DOCUMENT CONTROL PAGE

Title:	North West Children's Major Trauma Operational Delivery Network (ODN) Clinical Guidelines
Version:	4
Supersedes:	North West Children's Major Trauma Operational Delivery Network (ODN) Clinical Guidelines V3 (2018) Changes: Whole document rewrite and updated
Application:	North West Children's Major Trauma Operational Delivery Network (ODN)

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Designation:	Network Manager
Ratified by:	North West Children's Major Trauma Operational Delivery Network (ODN) and RMCH Ratification Group
Date of Ratification:	10/11/2023

Issue / Circulation Date:	17/11/2023
Circulated by:	North West Children's Major Trauma Operational Delivery Network (ODN)
Dissemination and Implementation:	North West Children's Major Trauma Operational Delivery Network (ODN)
Date placed on the Intranet:	17/11/2023

Planned Review Date:	December 2026
Responsibility of:	Network Manager - North West Children's Major Trauma Operational Delivery Network (ODN)

EqIA Registration Number:	2023-092

Contents

1. Introduction & Purpose

The North West Children's Major Trauma Operational Delivery Network (NWChMTN) comprises the two Children's Major Trauma Centres (ChMTC) - Alder Hey Children's Hospital (AH) and the Royal Manchester Children's Hospital (RMCH), the designated Trauma Units of Cheshire and Merseyside (CM), Greater Manchester (GM) and Lancashire and South Cumbria (LSC), the Local Emergency Hospitals (LEH) with the North West Ambulance Service (NWAS) including North West Air Ambulance (NWAA), North West and North Wales Transport Service (NWTS).

This document has been developed to provide guidance on the safe clinical management of children who sustain major trauma injuries or those who are triaged onto the major trauma pathway throughout the North West Children's Major Trauma Network.

2. North West Children's Major Trauma Pathway

Each Trauma Unit and Local Emergency Hospital is linked to a named designated Major Trauma Centre. Please see table below.

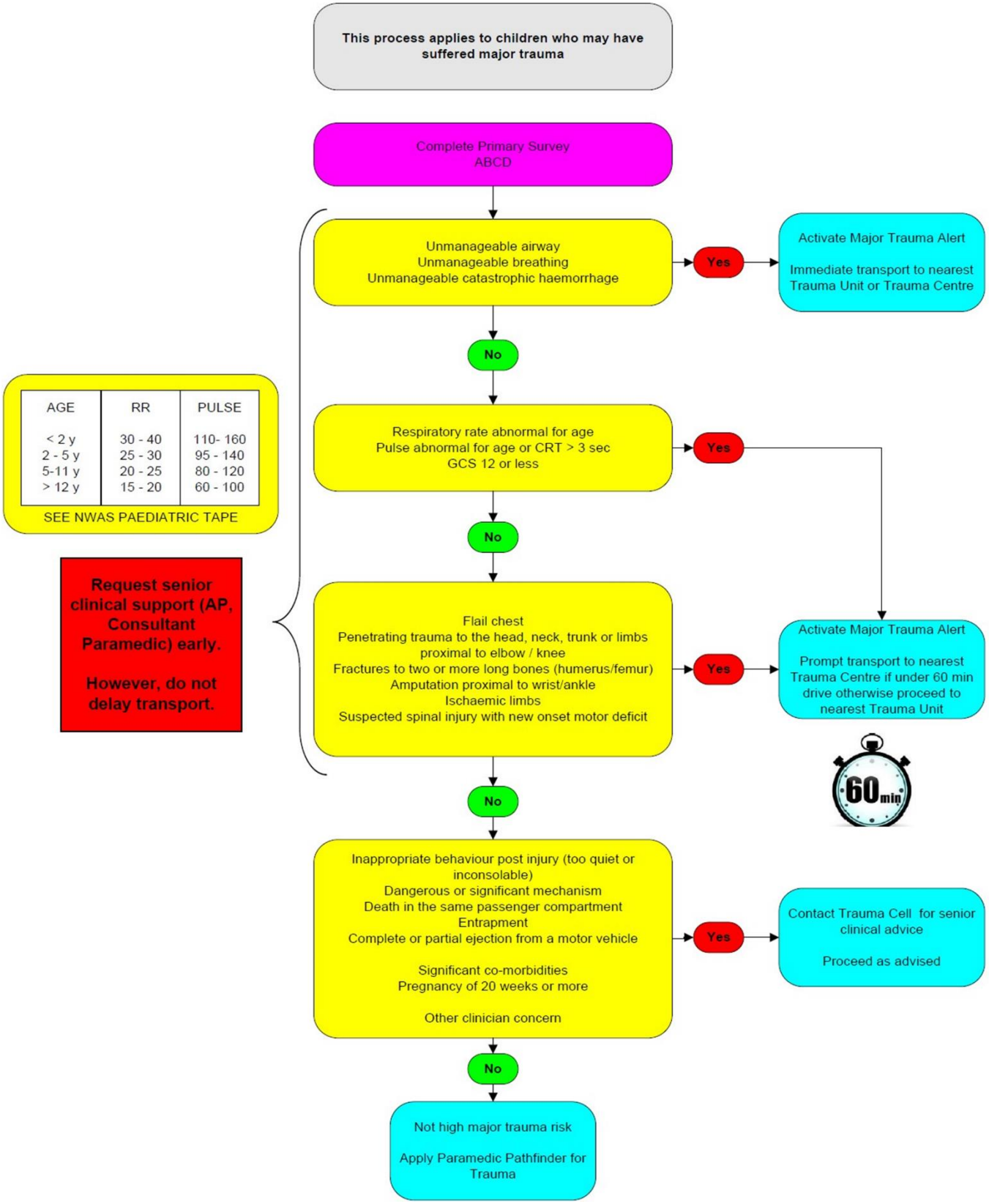
Designated Trauma Units & Local District Hospitals for each MTC

RMCH	AHCH
Greater Manchester • Stockport NHS Trust (TU) • Royal Albert and Edward Wigan (TU) • Royal Oldham (TU) • Salford Royal FT Trust (TU / Adult MTC) • Wythenshawe Hospital (TU) • Fairfield Hospital (LEH) • North Manchester General Hospital (LEH) • Royal Bolton Hospital (LEH) • Tameside Hospital (LEH) **Lancashire & South Cumbria** • Royal Preston Hospital (TU / Adult MTC) • Blackburn Royal Infirmary (TU) • Chorley and South Ribble Hospital (LEH) • Burnley General Hospital (LEH)	**Cheshire and Mersey** • Arrow Park Hospital (TU) • Leighton Hospital (TU) • Countess of Chester Hospital (TU) • Southport and Ormskirk Hospital (TU) • Whiston Hospital (TU) • Warrington Hospital (TU) **Isle of Man** • Noble's Hospital (LEH) **North West Midlands** • Leighton Hospital (Mid Cheshire NHS Trust) (TU) • Royal Stoke Hospital (North Staffs Only) (TU) **North Wales** • Ysbty Gwnedd (LEH) • Glan Clwyd (LEH) • Wrexham Maelor (LEH) **Lancashire and South Cumbria** • Royal Lancaster Infirmary (TU) • Blackpool Victoria Hospital (TU) • Furness General Hospital (TU)

North West Ambulance Service NHS Trust

Paramedic Pathfinder - Major Trauma in Children

V 2.0 1 September 2015



North West Major Trauma Children's Network
Pathway for Transferring a Major Trauma Child into a Major Trauma Centre

DO

1. Stabilise patient

- Stabilise airway
- Support breathing
- Stop catastrophic haemorrhage

2. Make calls to:

- Designated Children's Major Trauma Centre
- **Speak to the TTL and agree transfer**
- Use ASICHE Report to provide information (Age, Sex, History, Injuries, Condition, Estimated Time of Arrival
- NWTS if required for advice on stabilsation and transfer
- NWAS to arrange Category 2 Transfer - Major Trauma

3. Ensure:

- Transfer with local team
- Documentation sent with patient
- Inform TTL when the child leaves your hospital
- Inform TTL at MTC if safeguarding concerns
- Images are transferred with PACS

NWTS	Royal Manchester Children's Hospital	Alder Hey Children's Hospital	NWAS
0800 084 8382	0161 701 9191	0151 252 5401	0345 140 0144

DON'T

- Delay Transfer.
- Contact individual specialist/check bed availability (this will be done by the ED consultant at the MTC).
- Perform unnecessary procedures.
- Perform CT unless advised by MTC.

PAEDIATRIC TIME-CRITICAL TRANSFER GUIDELINES

WHO DOES THIS APPLY TO?

All children under 16 years with one of:

- **Major trauma – see NWAS pathfinder**
- **Suspicion of raised intracranial pressure or a space-occupying intracranial lesion**
- **Acute surgical abdomen/limb injury with suspected ischaemia**

MAIN POINTS

4 Do's.....
Stabilise the patient
Stop major haemorrhage
Organise transfer
Documentation

4 Calls
Children's Major Trauma Centre
(AHCH or RMCH)
NWTS
NWAS
Safeguarding Team

4 Don't's.....
Delay
Undertake CT unless advised
Forget C-spine immobilisation
Do unnecessary procedures

- **SAFE but RAPID transfer**
- **AVOID HYPOXIA , HYPOTENSION or HYPOGLYCAEMIA to prevent secondary injury**
- Do not delay transfer to ChMTC (Alder Hey or Royal Manchester Children's Hospital) or specialist surgical centre as this increases risk of serious injury or death
- Transfer should be undertaken by local team not NWTS
- Departure to ChMTC or specialist surgical centre should occur within 1 hour of arrival in hospital

Responsibilities of Trauma Team

Stabilise child
Intubate and ventilate child if required
Stop major haemorrhage and treat circulatory instability
Contact ChMTC (for telephone numbers see below)
Contact NWTS (08000 848382) for advice if PICU/PHDU level patient
Discuss need for CT scan with ChMTC
Identify appropriate transfer team (experienced anaesthetist and appropriate nurse/ODP)
Contact NWAS via 999 and ask for a "**Category 2 Major Trauma Transfer**" or equivalent ambulance
Arrange PACS transfer **and** copies of unencrypted CD of all images to ChMTC
Refer to safeguarding team if appropriate
Undertake transfer

NWTS: 08000 84 83 82

Alder Hey Major Trauma Team
0151 252 5401

NWTS will....

