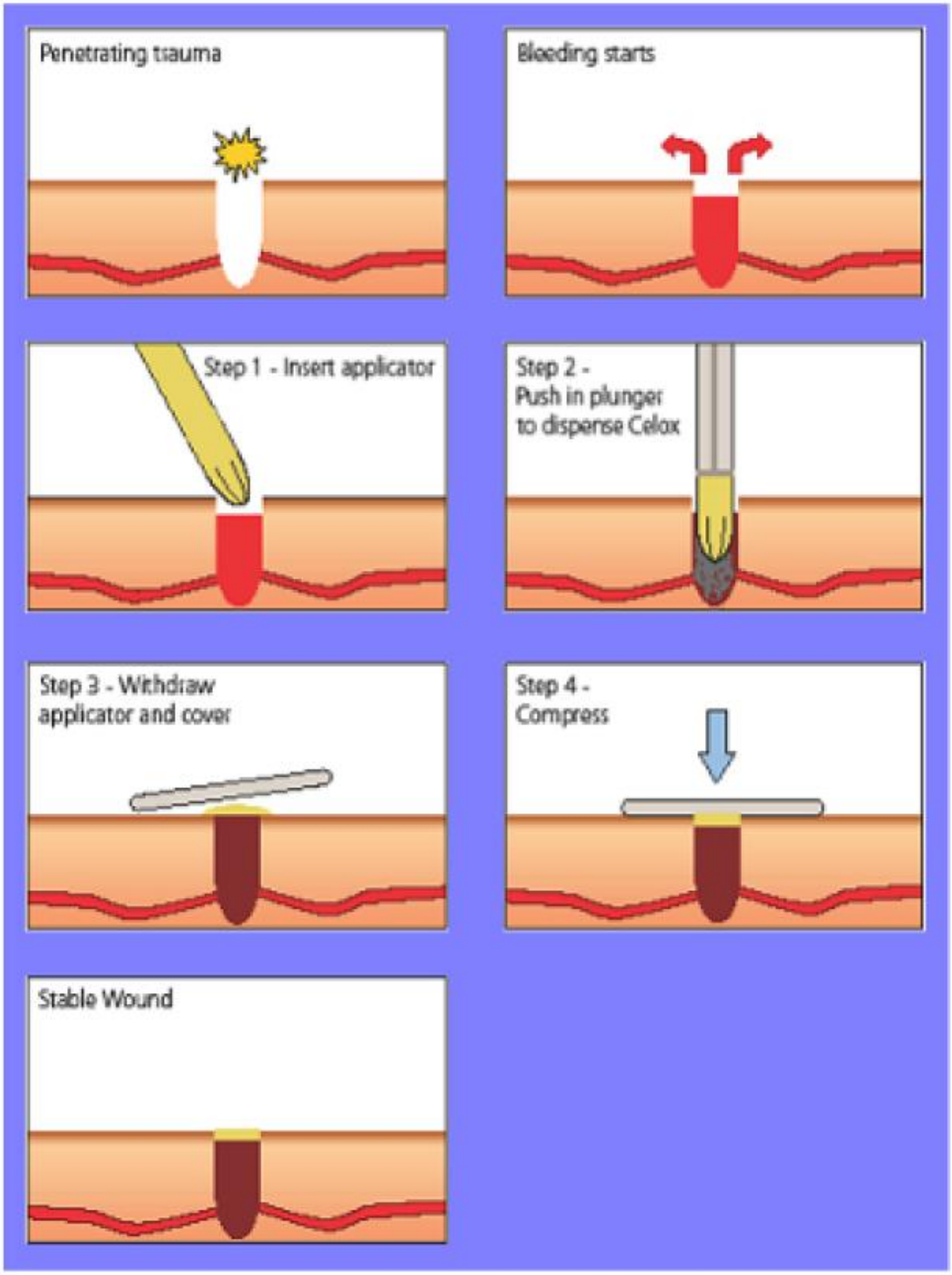
Indications

1. Arterial & venous bleeds
2. Bullet & Knife wounds
3. Blast & Shrapnel Wounds
4. Wound Packing

Using Celox



Celox Granules



Tetanus Prevention

Tetanus Prone Wounds

- Any wound or burn needing surgical intervention that is delayed for > 6 hrs
- Any wound or burn that has any of the following characteristics
  - **Significant degree of devitalised tissue**
  - **Puncture-type wound**
  - **Contact with soil or manure likely to harbour tetanus organisms**
- Compound fractures
- Any wound containing foreign bodies
- Wounds or burns in patients with systemic sepsis

Other Patient Groups

Intravenous drug users are at greater risk of tetanus. Make every attempt to ensure they are fully protected against tetanus. Booster doses should be given if there is any doubt about their immunisation status.

Immunosuppressed patients may not be adequately protected against tetanus, despite having been fully immunised. They should be managed as if they were incompletely immunised.

Thromboprophylaxis

All patients
All major trauma patients should have a risk assessment completed on admission in line with the DH Risk Assessment for VTE.

Head Injury & Spinal Injury Patients
Patients are at risk of expanding haematoma so need careful assessment of the risks and benefits of chemical thromboprophylaxis. If concerned, discuss with the Neurosurgical team on call as mechanical thromboprophylaxis may be more appropriate. Patients in whom clexane is being withheld should have a daily review of the decision by the clinical team.

Antiembolism Stockings & Enoxaparin
All trauma patients should have these stockings until fully mobile unless there is an absolute contra-indication. Most patients should receive 40mg enoxaparin daily, unless local policy dictates otherwise, or if the risk is considered to be too high. Again, this decision should be reviewed on a daily basis.