Liaise with any specialists required
Advise DGH on stabilisation & transfer
Inform PICU team about incoming transfer
Encourage swift departure from DGH
Inform transferring team which clinical area they should be taking child to (PED, PIC, PHD, theatres)

RMCH Major Trauma Team
0161 701 9191

For drug calculations use www.crashcall.net

NWTS Referral line number: 08000 84 83 82

NWTS Major Trauma Transfer Guideline v4 11.03.13.

TOP TIPS FOR A SAFE TRANSFER

For drug calculations use www.crashcall.net

Equipment required - everything must be securely fixed onto trolley (check battery life)
Use Critical care transfer trolley if available
Appropriate portable ventilator (Babypac under 10kg, Ventipac >10kg, Breas LTV or Oxylog 3000+ for >5kg)
Ensure enough oxygen for transfer
Portable monitor (ECG, sats, $ETCO_2$ (if ventilated) and non-invasive BP on 5 minute cycle)
Battery powered infusion pumps
Vacuum mattress or spinal board and collar/blocks for transfer plus means to fix onto trolley

A/B

	Need for intubation: GCS < 8/15 or fluctuating LOC
	Aim Saturations > 98%
	Monitor and maintain end-tidal CO_2 34-37 mmHg or 4.5-5 kPa
	ETT secured: **ORAL**, correct size (min leak) & position (check on CXR). Do NOT cut ET tube
	C spine immobilisation for all major trauma patients regardless of CT spine findings
	Oro-gastric tube on free drainage

C

	Maintain Mean BP (& Cerebral Perfusion Pressure): approximate targets for age
	One good, well secured peripheral line plus ability to place intra-osseous or 2nd line
	Do NOT delay transfer by placing arterial or central lines (or urinary catheter)
	Use fluid bolus and dopamine or noradrenaline via intra-osseous or peripheral line to support BP
	Major bleeding? Trigger local major haemorrhage guidelines (children) including Tranexamic acid

D

	Monitor pupil size & response every 15 minutes
	Sedate adequately (morphine and midazolam) and paralyse for journey
	Nurse 30° head up if possible for Head Injuries
	Identify & treat seizures give phenytoin
	Target temperature 36-37 °C. Treat hyperthermia/avoid hypothermia.
	Maintain normal blood glucose (treat if low i.e. < 3)
	Maintenance fluid: 0.9% saline (+ dextrose if glucose low)
	Aim: sodium > 140 – if Na < 135 consider 2.7% saline bolus
	Identify any associated injuries/problems

Age	Mean BP	Aim CPP
< 1 yr	55-65	> 40
1-5 yrs	70-80	> 50
6-11 yrs	80-90	>60
12-14 yrs	85-95	>70

MANAGEMENT OF SUSPECTED INTRACRANIAL PRESSURE SPIKES
WARNING signs: cardiovascular instability +/- urticarial/fleeting rashes
DEFINITE signs: BRADYCARDIA/HYPERTENSION/PUPIL DILATATION
Ensure end-tidal CO_2 34-37 mmHg or 4.5-5 kPa
Give Mannitol OR Hypertonic saline (2.7% NaCl)
Increase sedation (e.g. morphine/midazolam or fentanyl/propofol)

Documentation
Copy of notes/results/observation and prescription charts
X-ray & CT scans sent via PACS and un-encrypted CD

Parents
Give them a copy of NWTS parent information leaflet (www.nwts.nhs.uk) which has directions to both regional paediatric neurosurgical/major trauma centres plus the direct phone number of relevant PICU
Make sure transfer team have parents' contact details
Ensure parents are safe to travel in their own vehicle: if not organise taxi

References: NICE Head Injury Guidelines, NW Major Trauma Network, STRS guidelines

Authors: Kate Parkins, Rachael Barber

Please use the following link for the NWTS STOPP Tool http://www.nwts.nhs.uk/clinicalguidelines

Sharing of Information in the Event of Family Separation

Protocol for the sharing of information where families are split between MTC's/TU's.

This protocol should be used by MTC's and TU's to ensure that information is shared in the safest way between hospitals in the event a family becomes split due their age/trauma injuries.

MTC's

A&E Call received relating to the required transfer of an injured child into your hospital where multiple members of the family were injured.

↓

A&E Ensure information is taken on the other members of the family and where they are going to be transferred to.

↓

A&E During normal working hours ****-**** contact your Trauma Coordinator on Bleep *** or Ext ****.

Relay all the information you have gathered on the other family members and where they are being transferred

↓

The Trauma Coordinator will then liaise with the Ward where the patient is going to be admitted to, on arrival, and provide them with a password that will be required in the event any enquiries are made in relation to the patient.

The Trauma Coordinator will ring the other MTC's/TU's where other family members have been admitted to and relay the necessary contact information (Ext numbers/personnel) to their Trauma Coordinator or equivalent.

A&E If the call is taken out of hours, take no further action until the patient has arrived.

↓

When the patient arrives the Trauma Lead will ensure that they liaise with the ward where the patient is going to be admitted at the earliest possible convenience. They will provide them with the password that will be required in the event any enquiries are made in relation to the patient.

A member of the trauma team will ring the other MTC's/TU's where family members have been admitted and relay the necessary contact information (Ext numbers/personnel) to their Trauma Lead.

TU's

Call made to MTC relating to the required transfer of an injured child. If other family members are being transferred to alternative MTC's or they are staying at your TU.

↓

Ensure information is relayed to the admitting MTC on the other members of the family and where they are going to be transferred to.

Trauma Team Triggers:

1) On receipt of Major Trauma pre-alert from NWAS or Trauma Unit, self-presentation of trauma patient with or later presentation of:

Anatomical triggers:
Unmanageable airway (not protecting own)
Unsupportable inadequate breathing
Unstoppable haemorrhage (not controlled by simple pressure)

Physiological triggers: GCS 12 or less
Abnormal physiology: (guide values):

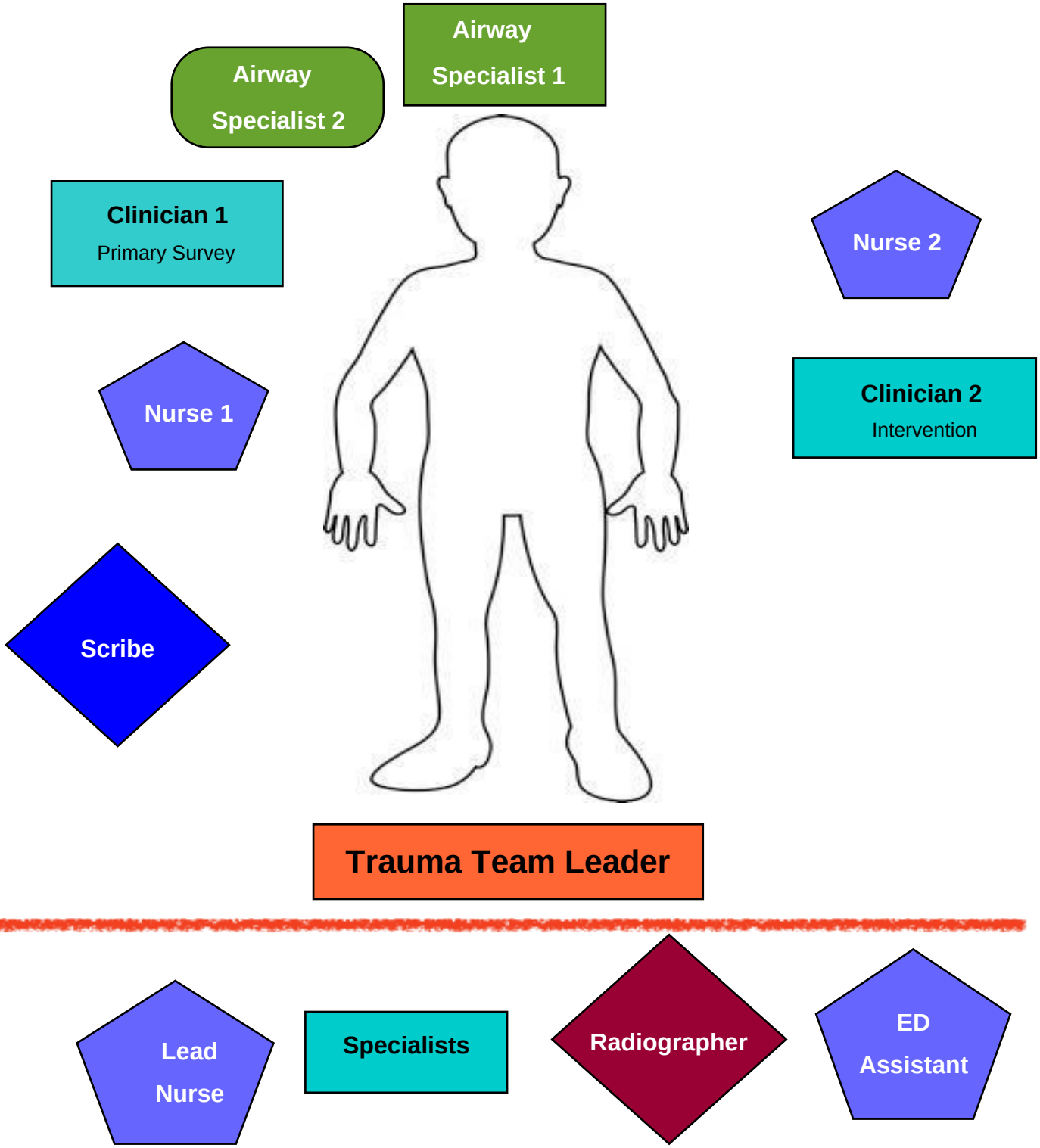
Age	**Heart Rate** beats/min		**Respiratory Rate** breaths/min	**Systolic BP** mmHg
	Tachycardia	***Bradycardia***		
0-7 days	>180	<100	<30 or >60	<60
7-28 days	>180	<100	<30 or >60	<80
1 month – 1 year	>180	<90	<30 or >40	<75
2-5 years	>140	<60	<25 or >30	<75
6-12 years	>130	<60	<20 or >25	<85
>12 years	>110	<60	<15 or >20	<90

Clinical signs triggers
Flail chest
Penetrating trauma to head, neck, trunk, or limbs proximal to elbow or knees
Fractures of 2 or more long bones (humerus/femur/tibia) or fractured pelvis
Amputation proximal to wrist or ankle
Crushed, mangled or degloved extremities
New onset sensory or motor deficits (whole limb or partial)
Rigid abdomen
Severe burns >20%

Mechanism of injury triggers
Falls over 3 times patient's own height
Entrapment
Complete or partial ejection from a motor vehicle
Death in the same passenger compartment

Other triggers
Significant comorbidities
Pregnancy of 20 or more weeks
Other clinician concern

Trauma Team


Airway Specialist 1
Airway Specialist 2
Clinician 1
Primary Survey
Nurse 2
Nurse 1
Clinician 2
Intervention
Scribe
Trauma Team Leader
Lead Nurse
Specialists
Radiographer
ED Assistant

Trauma Team

Trauma management is a team responsibility, which requires clear leadership by an experienced Trauma Team Leader (TTL) who is designated for each Trauma call. The Trauma Team should ideally assemble in the ED before the patient arrives.