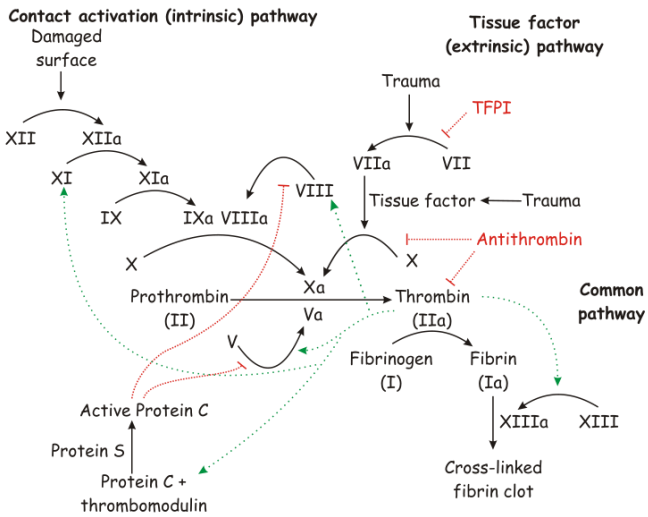
Damage Control Resuscitation

Coagulopathy in Trauma

Uncontrollable haemorrhage is the leading cause of potentially reversible early hospital mortality in trauma. Recent studies have shown that up to 25% of severely injured patients have evidence of coagulopathy prior to arrival in hospital.

Military studies have demonstrated a significant survival advantage with the use of standard massive transfusion procedures and commonly involve transfusion ratios of 1 RBC: 1 FFP: 1 Platelets. Such evidence has yet to be proven with RCTs in a civilian setting, although increasing numbers of hospital trusts have developed massive transfusion protocols for trauma patients.

The classical coagulation pathway centres on intrinsic and extrinsic mechanisms. Initial tissue damage exposes collagen which platelets bind to via glycoprotein Ia/IIa receptors. Further release of thromboxane and platelet activating factor prompts platelet activation and aggregation, (intrinsic pathway).



The extrinsic pathway can be activated by trauma and leads to the activation of FVII with subsequent fibrin formation.

The cell-based model considers an in vivo principle of coagulation and applies to what occurs in individuals, necessitating the analysis of whole blood. The model focuses on overlapping stages of haemostasis:

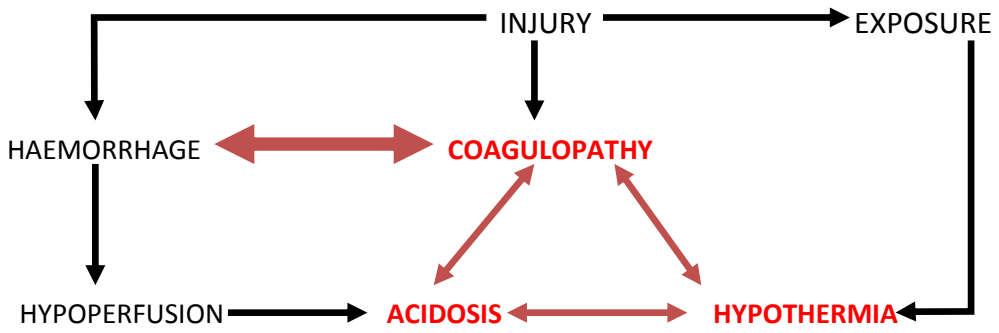
INITIATION	→	**AMPLIFICATION**	→	**PROPAGATION**
Circulating active FVIIa forms complex with exposed tissue factor		*FVIIa.TF generates small amount of thrombin which activates platelets*		*Coagulation factors assemble on activated platelets generating large amounts of thrombin*

The rate and peak of thrombin generation influences clot structure and stability by activating factor XIII which cross links fibrinogen and stabilises the clot.

Trauma initiates an immediate activation of coagulation and fibrinolysis, followed by fibrinolytic shutdown and then subsequent reactivation of fibrinolysis. Clotting abnormalities are worsened by hypothermia, haemodilution and acidosis which can produce a post-traumatic coagulopathy and mortality of approximately 50%.

The Lethal Triad

The "lethal triad" refers to the combined effects of hypothermia, coagulopathy and acidosis that worsen outcome.



Following a traumatic injury, patients become hypothermic from exposure to their environment and the administration of cold intravenous fluids. **This worsens coagulopathy**.

Following a traumatic injury, patients may develop hypovolaemic shock from bleeding which causes hypoperfusion of vital organs and produces a lactic acidosis. **This worsens coagulopathy.**

Following a traumatic injury, patients have a depletion of clotting factors, (which may worsen on the administration of fluids devoid of blood components), and an activation of coagulation and fibrinolysis. **This worsens coagulopathy**.

Coagulopathy produces ongoing bleeding, hypovolaemia, hypoperfusion, worsening acidosis and hypothermia, which in turn, worsens coagulopathy.

Breaking the Lethal Triad

The patient's deterioration can be halted by initiating the following management strategy:

1. STOP BLOOD LOSS
2. MINIMIZE HEAT LOSS
3. RESTORE TISSUE OXYGENATION
4. CORRECT COAGULOPATHY

In order to ensure appropriate management, the Trauma Team Leader must follow these principles, and in the first instance, be able to diagnose the shocked patient.

Shock

Shock has many definitions, but in general can be said to exist when there is a mismatch in the delivery of oxygen to meet the necessary tissue requirements. The different types of shock are as follows:

TYPE	PHYSIOLOGY	SIGNS	EXAMPLE
HYPOVOLAEMIC	Reduced venous return to the heart due to fluid loss	Narrow Pulse Pressure Low BP Raised HR	Blood loss, Burns
CARDIOGENIC	Sympathetic response doesn't restore cardiac output due to a dysfunctional LV which can't improve its contractility	Raised HR Low BP Chest Trauma Non-response to fluid resus	Pericardial tamponade
NEUROGENIC	Injury above T4 affects sympathetic outflow from sympathetic tract	Low BP Low HR	Unstable Vertebral Column #
SEPTIC	Prolonged tissue hypoxia with uncoupling of O2 delivery and consumption. Liberation of inflammatory mediators	Wide pulse pressure Warm skin Low BP; Raised HR	Bowel perforation

When estimating for blood volume loss, the Trauma Team should take into account a patient's: Heart Rate; Blood Pressure; Respiratory Rate; Capillary Refill Time; Skin Colour; Urine Output and Conscious Level.