The whole team should listen to the ambulance handover. The handover should be documented on the trauma board under the headings ATMIST. This will ensure reliability of the pre-hospital events and reduce the repetition of the story detracting from patient care.

Trauma team roles and responsibilities

Whilst roles and responsibilities are outlined in the list below, these are neither exhaustive nor inclusive. The TTL is the single point of contact for all information and decision-making and should work in tandem with the scribe. All team members should inform the TTL of their skills and competencies on arrival to the ED and perform designated roles. The team members should be identifiable as per local standard operating policy this helps to improve communication within the team. Staff should stay outside the resuscitation zone (behind the red line) unless they have been given specific permission to enter the area.

Trauma Team Leader – Agreed actions

Pre arrival check list

The following should be actioned prior to the patient's arrival where possible:

- All members of the Trauma Team should be identified, and key roles assigned by TTL
- Allocate scribe role and ensure clarity on responsibilities
- Team members 'book in' with scribe
- Personal Protective Equipment worn by all key personnel
- Warmed fluid prepared
- ATMIST documented on the trauma board

The TTL role is to command the resuscitation, coordinating staff and resources. They are rarely required to be 'hands on' with the patient.

This role may be handed over, but there must be a named lead for the entire patient journey.

The key responsibilities of the TTL are to:

- Log your details with the scribe
- Ensure team wear personal protective equipment (including lead gowns and sticker identifying the role), allocated roles are clear and personal introductions made
- Lead the handover (to be heard by all team members) from the pre-hospital team
- Immediately assess the child on entry to the ED bay to ensure CPR not required
- Appropriately direct team members in their actions according to their competence
- Establish priorities for investigation and management
- Order or authorise investigations and procedures
- Receive and interpret results of investigations and hand over to subsequent lead for child
- Consult with other specialties and make decisions including most appropriate clinician to undertake procedures.
- Liaise with MTC / LEH TTL if at trauma unit.
  - Ensure clear and documented handover
  - Decide on appropriate disposition of the patient
- Speak to relatives
- Check completeness of documentation
- Debrief team

Also consider the following may be required:

- Resuscitation is a continuum not dependent on geographical location
- Ensure everyone involved in patient pathway, including support services (e.g. blood bank), is aware of the patient's location as they move through the system
- Ensure appropriate leader and team for the entire patient journey
- Early calls to notify CT or specialty Consultants on call as required e.g. Neurosurgeon, Consultant General Surgeon, interventional radiology, cardiac surgeon
- Tranexamic acid (consider timeliness)
- Activate massive haemorrhage protocol
- CT within 60 minutes of arrival
- Antibiotics, urinary catheter, arterial lines and tetanus immunoglobulin*
- The possibility of parents being present when patients are being resuscitated
- Any cultural, religious and pastoral needs

*Please note there is a global shortage of immunoglobulin products and tetanus immunoglobulin should only be used when indicated in accordance with this guidance https://www.gove.uk/government/publications/tetanus-advice-for-health-professionals. Supply may be required from Pharmacy.

Clinician 1 - Agreed Actions

The key responsibilities of Clinician 1:

- Identify yourself to the TTL and log your details with the scribe
- Inform TTL of skills and competencies
- Wear personal protective equipment (including sticker with assigned role)
- Actively listen to the ambulance handover
- Conduct a primary survey
- Reassure patient on arrival, set the scene of what is happening
- Take AMPLE history (**A**llergies, **M**edications, **P**ast medical history, **L**ast meal, **E**verything else relevant)
- Vascular access (intravenous or intraosseous)
- Trauma bloods
- Undertake secondary survey
- Administer medications as directed by TTL
- Ensure notes are complete and clear plans are documented
- All findings or acute changes should be clearly communicated to the TTL
- Patients cool very quickly and this can have profound effects on haemostasis; ensure patient is kept warm.

Clinician 2 - Agreed Actions

The key responsibilities of Clinician 2:

- Identify yourself to the TTL and log your details with the scribe
- Inform TTL of skills and competencies
- Wear personal protective equipment (including sticker with assigned role)
- Actively listen to the ambulance handover
- Vascular access (intravenous or intraosseous)
- Trauma bloods
- Request investigations and chase results
- Prescribe medication and fluid
- Write in the notes and document all actions and findings
- All findings or acute changes should be clearly communicated to the TTL
- Patients cool very quickly and this can have profound effects on haemostasis; ensure patient is kept warm

Anaesthetist / Airway Specialist 1 - Agreed Actions

The key responsibilities of the anaesthetist:

- Identify yourself to the TTL and log your details with the scribe
- Wear personal protective equipment (including sticker with assigned role)
- Actively listen to the ambulance handover
- Reassure patient on arrival, set the scene of what is happening
- Assessment of airway and breathing with cervical spine immobilisation
- Ensure patient oxygenated and ventilated with no airway obstruction
- Take AMPLE history (**A**llergies, **M**edications, **P**ast medical history, **L**ast meal, **E**verything else relevant)
- Monitoring of vital signs
- Monitoring of fluid and drug administration
- Analgesia provision, in discussion with TTL.
- Provide anaesthesia for surgical procedures
- Provide a clear handover of care to lead consultant for next stage of definitive care
- Write in the notes and document all actions and findings with a clear plan
- All findings or acute changes should be clearly communicated to the TTL
- It is usually appropriate for the anaesthetist to talk to the patient and provide on-going assessment of GCS
  The anaesthetist will control the log roll
- Consider need for, and route of, endogastric tube
- Arterial lines may be indicated, to avoid delay to CT this can usually be done after CT or in the operating theatre; it should not delay either
- Communication with theatres role is shared with operating surgeons
- Anaesthetist may have the role of lead for massive transfusion protocol in PED, once in theatre this is their responsibility and blood bank must be informed of any changes to patient details and location

Anaesthetic Practitioner / Airway Specialist 2 - Agreed Actions

The key responsibilities of the anaesthetic practitioner:

- Identify yourself to the TTL and log your details with the scribe
- Wear personal protective equipment (including lead gown and sticker with assigned role)
- Actively listen to the ambulance handover
- To assist Airway Specialist 1 with their responsibilities
- ODP / Airway Specialist 1 takes emergency airway equipment / drugs to CT and re-stocks key equipment

Surgeon - Agreed Actions

The Surgeon focuses on assessment of the abdomen and perineum.

The key responsibilities of the surgeon:

- Identify yourself to the TTL and log your details with the scribe
- Inform TTL of skills and competencies
- Wear personal protective equipment (including lead gown and sticker with assigned role)
- Actively listen to the ambulance handover
- Primary assessment of thorax and abdomen including genitalia
- Secondary assessment of the abdomen
- May need to undertake thoracostomy or thoracotomy as directed by TTL
- Urinary catheter, where appropriate
- Stay with the patient in PED / CT until stood down by the team leader
- Assist with log roll
- Inform the Consultant Surgeon on call if patient has complex multisystem injury or is likely to need early surgery
- Liaise with theatres and anaesthetics colleagues for patients needing theatre, for paediatric surgical procedure
- Obtain necessary consent
- Write in the notes and document all actions and findings with a clear plan

Also consider the following:

- All findings or acute changes should be clearly communicated to the TTL
- Active discussion of the surgical plan with the TTL will allow the patient's priority needs to be addressed
- The possibility of parents being present when patients are being resuscitated

ED Nursing Staff – Nurse 1 and 2 Agreed Actions

Two members of the ED nursing staff are allocated to the team. They should work with Clinicians 1 and 2 and assist in their tasks. The nurses should not have to leave the resuscitation room, portering staff should be available to take samples to the labs etc.

The key responsibilities of the nurses:

- Identify yourself to the TTL and log your details with the scribe
- Wear personal protective equipment (including sticker with assigned role)
- Prepare necessary equipment for major trauma patient
- Agree responsibility for ongoing recording of vital signs
- Actively listen to the ambulance handover
- Document vital signs, including temperature, every 5 minutes in unstable patients and every 15 minutes otherwise
- Assist with IV therapies including rapid infuser, intraosseous devices, fluid and medication etc.
- Prepare for transfer to CT and/or theatre
- Assist with procedures as identified e.g. urinary catheter, chest drain
- Ensure patient identification labels are secured on the patient
- All findings or acute changes should be clearly communicated to the TTL
- Patients cool very quickly and this can have profound effects on haemostasis; ensure patient is kept warm
- Any cultural, religious and pastoral needs

Scribe - Agreed Actions

A member of the Trauma Team will be assigned by the TTL to be responsible of keeping the full record of the trauma call. They should have appropriate experience. They should also be positioned near the TTL so that all information passing through the TTL is then passed to them.

The key responsibilities of the scribe:

- Actively listen to the ambulance handover
    - Inform the team leader every 15 minutes that pass, or the agreed time interval as required by the TTL
- Use local standard operational protocols to record a chronological record of all events and information to include:

    - Personnel present at call including specialty and grade
    - Time of patient arrival
    - Mechanism of injury
    - Previous Medical History
    - Physical findings
    - Transfer times i.e. CT, theatre
    - Vital signs. Urine output. Glasgow Coma Scale

- Results of X-rays, scans and other investigations
- All interventions, with timings
- Fluids administered
- Drugs administered
- Summary of injuries
- Transfer of patient to receiving location including time of handover and transfer of leadership

- This role continues into CT and until the patient is discharged from the ED
- Inform the team leader if key observations have not been recorded e.g. temperature or GCS

Radiographer – Agreed Actions

The key responsibilities of the radiographer:

- Attend trauma room and perform portable plain film x-rays as required
- Contact CT radiographer if requested by TTL

Orthopaedic Surgeon - Agreed Actions

The key responsibilities of the orthopaedic surgeon:

- Identify yourself to the TTL and log your details with the scribe
- Inform TTL of skills and competencies
- Wear personal protective equipment (including stickers with assigned role)
- Actively listen to the ambulance handover if present
- Assessment of limbs, spine and pelvis including a neurovascular assessment prior to muscle relaxants
- Check or apply pelvic binder or splints
- Assessment of wounds and photographic documentation before covering
- Assessment of limb injury
- Initial dressing of wounds and stabilisation of fractures
- Liaise with theatres and anaesthesia colleagues for patients needing theatre, as appropriate.
- Obtain necessary consent
- Document findings and actions
- All findings or acute changes should be clearly communicated to the TTL
- Active discussion of the surgical plan with the TTL will allow the patient's priority needs to be addressed

Lead Consultant – Key Roles and Responsibilities

The Lead Consultant for the patient should be identified as soon as possible after initial assessment. (See local Lead Consultant Policy.)

The key responsibilities of the Lead Consultant:

- To lead the team in the acute clinical management of the patient.
- Completion of the Tertiary Survey
- To lead in the rehabilitation of the patient, including liaison with the Major Trauma Team, and the Trauma and Rehabilitation Coordinators to facilitate:
- The initiation of the Rehabilitation Prescription within the first 24 hours after admission
- The first multi-disciplinary team meeting within 48 hours of admission (including weekends)
- Weekly MDT meetings while the patient is an inpatient
- Ensure onward rehabilitation and follow-up as required in the community

Additional Trauma Team Members.

If deemed necessary by the TTL, the Consultant On Call for any of the trauma specialities may be contacted via switchboard at any point.

The Paediatric Intensive Care Unit may also be contacted to provide support as necessary. This should be done by contacting PICU directly.

In the event that the specialty trainee for a speciality does not respond, or responds to a call but is unable to attend in the time period required by the patient's condition (as judged by the TTL), then the call will be escalated to the Speciality Consultant through Switchboard.

TTL and Speciality Consultant will then liaise and agree a plan of action that makes best use of available resources to provide optimal clinical care.

Primary Survey

Aims

The primary survey aims to identify and treat immediate threats to life while ensuring airway and spine are protected from further compromise or injury. The patient thus assessed, vital functions stabilised, and further deterioration prevented.

The team-based approach described in the Trauma Team Roles and Responsibilities allows parallel assessment and management of airway, breathing, circulation and neurological systems and should result in identification of:

- **C**atastrophic haemorrhage
- **A**irway obstruction
- **T**ension pneumothorax
- **O**pen pneumothorax
- **M**assive haemothorax
- **F**lail chest
- **C**ardiac tamponade

- **S**hock
- **D**ecompensating head injury

The primary survey should be completed within 5 minutes of arrival into the department.

Patient arrives

TTL performs "5 second round"
Looks for signs of life
Catastrophic haemorrhage

Directs Trauma Team to begin Primary Survey and Immediate Actions including haemorrhage control measures

Airway	**Breathing**	**Circulation**	**Dysfunction**	**Exposure**
Look, listen, feel to assess airway C-spine control Open airway Remove obvious obstruction Airway adjuncts and Definitive control if required	Look, feel, tap, listen (including heart sounds) to assess breathing Identify and initiate treatment of immediate life threats (**ATOMFC**) Assess neck for signs of injury	Apply pressure dressing to overt bleeding wounds Assess circulation for shock Pulses - peripheral and central Apply monitoring - ECG Pulse oximetry Automatic BP Assess abdomen and perineum Splint pelvis if suspicion of pelvic injury Vascular access Bloods - including bedside glucose Give Tranexamic Acid	Assess GCS Pupils Posture and Limb lateralising signs	Maintain temperature in normal limits Expose to identify external bleeding and other signs of injury Manipulate and splint limb threatening injuries Log roll if appropriate

Trauma Imaging
As per the Royal College of Radiologists Paediatric Trauma Protocols

Assess, Intervene, Re-assess

Haemorrhage Control

- Five 'Bs" Sources of bleeding - *"Blood on the floor, and five more"*:
  - Blood - obvious bleeding
  - Breast (chest)
  - Belly (abdomen)
  - Bum (pelvis)
  - Bones (limbs)
  - Brain - Infants with open sutures significant blood can be lost intracranially without obvious signs of raised intracranial pressure.

- Stop bleeding and manage the effects of bleeding and the coagulopathy of trauma
- Apply direct pressure to overt bleeding
- Apply splints to pelvis / extremities if bleeding or suspicion of bleeding
- Give **tranexamic acid** bolus if not already given then start infusion (see below):

For patients who have an inherent/drug induced (i.e. Warfarin/NOAC) clotting disorder:

If signs of active bleeding:
- Contact the Haematologist immediately for advice to discuss possible reversal of any anticoagulant agent and refer to Massive Haemorrhage Protocol.

If no signs of active bleeding:
- Ensure early communication with Haematologist and refer to Massive Haemorrhage Protocol.

Tranexamic acid

The use of tranexamic acid has been shown to significantly reduce deaths from trauma and should be given to all patients ***with*** significant bleeding or ***at risk*** of significant bleeding within 3 hours of injury (after this it may cause more harm).

- Give tranexamic acid to any trauma patient who receives fluid (crystalloid, colloid, blood products) for volume in the first 3 hours.

- Seriously consider giving tranexamic acid to any patient you are worried enough to group and save or cross-match - you've already decided that they have bled or are at risk of bleeding.

Patients under 16 years old:

Loading dose: Dilute 15mg/kg (max. 1g) in 10mL of sodium chloride 0.9% or glucose 5% and give via intravenous injection over 10 minutes (within 3 hours of injury).

followed by

Maintenance infusion: Dilute 1g to 500mL with sodium chloride 0.9% or glucose 5% and infuse intravenously at a rate of 2mg/kg/hr [1mL/kg/hr] (max. 125mg/hr [62.5mL/hr]) for 8 hours or until bleeding stops.

Patients over 16 years old:

Loading dose: Dilute 1g in 10mL of sodium chloride 0.9% or glucose 5% and give via intravenous injection over 10 minutes (within 3 hours of injury).

followed by

Maintenance infusion: Dilute 1g to 500mL with sodium chloride 0.9% or glucose 5% and infuse intravenously at a rate of 125mg/hr [62.5mL/hr] for 8 hours or until bleeding stops.

- Use haemostatic agents e.g. Celox, QuikClot

- **Activate Massive Haemorrhage Protocol if criteria met:**
  (see Local Standard Operational Policy)

  - Ongoing severe bleeding (overt or covert) and received 20mL/kg of blood products or 40mL/kg of any fluid for resuscitation in preceding hour
  - Signs of hypovolaemic shock and / or coagulopathy

- Consider definitive or damage control surgery or Interventional Radiology if bleeding not controlled or refractory shock - **Involve Surgeons / Radiology early**

Airway

- Assess and manage airway obstruction-whilst stabilising the cervical spine
- Airway opening manoeuvres - jaw thrust preferred; oropharyngeal airway may help
- Remove obstruction under direct vision only

Indications for intubation:

- Respiratory or cardiac arrest (non-responsive, apnoeic patients who can be ventilated adequately with bag-valve-mask (BVM) do not need immediate intubation but are likely to need rapid sequence induction by a competent practitioner)
- Loss of protective airway reflexes (more likely with GCS<9)

  - Persistent or impending airway obstruction as in inhalational burns
  - Hypoxia despite high flow oxygen
  - Shock unresponsive to fluid resuscitation
  - Need for controlled hyperventilation (e.g. management of acute rise in ICP in head injury)
  - Management of agitated/combative patient at high risk of spinal injury (to allow maintenance of spinal protection)
  - Provision of secure airway for investigations (e.g. CT scan) or prolonged transfer time (e.g. to specialist centre)
  - Obvious need for prolonged control of the airway e.g. multiple injuries

- Refer to Major Trauma Emergency Airway Guidance section in this document (p.33)

Cervical Spine Immobilisation

Indications for C-spine immobilisation:

- Suspicion of or potential for spinal injury or unknown mechanism of injury
- High risk mechanism:
  - RTA pedestrian, cyclist or car passenger at high speed
  - Ejected from vehicle
  - Fall greater than 3 times own height
  - Thrown over handlebars of bike
  - Thrown flowing electric shock or blast

or any of:

- Midline tenderness
- Focal neurological deficit
- History of altered sensation, weakness or other signs of spinal injury (priapism)
- Reduced / altered conscious level
- Intoxication
- Painful or distracting injury
- Unable to clinically assess

Immobilise child/young person with blocks and tape, unless uncooperative child in which case manual immobilisation should be used.

Breathing

- High flow oxygen

- Monitor oxygen saturations
- Look at chest wall movement
- Feel and percuss chest wall
- Listen for air entry, breath sounds and heart sounds
- Look for and treat immediate life threats
    - Tension Pneumothorax
    - Open Pneumothorax
    - Massive Haemorrhage
    - Flail Chest
    - Cardiac tamponade
- Look for signs of neck injury and assess neck veins
- Support ventilation as required to maintain oxygenation

Circulation

- Feel for peripheral and central pulses - assess heart rate
- Monitor ECG
- Measure blood pressure - put non-invasive cuff on 5 minute auto-cycle
- Assess for signs of shock:
- Indicators of shock in children are a combination of at least 2 of:
    - Tachycardia
    - Bradycardia
    - BP less than 5th centile (see table below)
    - Roughly 70mmHg plus (2 x age in years)
    - Pulse pressure <20mmHg
    - Capillary refill time >3 seconds centrally or central / peripheral gap
    - Abnormal conscious level, agitation, confusion, lack of normal social interaction
    - Glasgow Coma Score <13 or falling, responds to only voice, pain or
    - unresponsive
    - In shock with bradycardia consider neurogenic shock

Indicative values in paediatric shock:

Age	**Heart Rate** beats/min		**Respiratory Rate** breaths/min	**Systolic BP** mmHg
	Tachycardia	Bradycardia		

0-7 days	>180	<100	<30 or >60	<60
7-28 days	>180	<100	<30 or >60	<80
1 month – 1 year	>180	<90	<30 or >40	<75
2-5 years	>140	<60	<25 or >30	<75
6-12 years	>130	<60	<20 or >25	<85
>12 years	>110	<60	<15 or >20	<90