Changes to any of these observations should be taken seriously, and careful consideration should be given to: the mechanism of injury and possible spread of kinetic energy across the patient; the nature of injuries sustained; characteristics of the individual patient; and the overall response to initial treatment, (e.g. fluid administration; application of pelvic binders).

Classification of Haemorrhage Severity

ATLS guidelines refer to the following table for classification of the severity of hypovolaemic shock:

American College of Surgeons Advanced Trauma Life Support classification of haemorrhage severity

Haemorrhage severity according to ACS/ATLS classification[a]	Class I	Class II	Class III	Class IV
Blood loss (ml)	<750	750–1,500	1,500–2,000	>2,000
Pulse rate (per minute)	<100	>100	>120	>140
Blood pressure	Normal	Normal	Decreased	Decreased
Pulse pressure (mm Hg)	Normal	Decreased	Decreased	Decreased
Respiratory rate (per minute)	14–20	20–30	30–40	>40
Urine output (ml/hour)	>30	20–30	5–15	Negligible
Central nervous system (mental status)	Slightly anxious	Mildly anxious	Anxious, confused	Lethargic

The table is a useful guide but patients with blunt or penetrating mechanisms of injury manifest signs of shock at different stages:

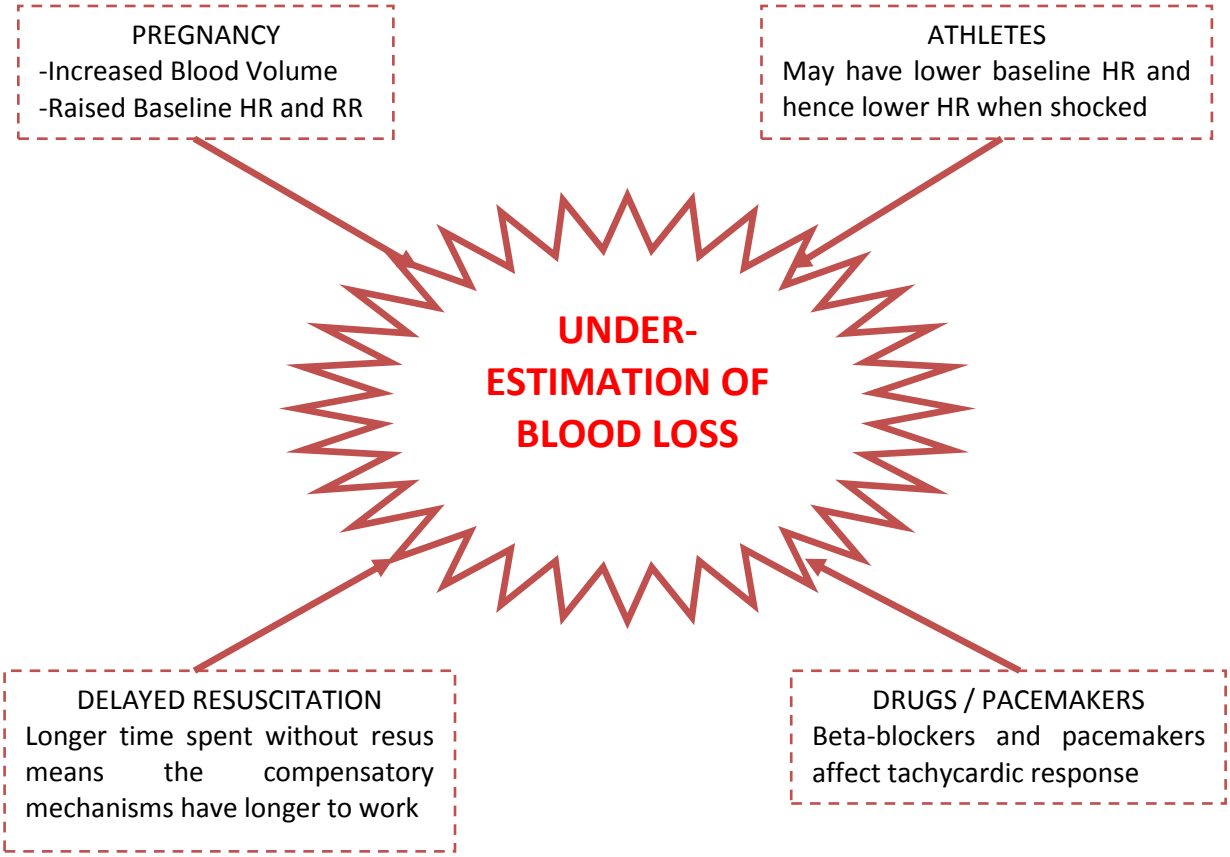
Physiological Changes	Blunt Injury	Penetrating Injury
Normal Observations	15-30% Blood Loss	<15% Blood Loss
HR 100-140 Reduced BP CRT > 3 seconds	30-40% Blood Loss	15-30% Blood Loss
HR > 140 Systolic BP < 70mmHg GCS 3	>40% Blood Loss	30-40% Blood Loss

Patients with blunt trauma compensate to a much greater degree by diverting blood from non-essential organs. In such circumstances, the blood pressure can be maintained until up to 40% of volume loss. In contrast, patients with penetrating trauma will drop their blood pressure at lower volumes of blood loss

The practical implications of this are that ***for a patient with blunt trauma and abnormal vital signs, they are likely to require greater volumes of resuscitating fluid than a person with penetrating injury.***

Special Circumstances

There are particular circumstances in which the amount of blood loss can be underestimated:



Damage Control Resuscitation

The principles of damage control resuscitation are:

1. CONTROLLED HYPOTENSION
2. HAEMOSTATIC RESUSCITATION
3. DAMAGE CONTROL SURGERY

Massive Transfusion Policy

Introduction

As part of the commissioning to become a member of the Trauma Network, all receiving sites should have a clearly defined massive haemorrhage policy for trauma, approved by the local blood transfusion committee.