- Remember early shock in trauma may be:
  - Hypovolaemic - due to blood loss
  - Cardiogenic - due to impaired heart function (myocardial injury or impaired filling)
  - Neurogenic - suggested by hypotension without tachycardia
- Haemorrhage control as above
- **Activate Massive Haemorrhage Protocol if criteria met:** (see Local Standard Operational Policy)
  - Ongoing severe bleeding (overt or covert) and received 20mL/kg of blood products or 40mL/kg of any fluid for resuscitation in preceding hour
  - Signs of hypovolaemic shock and / or coagulopathy
- Vascular access - ideally 2 large bore cannulae access **BUT** do not waste time and resources attempting to get second line if this will delay further assessment and resuscitation. Successful resuscitation can occur with a single access. Further access is likely to be required but can be gained once the patient is stable.
- Remember the Intraosseous route for vascular access
- Fluid resuscitation - start in 10mL/kg aliquots and assess response and need for further fluid/blood resuscitation Aim for:
- Heart rate within normal for age range
  - Pulse pressure more than 20mmHg
- Improving conscious level
- Normal pH, base excess and lactate less than 2
- Assess and document GCS at presentation and prior to sedation / anaesthetic or intubation (see below)
- Assess pupils for size, equality and reactivity
- Assess posture and responses for lateralising signs

- Manage raised intracranial pressure
  - Ensure good oxygenation
  - Head tilt 20 degrees and head in midline
  - Ensure blood glucose above 3mmol/L (give 3mL/kg of glucose 10% to correct hypoglycaemia)
  - Maintain blood pressure (aim for age-appropriate MAP or systolic BP > 95th centile for age) with fluid resuscitation and inotropes (e.g. noradrenaline)
  - Treat pyrexia with antipyretics or active cooling (cooling blanket)
  - Treat seizures as per local guidelines (regional NWTS Guideline for Management of Generalised Convulsive Status Epilepticus in Children is available at https://www.nwts.nhs.uk/_file/QVBigoyxkF_309689.pdf)
  - Treat pain with opioid analgesia
  - Intubate, paralyse and sedate
  - Specific measures for actual or impending herniation
  - Hyperosmolar therapy with sodium chloride 2.7% or mannitol
  - Controlled ventilation

Dysfunction Glasgow Coma Score

Adult	Child	
Best Eye Response (4) 4. Eyes open spontaneously 3. Eye opening to verbal command 2. Eye opening to pain 1. No eye opening	**Best Eye Response (4)** 4. Eyes open spontaneously 3. Eye opening to verbal command 2. Eye opening to pain 1. No eye opening	
Best Verbal Response (5) 5. Orientated 4. Confused 3. Inappropriate words 2. Incomprehensible sounds 1. No verbal response	**Best Verbal Response (5)** 5. Alert, babbles, coos, words or sentences to usual ability 4. Less than usual ability and/or spontaneous irritable cry 3. Cries inappropriately 2. Occasionally whimpers and/or moans 1. No vocal response	**Best Grimace Response (5)** *Use in pre-verbal or intubated patients* 5. Spontaneous normal facial/oro-motor activity 4. Less than usual spontaneous ability or only response to touch Stimuli 3.Vigorous grimace to pain 2. Mild grimace to pain 1. No response to pain
Best Motor Response (6) 6. Obeys commands 5. Localising pain 4. Normal flexion to pain 3. Abnormal flexion to pain (decorticate) 2. Abnormal extension to pain (decerebrate) 1. No motor response	**Best Motor Response (6)** 6. Obeys commands or performs normal spontaneous 5. Localises to painful stimuli or withdraws to touch 4. Normal flexion to pain 3. Abnormal flexion to pain (decorticate) 2. Abnormal extension to pain (decerebrate) 1. No motor response to pain	

Exposure and Environment

- Prevent hypothermia - maintain normothermia
  - If temperature below 36 degrees administer warm fluids and use a warming blanket
- Expose to ensure all life-threatening injuries identified
- Log roll
  - Inspect entire back and buttocks for signs of injury
  - Palpate spine for tenderness
  - Assess sensation
  - Remove debris and spinal board

Pain assessment and management

- See local children's pain scores and pain management protocols.

- Step-wise analgesia according to pain score and may include:
  - Intranasal Diamorphine
  - Intravenous Morphine
  - Intravenous Ketamine - in shocked patients
  - Intravenous Paracetamol
  - Entonox
  - Regional/Local Nerve Blocks
  - Non-pharmacological methods-including:
    - Splinting
    - POP
    - Urinary catheterization unless urethral injury is suspected
    - Play/distraction therapy

Titrate analgesia to pain score and re-assess frequently

Laboratory investigations

- Glucose
- Cross match
- FBC
- Clotting and fibrinogen
  - Consider point of care dynamic tests, such as ROTEM or TEG
- Blood gas to include lactate
- Biochemistry profile to include LFTs and Calcium
- Amylase
- Serum beta-HCG in girls of child-bearing age

Children's Major Trauma Imaging Guidelines

The North West Children's Major Trauma ODN endorses the Paediatric Trauma Protocols produced by the Royal College of Radiologists (RCR) and have adopted these as the basis for network imaging guidelines.

The full guidance is available from the RCR:

https://www.rcr.ac.uk/system/files/publication/field_publication_files/BFCR(14)8_paeds_trauma.pdf

Algorithms from that document have been appended for quick reference.

Additional Guidance for Secondary Transfers

Where the child is initially received in a Trauma Unit (TU) or local Emergency Hospital (LEH) prior secondary transfer to a Children's Major Trauma Centre (ChMTC):

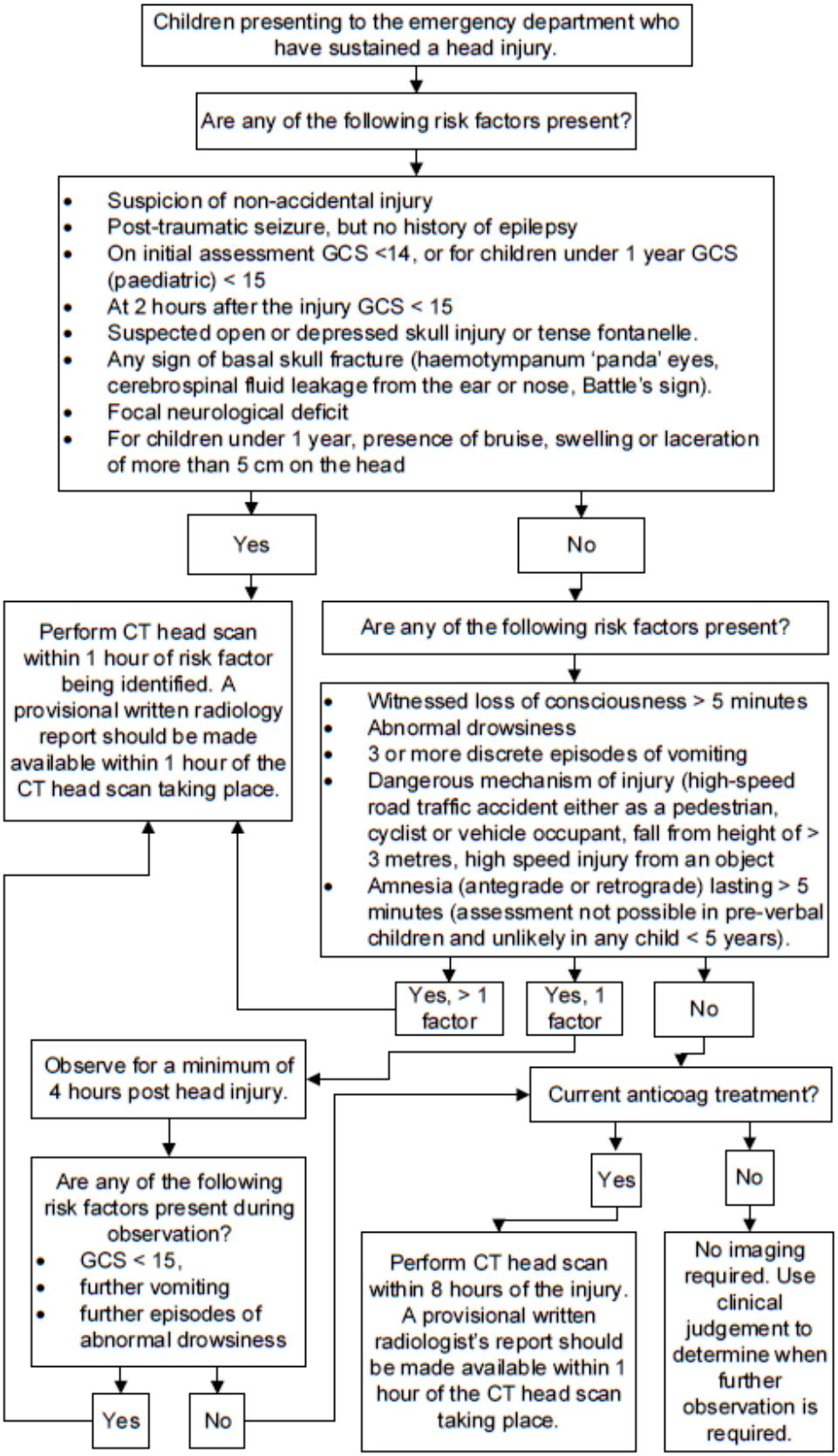
- Decisions regarding imaging performed at the TU/LEH should be made following discussion between TTL at the TU/LEH and ChMTC if time allows.

- For the patient who has an emergency transfer (Category 2 Trauma Transfer) – If local CT not performed, then plain X-rays of the Chest should be performed and reviewed prior to transfer. If there is suspicion of pelvic or hip injury, then a plain X-ray of the Pelvis should also be obtained and reviewed prior to transfer.

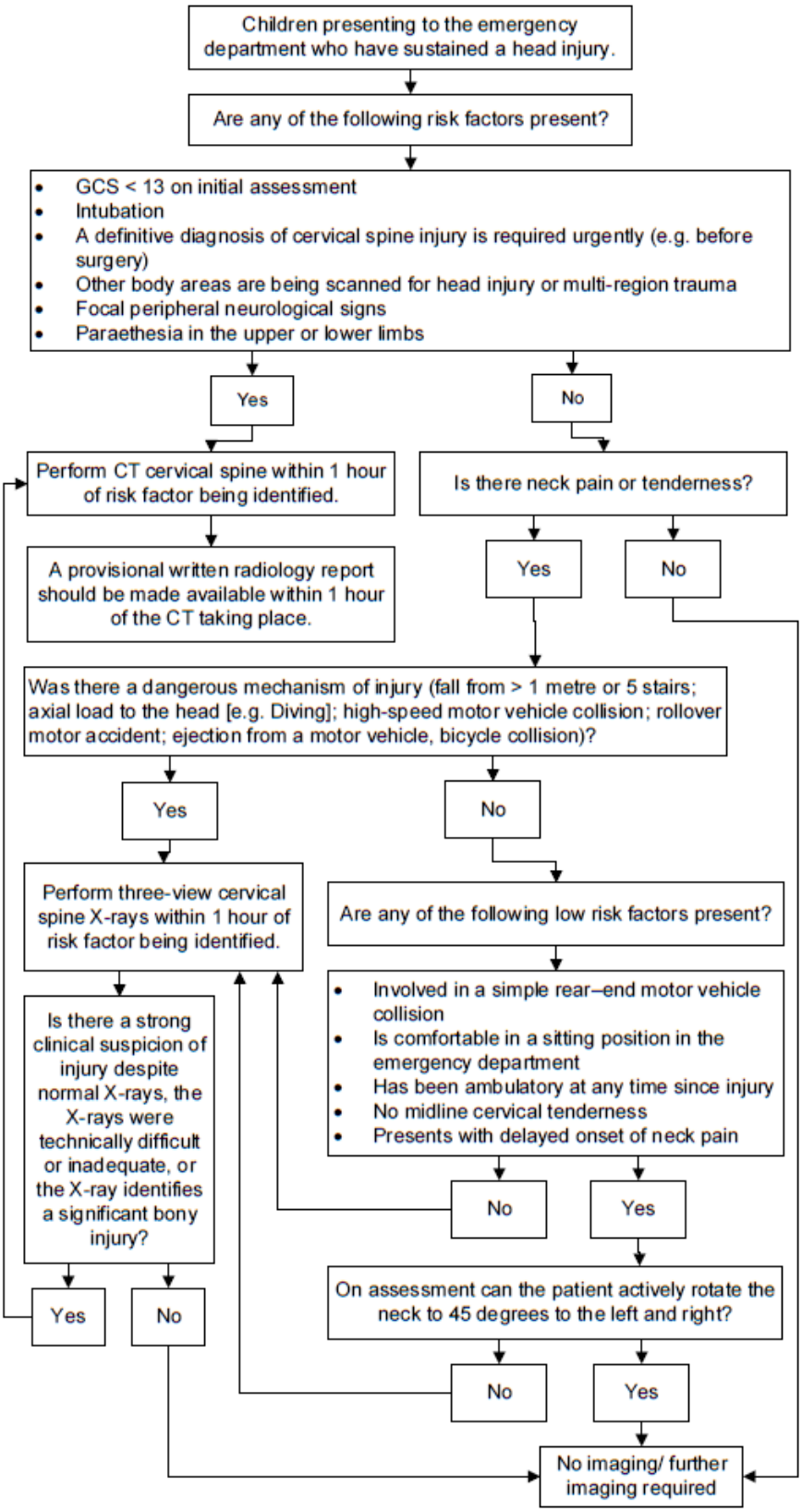
- This, together with a primary survey clinical assessment, should enable any injuries requiring emergency treatment, or with a potential for deterioration *en route* are identified.

- When imaging has been performed at the TU or LEH the transferring team must ensure that the images are available on the PACs system or if the PACs system is not available copies of the images must be sent with the patient on disc.

Suspected Head Injury



Suspected Cervical Spine Injury

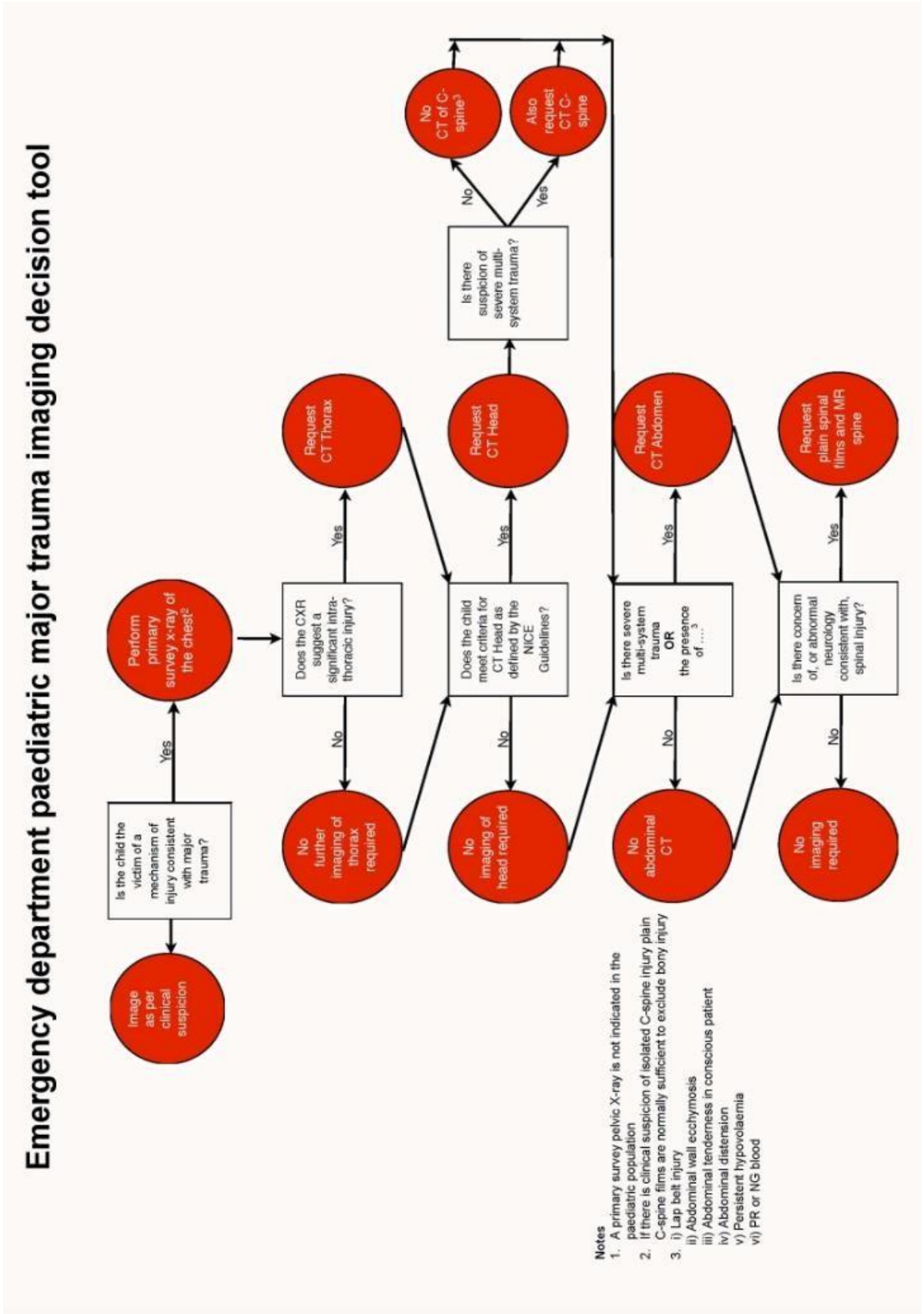


Indications for CT Thorax

- Penetrating trauma - requires contrast enhanced CT
- Abnormal plain chest x-ray
- High clinical suspicion of injury. Consider in patient who has evidence of multisystem trauma and who is:
- Patient intubated prior to hospital assessment
- Unconscious patient
- Haemodynamically unstable
- Unable to oxygenate adequately

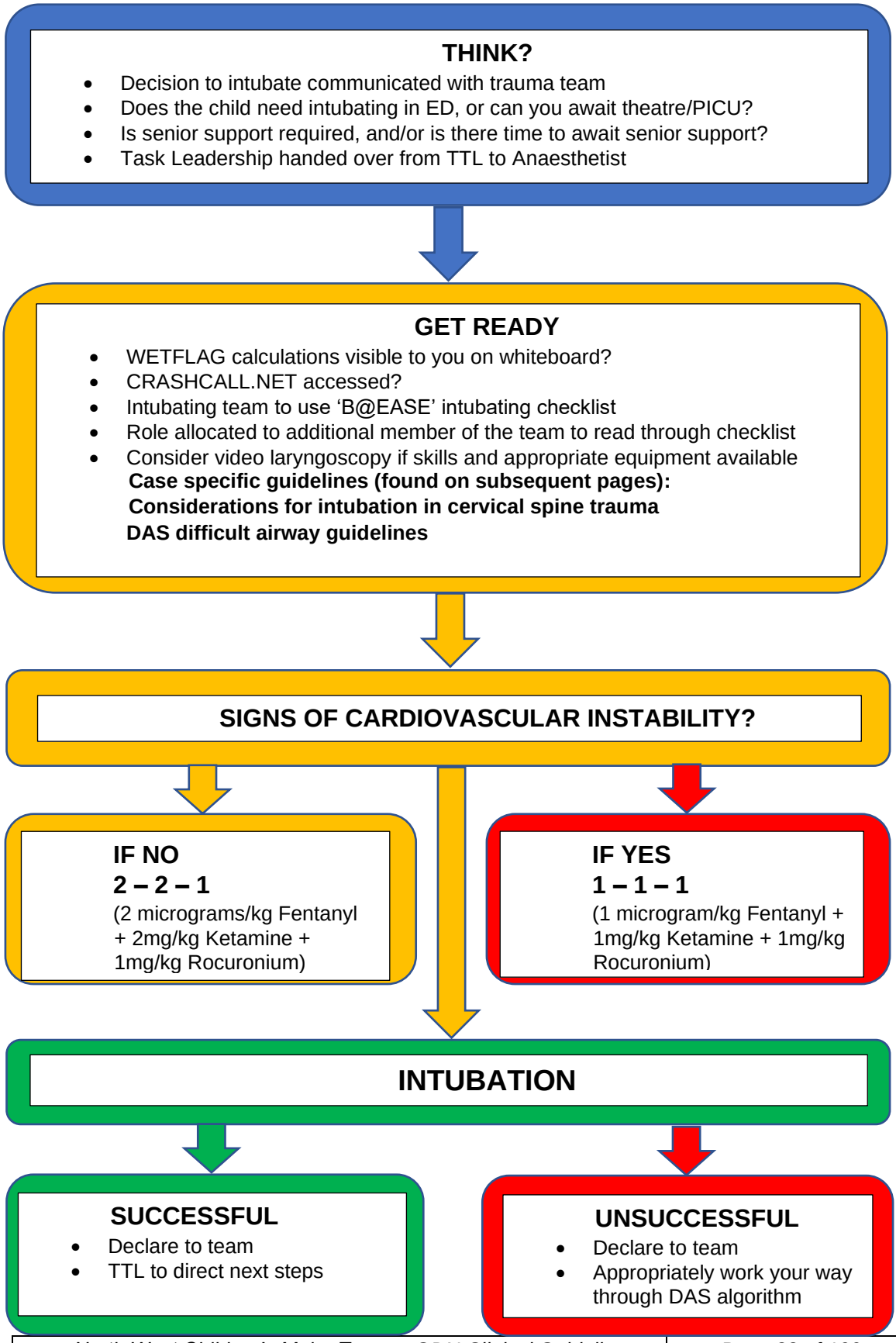
Indications for CT Abdomen and Pelvis

- Lap belt or handlebar injuries
- Abdominal wall bruising
- Abdominal tenderness in a conscious patient
- Abdominal distension
- Clinical evidence of persistent hypovolaemia; for example, persistent unexplained tachycardia or shock
- Blood from rectum or nasogastric tube or urethra
- Consider the need for CT Abdomen in children who have been intubated prior to hospital assessment, especially where there is evidence of multisystem trauma