Massive transfusion is defined as the replacement of a patient's total blood volume in less than 24 hours, or a 50% volume loss within 3 hours or a rate at a loss of 150ml/min. The purposes of massive transfusion pathways are to prevent coagulopathy, rather than waiting for it to develop.

The massive bleed procedure should be activated for all trauma patients with signs of shock, (i.e. tachycardia > 110bpm; SBP <90mmHg).

A 2010 NPSA Rapid Response Report[10] for "The transfusion of blood and components of blood in an emergency" highlighted that any emergency protocol should include "*robust and clearly understood communication channels between staff in the clinical area and those in the blood transfusion laboratory*".

The report also stressed the importance of having a "*locally agreed and well understood trigger term*" to trigger the protocol, such as "I want to trigger the massive blood loss protocol".

It is important that all staff involved in the care of trauma patients are aware of how to activate the massive bleed protocol.

Appendix 1

Massive Bleed Procedure

Administer crystalloids / colloids until >1500mls blood loss (less in patient with low body weight)

Clinician telephones blood bank immediately:
BHH – **40705/40706** (8am – 8pm)
SOL – **44527** (8.30am - 5.30pm Mon-Fri)
Out of hours (all other times) both sites bleep **2449**
GHH – **49290/49213**
Out of hours bleep **8779**

Clinician gives patient details, location, contact telephone numbers
Always inform blood bank of degree of urgency. **State: 'I want to trigger the massive blood loss protocol'.**

Clinical staff take samples for blood group & cross-match, FBC, clotting screen (PT, APTT, fibrinogen), biochemistry. **All request forms should state 'Massive bleed'.**

GHH: Clinical staff or porter (dial 2222) to take all samples to blood bank

BHH:
Contact rapid carrier porter by dialling 2222 to take all samples to the blood bank

Sol:
Clinical staff or porter (dial 2222) to take all samples to blood bank

Is patient stable enough to wait 10 minutes for blood?

Remember:
All patients must have a unique identification number and be wearing an ID wristband

YES

Ask the Blood Bank for group specific blood
(Out of hours at Solihull group specific blood will take longer – O Rh (D) negative blood should be used until this is available)

NO

Ask the Blood Bank for 2 units of group O Rh (D) negative blood – available immediately

Remember:
Monitor FBC, INR, APTT and fibrinogen regularly throughout transfusion – at least every 2 hours or per 12 units transfused

Further units of blood will be cross-matched by blood bank but can be issued as group specific if required

4 units of FFP will be issued routinely by the blood bank when 6 units of blood have been issued

Further blood products should be considered when:
INR / APTT ratio >1.5 – give another 4 units FFP
Platelet count <75 x 10^9/l - give 2 adult doses platelets
If approaching 12-15 units of blood transfused – order 2 adult doses platelets
Fibrinogen <1.5g/l – give 1 adult dose of cryoprecipitate

9

Massive Bleed Procedure Activation Criteria

Pre-Hospital

1. Request by Helimed to ED

Blood Bank MBP Activation

1. By blood bank after discussion with the Trauma Team Leader after 2 units have been given and a further 4 units requested for imminent use

Emergency Department MBP Activation

1. Unstable Fractured Pelvis & Haemodynamic Instability
2. Blast Injury & Haemodynamic Instability
3. HR > 120 bpm
4. Systolic BP < 90mmHg

Role of the Trauma Team Members

Before any patient arrives, the Trauma Team Leader must ensure that everyone present has a clear understanding of their expected role. The Team Leader should identify a team member to be responsible for taking blood tests, labelling these tests, and liaising with blood bank. *This team member alone should liaise with blood bank and no-one else.*

If the Trauma Team Leader identifies the need to activate the Massive Bleed Protocol, this should be relayed to the aforementioned team member who should do the following:

1. Contact Blood Bank on the following numbers and State:

   " I want to trigger the massive blood loss protocol "

   BHH Ext 40705 (8am - 8pm) / Bleep 2449 (8pm – 8am)
   GHH Ext 49290 (8am – 8pm) / Bleep 8779 (8pm – 8am)

2. Give the following information – *Patient Details (Name, PID, DOB); Location of Patient; Venous Blood Gas Hb; Contact Extension Number; and Name of Clinician Allocated to Liaise with Blood Bank*.

3. Specify the need for urgent O negative blood – two units will be issued, (if patient can wait 10 minutes, use Group Specific blood).

4. Label all bottles and write "Massive Bleed" on all request forms – request FBC, Fibrinogen, INR, Crossmatch 6 units blood

5. Dial 2222 request "Rapid Carrier Porter to Birmingham Heartlands A&E Resus"

6. Give Blood samples to Rapid Carrier Porter (RCP) to take immediately to Pathology and to return with 2 units 0 negative blood.

7. Call blood bank after 10 minutes of receiving O negative blood to request further 4 units of Type Specific Blood and 4 units FFP and send RCP when ready.