Emergency department paediatric major trauma imaging decision tool
Is the child the victim of a mechanism of injury consistent with major trauma?
Yes
Image as per clinical suspicion
Perform primary survey x-ray of the chest[2]
Does the CXR suggest a significant intra-thoracic injury?
Yes
Request CT Thorax
No
No further imaging of thorax required
Does the child meet criteria for CT Head as defined by the NICE Guidelines?
Yes
Request CT Head
Is there suspicion of severe multi-system trauma?
No
No CT of C-spine[3]
Yes
Also request CT C-spine
No
No imaging of head required
Is there severe multi-system trauma OR the presence of ....[3]
Yes
Request CT Abdomen
No
No abdominal CT
Is there concern of, or abnormal neurology consistent with, spinal injury?
Yes
Request plain spinal films and MR spine
No
No imaging required
Notes
1. A primary survey pelvic X-ray is not indicated in the paediatric population
2. If there is clinical suspicion of isolated C-spine injury plain C-spine films are normally sufficient to exclude bony injury
3. i) Lap belt injury
ii) Abdominal wall ecchymosis
iii) Abdominal tenderness in conscious patient
iv) Abdominal distension
v) Persistent hypovolaemia
vi) PR or NG blood

Emergency Airway Management

Paediatric Trauma Intubation Management Tool



The North West Children's Major Trauma Network

Emergency Airway Management

Paediatric Trauma Intubation Associated Notes

With reference to the flowchart on the previous page

Think?

- Decision to intubate is made by the anaesthetist, alongside input from the full trauma team
- Once decision made to intubate, this must be clearly communicated with trauma team leader (TTL)
- At this point, task leadership is passed to the anaesthetic team
- Note: Is ED the safest place to intubate this child? Does the child have an anticipated difficult airway? If so, is it safer to intubate in theatre? Is this patient safe to transfer un-intubated to PICU or theatre?
- Does a consultant anaesthetist need to be involved in the airway management of this child?
- Allocate one person to write all WETFLAG calculations on a whiteboard
- Allocate one person to access CRASHCALL.NET calculations for this patient on a nearby computer

GET READY

- Use the **B@EASE** intubating checklist
- Allocate one team member to read out checklist to the entire trauma team
- B@EASE is a 'Challenge and Response' checklist. Ask the question, and await the response
- No other patient interventions should be performed during this time unless necessary

- If cardiovascular instability is **NOT** suspected, then we advise safe use of ***FENTANYL, KETAMINE and ROCURONIUM in a ratio of 2-2-1*** (2 micrograms/kg Fentanyl + 2mg/kg Ketamine + 1mg/kg of Rocuronium)

- If cardiovascular instability **IS** suspected, then we advise safe use of ***FENTANYL, KETAMINE and ROCURONIUM in a ratio of 1-1-1*** (1 microgram/kg of Fentanyl + 1mg/kg of Ketamine + 1mg/kg of Rocuronium)

- Drug dose adjustments may be needed depending on the clinical circumstances
- The anaesthetist should use drugs within their area of expertise
- Propofol can be safely used providing you prepare for potential cardiovascular effects
- If you plan on the use of Rocuronium, ensure you are aware of where sugammadex is available
- Appropriate fluid resuscitation is important prior to induction of anaesthesia
- Adrenaline is a useful drug if required to preclude cardiac arrest in severely shocked patients on induction of anaesthesia. ***0.1mL/kg of 1:10,000 adrenaline, made up to 10mL with sodium chloride 0.9%***. Safely give 1ml aliquots of this solution as required administered IV/IO
- Ensure plan for continuing anaesthesia

INTUBATION

- Ensure you have control of the room and the team
- Minimise noise and ask for any excess team members to leave the room to reduce distractions
- **IF SUCCESSFUL**, then communicate this with the trauma team
- **IF NOT SUCCESSFUL**, then communicate this with the trauma team, and work through the DAS failed intubation algorithm

Considerations for intubation in Cervical Spine Trauma

Risk Factors

- GCS<13
- Multi region trauma
- Focal peripheral neurological signs
- Paraesthesia in upper or lower limbs
- Neck pain/tenderness/torticollis
- Dangerous mechanism of injury
  - Fall from significant height
  - Axial load to head
  - High speed motor collision
  - Ejection from motor vehicle
  - Roll over accident
  - Pedestrian/bicycle vs motor vehicle
- Young children at risk of C1-4 injuries without radiological changes (SCIWORA)

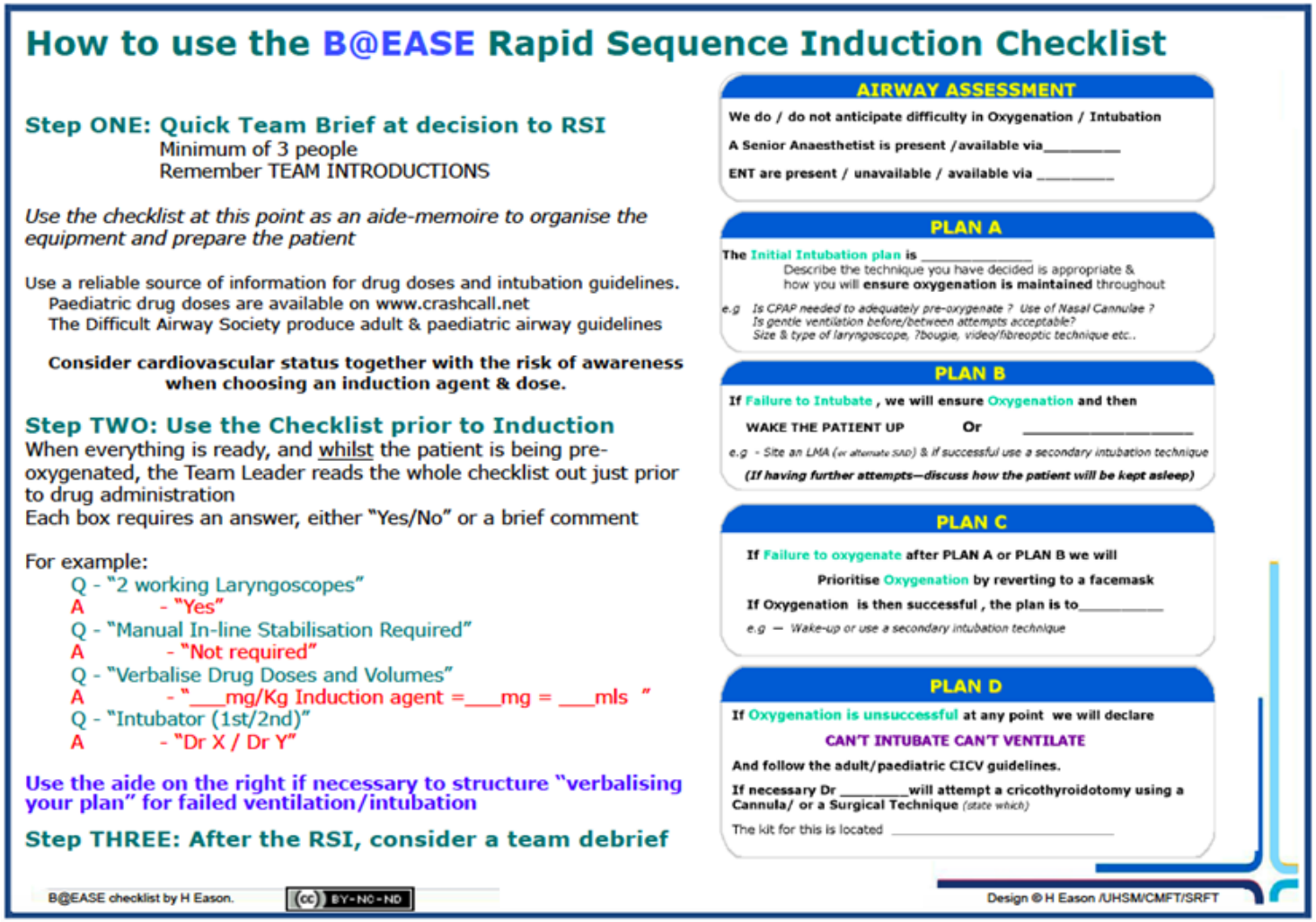
Preparation

- Position
  - Flexion may be more dangerous than extension
  - Diaphragmatic breathing easier if patient lies flat
- Prevention of 2° injury
  - Hypotension – Cord ischemia
  - Risk of neurogenic shock
  - Emergency drugs for cardiovascular instability
- Personnel
  - Ensure adequate assistance available
  - FONA (Front of neck access) equipment available

Intubation

- Remove collar and blocks
- Manual in-line stabilisation
- Minimal jaw thrust and chin lift during ventilation
- Consider video laryngoscopy if equipment and skills available

Acute paediatric intubation checklist



How to use the B@EASE Rapid Sequence Induction Checklist

Step ONE: Quick Team Brief at decision to RSI

Minimum of 3 people
Remember TEAM INTRODUCTIONS

Use the checklist at this point as an aide-memoire to organise the equipment and prepare the patient

Use a reliable source of information for drug doses and intubation guidelines.
Paediatric drug doses are available on www.crashcall.net
The Difficult Airway Society produce adult & paediatric airway guidelines

Consider cardiovascular status together with the risk of awareness when choosing an induction agent & dose.