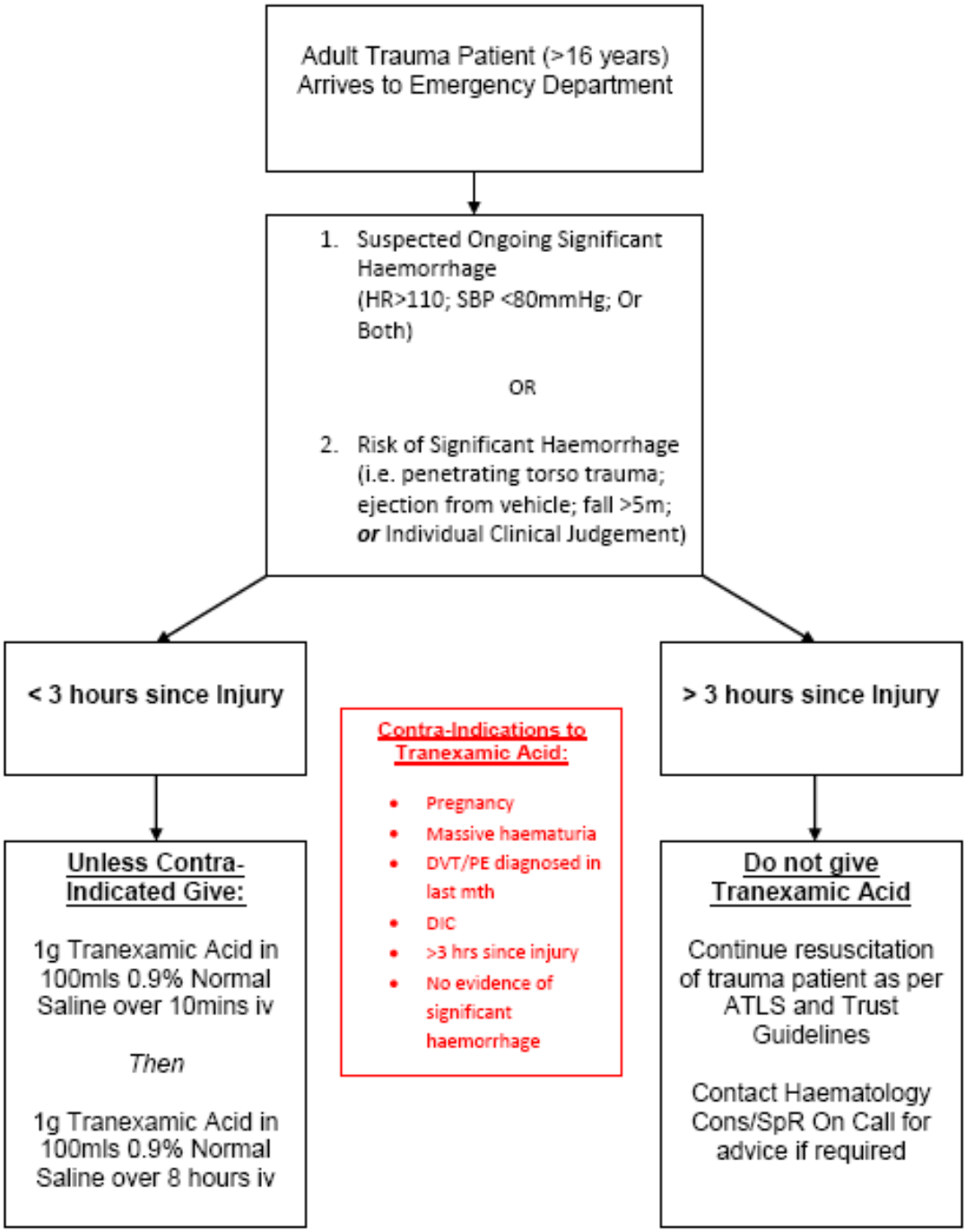
8. Check INR after Issued Blood has been transfused, including fibrinogen levels.

9. If fibrinogen <1.5g/L, request 1 unit cryoprecipitate

10. If INR >1.5, give another 4 units FFP

11. If platelet count < 75 x 10^9/L, request 2 adult doses of platelets, (these may have to be sent for via courier)

Tranexamic Acid Administration



Special Considerations for Transfusion of Blood Products

Capacity

Under the 2005 Mental Capacity Act, every adult, or anyone over the age of 18, must be assumed to have capacity to make decisions until it is established that they lack capacity. Furthermore, a person is unable to make a decision for themselves if they are unable to:

1. Understand the information relevant to the decision
2. Retain that information
3. Use or weight that information as part of the process of making the decision
4. To communicate the decision by whatever means necessary

The Act states that- "*a person lacks capacity in relation to a matter if at the material time he is unable to make a decision for himself in relation to the matter because of an impairment of, or a disturbance in the functioning of, the mind or brain*." Any medical intervention performed on a patient who lacks capacity must be done so in their best interests.

Competent patients have the right to have an anticipatory refusal of consent which remains valid provided it adheres to strict criteria:

- The treatment being refused must be specified clearly in the directive.
- The circumstances in which the refusal occurs must be written clearly.
- The directive must include a statement whereby it is stated that refusal is applied to the treatment in question, "even if life is at risk".
- The directive is in writing, signed by the patient, or by another individual in the patient's presence and by their specific direction.
- The directive is countersigned by a witness.

Advanced directives are no longer valid if the patient has conferred authority of decision making to a lasting power of attorney after the advanced directive was made.

Jehovah's Witnesses and Blood Products (Adults)

Following on from the 2005 publication of "The Watchtower", the transfusion of allogenic whole blood or its constituents of red cells, white cells, platelets and plasma remain prohibited under Jehovah's Witness doctrine.

Since 2000, there has been more emphasis placed on an individual's choice to permit the following:

- Cell saver scavenging
- Fractionated haemoglobin
- Platelet factor 4
- Albumin
- Cryoprecipitate
- Recombinant factor VII

- Factors VIII and IX

It is important to clarify patient choice in the matters of blood transfusion. In an emergency setting, some Jehovah's witnesses may opt for a transfusion so should still be counselled on this intervention where possible.

If a Jehovah's witness presents in an emergency situation and they are unconscious, they do not have the capacity to refuse treatment under the Mental Capacity Act. Any treatment given must be provided in their best interests but management decisions could be determined by signed blood refusal cards or advanced directives.

In an emergency, the doctor must be satisfied that any Jehovah's witness with an advanced directive or blood refusal card had made an informed decision at the time of making the directive. Occasionally such forms are signed with external influence and the threat of excommunication so the validity of such decisions comes into question. **As a rule, if there is doubt about the validity of a directive, life-saving treatment should be administered in the patient's best interests.**

Jehovah's Witness and Blood Products (Children and Adolescents)

A child is defined as anyone under the age of 18. Anyone under the age of 18 must not be allowed to die as the result of a lack of blood transfusion and in common law, clinicians are open to prosecution if this occurs.

Children aged 16 to 17 years have a legal right to consent to their own treatment, even if it is against the wishes of their parents. Furthermore, there is no necessity to seek consent from their parents regarding treatment. Conversely, a child under the age of 18 does not have the legal right to refuse treatment and lawful consent to life saving procedures can be given by the parents or by the courts.

If a child is under the age of 16, they can consent to treatment provided they are Gillick competent, hence must satisfy the following test:

1. Can the child understand the nature, purpose and hazards of the treatment?
2. Can the child make a value judgement and balance the risks and benefits?

If a child under the age of 16 is Gillick competent and agrees to a transfusion, this over-rides any parental objections. However, if the child is not Gillick competent and parental consent is not forthcoming, it may be necessary to obtain consent through the courts.

In emergency situations, such as patients fulfilling the criteria for massive transfusion protocol activation, blood transfusion should be given without waiting for a court order. In these circumstances, two doctors of consultant status should make a written, unambiguous entry in the patient's notes that blood transfusion is essential to save life or prevent serious permanent harm. At the same time, the Trusts solicitors should be contacted in order to obtain a court order.

The 1989 Children's Act outlines who may have parental responsibility and this includes:

- The Mother
- The Father provided he is married to the mother when the child was born or has acquired legal responsibility by:

    1. Parental responsibility order made by the mother
    2. Parental responsibility order made by the court
    3. Jointly registering the birth of the child with the mother

- Legally appointed guardian – court appointed or appointed by parent in the event of their death
- A person in whose favour a court has made a residence order concerning the child
- A local authority designated in a care order in respect of the child (but not where the child is being looked after under section 20 of the Children Act, also known as being 'accommodated' or in 'voluntary care').
- A local authority or other authorised person who holds an emergency protection order in respect of the child

Retrospective Information For Patients Receiving a Blood Transfusion

As an overriding principle, the SaBTO recommendation that valid consent should be obtained pre-transfusion and documented in the patient's clinical record by the healthcare professional should be implemented. However, there are two key groups of patients for whom retrospective information will specifically be required:

1. Patients treated in an emergency setting, where it was not possible to obtain valid consent pre-transfusion due to the patient's clinical condition
2. Patients who were told pre-procedure (e.g. pre-operatively) that they *might* require a transfusion as part of that procedure. These patients need to be informed whether they did or did not receive a transfusion.

It is important that healthcare professionals are aware of the differences between allogeneic (donated blood) and autologous (own blood). Patients only need to be informed of the risk of transfusion-transmitted infection (TTI) and that they can no longer donate blood if they have received allogeneic blood. It is important that any prescription / documentation can clearly differentiate between allogeneic and autologous blood.

When should patients be given retrospective information?

Retrospective information can be given to patients at any stage of their hospital treatment. However, in order to ensure that all patients are informed before their discharge from hospital, it is recommended that this should become part of the patient discharge procedure.

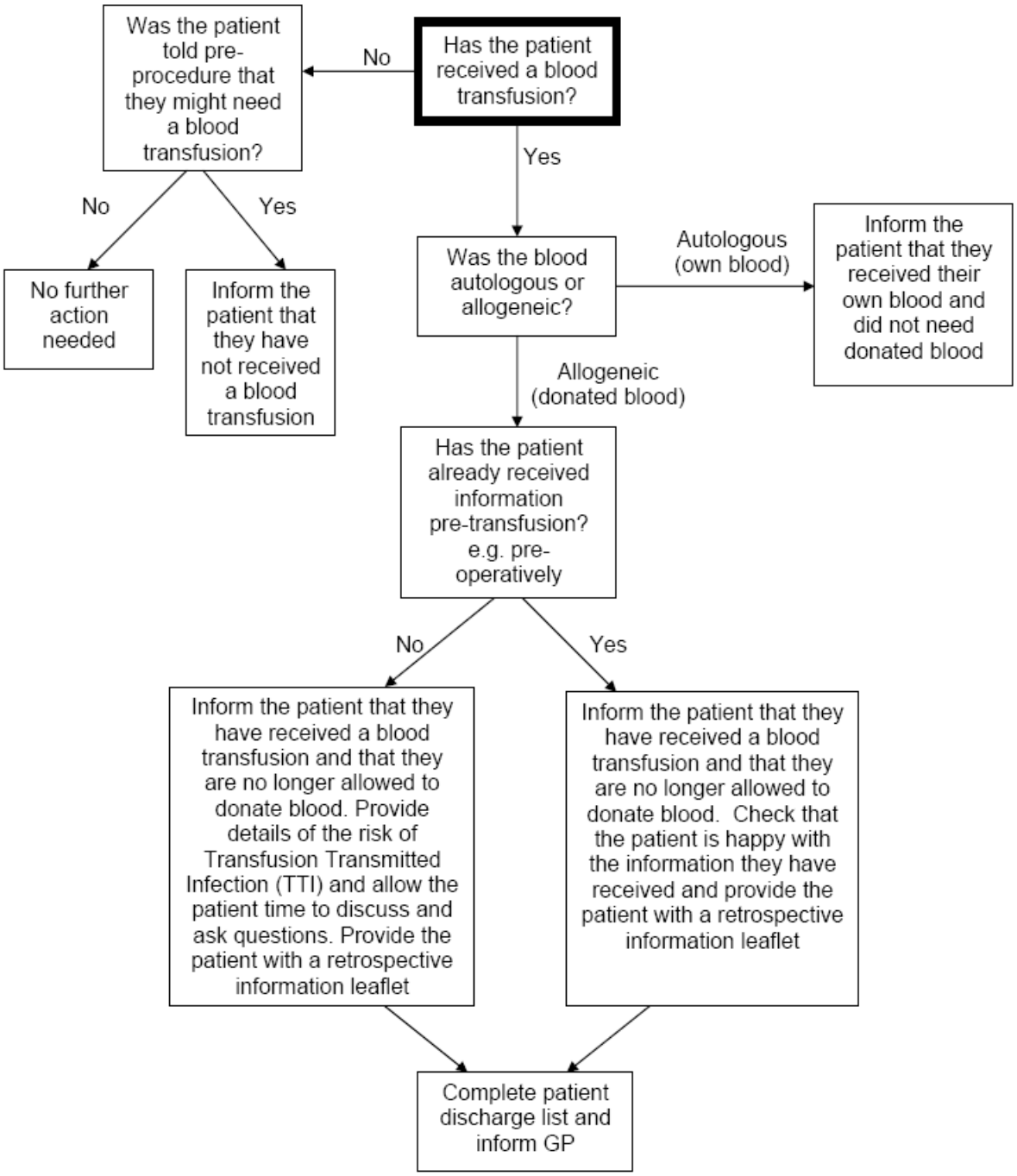
Questions relating to whether the patient has received a transfusion and whether retrospective information is required should be included on the patient discharge checklist. Ideally, information about transfusion should also be included on the discharge letter to the patient's GP.

What information should patients be given?

Patients who consented pre-procedure to receiving a blood transfusion if required, and therefore were given information relating to the risks of transfusion and the fact they will no longer be eligible to donate blood, may only need confirmation that they did or did not receive a transfusion.

Patients who received no information pre-transfusion should be provided with this information, both verbally and in writing, and given the opportunity to ask any questions. As a minimum, this retrospective information should include:

- The risk of transfusion-transmitted infections
- A statement that they are no longer eligible to donate blood.


Has the patient received a blood transfusion?
No
Was the patient told pre-procedure that they might need a blood transfusion?
No
Yes
No further action needed
Inform the patient that they have not received a blood transfusion
Yes
Was the blood autologous or allogeneic?
Autologous (own blood)
Inform the patient that they received their own blood and did not need donated blood
Allogeneic (donated blood)
Has the patient already received information pre-transfusion? e.g. pre-operatively
No
Yes
Inform the patient that they have received a blood transfusion and that they are no longer allowed to donate blood. Provide details of the risk of Transfusion Transmitted Infection (TTI) and allow the patient time to discuss and ask questions. Provide the patient with a retrospective information leaflet
Inform the patient that they have received a blood transfusion and that they are no longer allowed to donate blood. Check that the patient is happy with the information they have received and provide the patient with a retrospective information leaflet
Complete patient discharge list and inform GP

Transfer of Blood Products

Guidance on the Emergency Transfer of Blood Products

Introduction

A compelling need to transfer blood is rare in modern practice although the exception would be when a patient is actively bleeding and in whom the risk of transfer to a specialist unit was considered appropriate. The following are requirements of any transfer of blood products:

1. Blood is only transferred in the appropriate clinical scenario
2. Blood is transported and packaged in accordance with validated procedures to ensure product quality and safety
3. The transfer is correctly documented to maintain proof of the cold chain of blood storage
4. Vein-to-vein traceability is maintained
5. The roles and responsibilities of the dispatching and receiving hospitals are clearly defined
6. Wastage of blood is minimised
7. Transport of blood is optimally managed by transfer from one transfusion laboratory to another transfusion laboratory

Recommendations

When a patient needs ongoing transfusion and transfer to the MTC, this should be coordinated via the dispatching and receiving transfusion laboratories.

A. Two units of blood should be sufficient for a hyperacute transfer

B. Blood should never be transferred without the knowledge of the transfusion laboratories at dispatching and receiving sites

The Cold Chain and Blood Product Transfer

The cold-chain is a temperature controlled supply chain of storage and distribution activities which maintain a given temperature range. Insulated boxes containing cool packs, or other validated packaging materials, ensure that the optimum temperature is maintained for transport. Records must be kept to ensure an audit trail of the cold chain.

The following table provides the technical information pertinent to the cold chain:

Guidance for the Emergency Transfer of Blood with Patients: NHSBT Temperature Storage Validation

	UBP 110 Ambient Temperature			UBP 130 Ambient Temperature			UBP 150 Ambient Temperature		
Red Cell Components Including all component(s) stored at $4^0C \pm 2^0C$	**2 to 6^0C**	**Up to 27^0C**	**Up to 32^0C**	**2 to 6^0C**	**Up to 27^0C**	**Up to 32^0C**	**2 to 6^0C**	**Up to 27^0C**	**Up to 32^0C**
	12hrs	**6.5 hrs**	**NA**	**12hrs**	**6.5 hrs**	**4.5 hrs**	**NA**	**NA**	**NA**
	Capacity: **Up to 6 Adult Red Cell Units**			Capacity: **Up to 16 Adult Red Cell Units**					
Platelet Components Including all component(s) stored at $22^0C \pm 2^0C$	**-2 to 6^0C**	**Up to 27^0C**	**Up to 32^0C**	**-2 to 6^0C**	**Up to 27^0C**	**Up to 32^0C**	**-2 to 6^0C**	**Up to 27^0C**	**Up to 32^0C**
	3 hrs	**7 hrs**	**4.5 hrs**	**NA**	**8 hrs**	**NA**	**NA**	**NA**	**NA**
	Capacity: **6 Adult Platelets with 2 Medicool layers below and one above**			Capacity: **6 Adult Platelets with 2 Medicool layers below and one above**					
Frozen Components Including all component(s) stored below - 30^0C	**2-6^0C**	**Up to 27^0C**	**Up to 32^0C**	**2-6^0C**	**Up to 27^0C**	**Up to 32^0C**	**2-6^0C**	**Up to 27^0C**	**Up to 32^0C**
	NA	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**11 hrs**
							Capacity: **Up to 8 Adult FFP units with 3 x 500 g packs of dry ice**		

Procedure for the Dispatching Hospital Transfusion Laboratory

1. Locate the blood to be sent
2. Complete a transfer document
3. Place the blood in an appropriate transport box validated for the number of units being transferred.
4. Place all documentation in the transport box
5. Replace and seal the transport box (if the seal is removed or broken, the cold chain has been broken)
6. Staff accompanying patients should be advised about temperature control
7. On dispatch of the blood, immediately telephone the transfusion laboratory of the receiving hospital
8. Fax a transfer document to the receiving transfusion laboratory
9. The receiving hospital should record the final fate of the units:
   - transfused to the patient
   - wasted due to breach of cold chain
   - not transfused but put into receiving hospital's stock

Procedure for ED Staff and Escort Staff

All patients must have a wristband in place and any checks prior to transfusion of blood components must be done according to existing practice. The escort team must be informed that the transport box must only be opened if the patient requires ongoing transfusion.

Guidance for the Emergency Transfer of Blood with Patients APPENDIX 2

BLOOD and BLOOD COMPONENT TRANSFER FORM

This form must accompany units transferred with a patient between the Hospitals documented.

Blood and blood components must only be transported using a validated container and in strict accordance with a locally agreed method which complies with the Blood Safety & Quality Regulations (2005)

PATIENT NAME	ID or ADDRESS	DOB enter as: dd/mm/yy	GENDER

TYPE OF UNITS

Blood	FFP	PLTS
☐	☐	☐

Special requirements:

- Irradiated ☐
- CMV-ve ☐
- HLA Matched ☐

Enter donation number of all units transferred (Blood, FFP, Platelets) or attach details to form

UNIT 1	UNIT 2	UNIT 3

UNIT 4	UNIT 5	UNIT 6

BIRMINGHAM HEARTLANDS HOSPITAL **DISPATCHING HOSPITAL**

I confirm that the components listed above have been stored in accordance with National guidelines before issue and that the recipient site is aware of their obligation to transport, store, use and maintain fully traceability in accordance with Blood Safety & Quality Regs (BSQR 2005)

I confirm that the components listed above will be transported in a correctly packed, validated container and must arrive within a 4 hour period of the package time

Date Packed: **Time packed:** **Signature:**

……HOSPITAL NHS TRUST **RECEIVING HOSPITAL**

- The box was received sealed ☐
- The box had been opened ☐

I confirm that the components received were appropriately transported and will be stored in accordance with the requirements of the Blood Safety & Quality Regs

FINAL DISPOSITION

	UNIT 1	UNIT 2	UNIT 3	UNIT 4	UNIT 5	UNIT 6
Transfused en-route	☐	☐	☐	☐	☐	☐
Wasted	☐	☐	☐	☐	☐	☐
Stock	☐	☐	☐	☐	☐	☐
Signature	……	……	……	……	……	……

Where units are transfused en-route or before being received by your Transfusion Dept, please disclose above.

Guidance for the Emergency Transfer of Blood with Patients Label for Transport Box

To:

This box should be taken immediately on arrival to the Hospital Transfusion Laboratory

BLOOD

URGENT
For Immediate Delivery

The Blood / Components contained in this box were issued from the Transfusion Laboratory at Birmingham Heartlands Hospital.

If found please telephone 0121 424 2000 immediately

Packed by: Signature of BMS PRINT NAME **Date:** **Time:**	**Delivered by:** Signature of Porter/Driver PRINT NAME **Date:** **Ti**
Delivered to: Signature PRINT NAME and DESIGNATION **Date:** **Time:**	**Date and time removed from t** Give exact time HH:MM Unit 1: Unit 2: Unit 3: Unit 4: Unit 5: Unit 6:

This transport box has been validated for the storage of blood comp
The contents of this box will be suitable for transfusion unti
HH:MM hours
Transport box opened/seal broken at: .....

In compliance with BSQR 2005, it is confirmed that the contents of this box hav
securely in accordance with Guidelines for the Blood Transfusion Serv

Blood Transfer Advice for Clinical Staff

During transfer:

- If blood is required during the patient's journey please ensure it is checked and transfused in accordance with local policy.
- Please ensure the transport box remains sealed unless blood is required for transfusion. Once opened, the cold chain has been broken and all the units must be transfused within 4 hours.
- If blood is removed for transfusion, please replace the lid.
- Blood is suitable for transfusion within the timeframe stated on the associated paperwork with the transport box, provided the seal is unbroken.

On arrival:

- When the patient arrives in the receiving clinical area, please ensure the transport box is handed over to the receiving staff member.
- Please state how much blood was transfused during the journey and any adverse events (if occurred).
- The responsibility for the blood now lies with the receiving hospital in line with their local policy.

ACTING ON TRANSFERRED BLOOD COMPONENTS UPON ARRIVAL