Step TWO: Use the Checklist prior to Induction

When everything is ready, and whilst the patient is being pre-oxygenated, the Team Leader reads the whole checklist out just prior to drug administration
Each box requires an answer, either "Yes/No" or a brief comment

For example:

Q - "2 working Laryngoscopes"
A - "Yes"
Q - "Manual In-line Stabilisation Required"
A - "Not required"
Q - "Verbalise Drug Doses and Volumes"
A - "___mg/Kg Induction agent =___mg = ___mls "
Q - "Intubator (1st/2nd)"
A - "Dr X / Dr Y"

Use the aide on the right if necessary to structure "verbalising your plan" for failed ventilation/intubation

Step THREE: After the RSI, consider a team debrief

AIRWAY ASSESSMENT

We do / do not anticipate difficulty in Oxygenation / Intubation

A Senior Anaesthetist is present /available via_____

ENT are present / unavailable / available via _____

PLAN A

The Initial Intubation plan is _____
Describe the technique you have decided is appropriate & how you will **ensure oxygenation is maintained** throughout

e.g Is CPAP needed to adequately pre-oxygenate ? Use of Nasal Cannulae ? Is gentle ventilation before/between attempts acceptable? Size & type of laryngoscope, ?bougie, video/fibreoptic technique etc..

PLAN B

If Failure to Intubate , we will ensure Oxygenation and then

WAKE THE PATIENT UP Or _____

e.g - Site an LMA (or alternate SAD) & if successful use a secondary intubation technique

(If having further attempts—discuss how the patient will be kept asleep)

PLAN C

If Failure to oxygenate after PLAN A or PLAN B we will

Prioritise Oxygenation by reverting to a facemask

If Oxygenation is then successful , the plan is to_____

e.g — Wake-up or use a secondary intubation technique

PLAN D

If Oxygenation is unsuccessful at any point we will declare

CAN'T INTUBATE CAN'T VENTILATE

And follow the adult/paediatric CICV guidelines.

If necessary Dr _____will attempt a cricothyroidotomy using a Cannula/ or a Surgical Technique *(state which)*

The kit for this is located _____

B@EASE checklist by H Eason. (cc) BY-NC-ND

Design © H Eason /UHSM/CMFT/SRFT

B@EASE
Rapid Sequence Induction Checklist

B @ E A S E

B R I E F

Equipment

Airway Equipment
- ❑ Oxygen/ Guedel/ NP airway
- ❑ Bag valve Mask & Circuit
  - ❑ *(Waters or Ayres T-piece)*
- ❑ etCO2 attached to HME/Catheter Mt.
  - ❑ *(Use during preoxygenation)*
- ❑ 2 working laryngoscopes & alternate
  - ❑ *(McCoy or straight blade)*
- ❑ Tubes
  - ❑ *(2 Adults, 3 Paeds)*
- ❑ Suction on
- ❑ Lubricating Jelly/Bougie/Stylet
- ❑ Syringe/Tube fixation

Drugs
- ❑ Induction, Paralysis & Emergency drugs drawn up
- ❑ Infusions ready
  - ❑ *(Sedation/Inotropes)*

Monitoring Equipment
- ❑ etCO2 – waveform seen
- ❑ BP – Cycling
- ❑ ECG
- ❑ SPO2

Airway/Anaesthesia

Physiology Optimised
- ❑ IV access location(s)
- ❑ Fluid running
- ❑ Airway assessed

Positioned Appropriately
- ❑ Bed tips and height adjusted
- ❑ Manual In-line Stabilisation required?
- ❑ Ear to Sternal notch in horizontal alignment

Pharmacology Plan
- ❑ Drugs checked and labelled
- ❑ Verbalise Drug doses (mg/kg)

❑ **Difficult airway trolley**

❑ **Defibrillator location**

Staff

Allocate roles e.g

Team leader

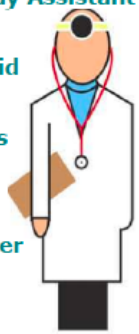
Intubator (1st / 2nd)

Airway Assistant

Cricoid

Drugs

Runner



Emergency Plan

Anticipated difficulty?

Verbalise Oxygenation/ Intubation & Ventilation plans
(see overleaf if necessary)

Plan A

Plan B

Plan C

Plan D

Post Intubation Plan
- ❑ Ventilator set up checked
- ❑ Infusions connected
- ❑ CXR requested
- ❑ Gastric tube required?

Further help available from Bleeps :

Acute paediatric intubation equipment and physiological parameters reference charts.

All sizes and distances are guides and should be confirmed clinically.

Age	Plain E.T.T. Internal Diameter (#ID, mm)	Length Oral	Length Nasal (cm at nose)	Microcuff Size (#ID, mm)	Bougie Size (Ch or FG)	LMA Size	Suction (Ch or FG)	Cricothyroid Needle (G)	Quicktrach (#ID, mm)
Preterm <2kg	2.0,2.5	6-7	7.5-9	-	5 = 1.7mm	1	6	18G =1.27mm	1.5
Preterm 2-4kg	3.0,3.5	7-8.5	9-10.5	3 (if >3kg)	5	1	6,7	18G	1.5
Term -3 months	3.5	8.5-10	10.5-12	3	5	1	7	16G =1.65mm	1.5
3 m- 1year	3.5,4.0	10-11	12-14	3, 3.5	5	1.5	7,8	16G	1.5
1 year	4.0, 4.5	11-12	14-15	3.5	5	1.5, 2	8,10	14G =2.11mm	2.0
2 year	4.5, 5.0	12-13	15-16	4.0	10=3.3mm	2	10	14G	2.0
3 year	5.0	13-14	16-17	4.0	10	2	10	14G	2.0
4-6 years	5.0, 5.5	14-15	17-19	4.5	10	2,2.5	10,12	14G	2.0
6 –8years	6.0, 6.5	15-16	19-21	5.0	15 = 5mm	2.5	12	14G	2.0
>8 years	6.5, 7.0,7.5	16-20	20-23	5.5	15	3	14	14G	2.0 (<35Kg) 4.0 (>35 Kg)

All physiological parameters are a guide. The patient should be assessed in the context of suspected or confirmed iniuries sustained.

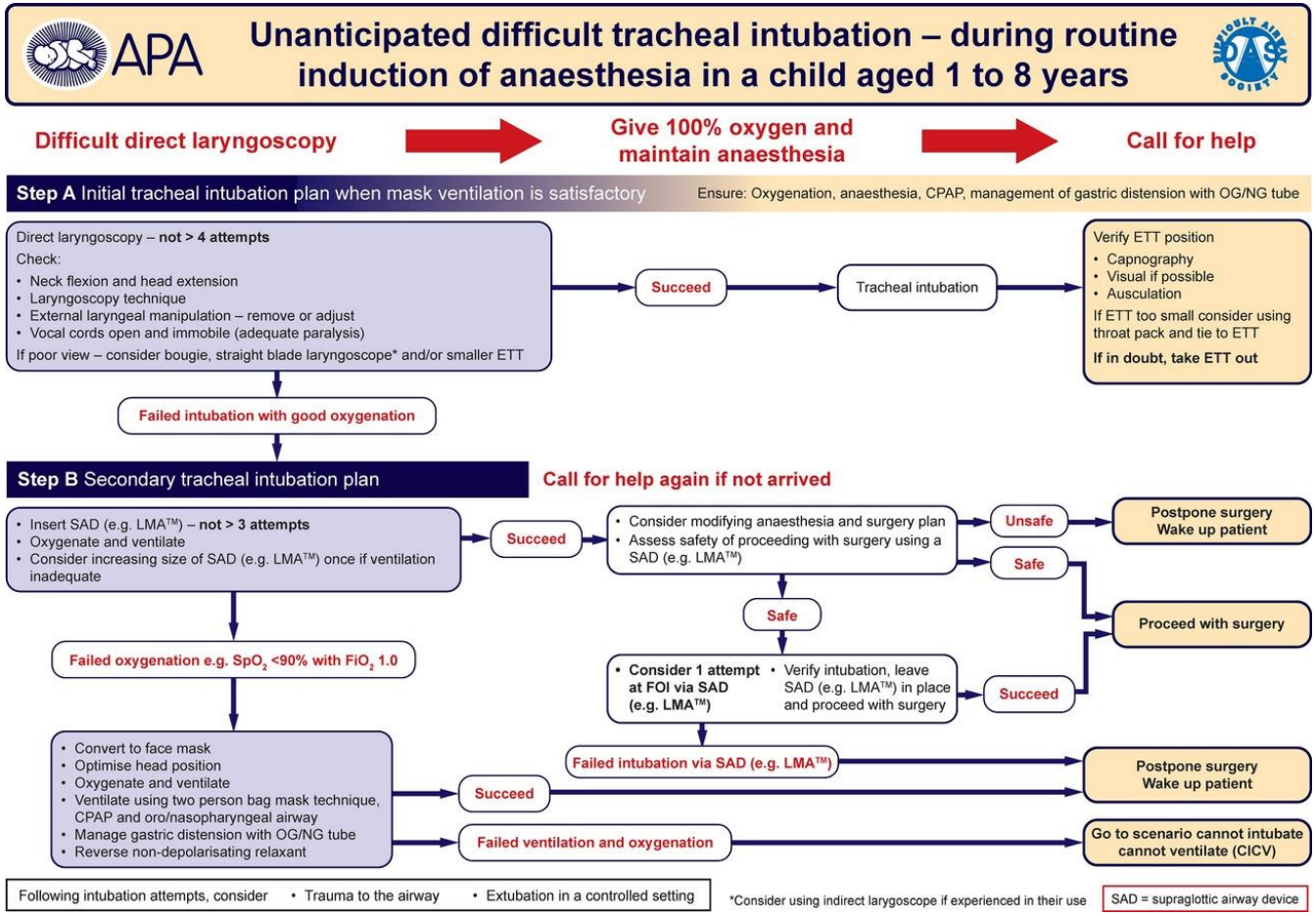
Normal ranges: respiratory rate (RR), heart rate (HR) and blood pressue (BP)

Age	Guide weight (kg)		RR At rest Breaths per minute 5th–95th centile	HR Beats per minute 5th–95th centile	BP Systolic		
	Boys	Girls			5th centile	50th centile	95th centile
Birth	3.5	3.5	25–50	120–170	65–75	80–90	105
1 month	4.5	4.5					
3 months	6.5	6	25–45	115–160			
6 months	8	7	20–40	110–160			
12 months	9.5	9			70–75	85–95	
18 months	11	10	20–35	100–155			
2 years	12	12	20–30	100–150	70–80	85–100	110
3 years	14	14		90–140			
4 years	16	16		80–135			
5 years	18	18			80–90	90–110	111–120
6 years	21	20		80–130			
7 years	23	22					
8 years	25	25	15–25	70–120			
9 years	28	28					
10 years	31	32					
11 years	35	35					
12 years	43	43	12–24	65–115	90–105	100–120	125–140
14 years	50	50		60–110			
Adult	70	70					

References

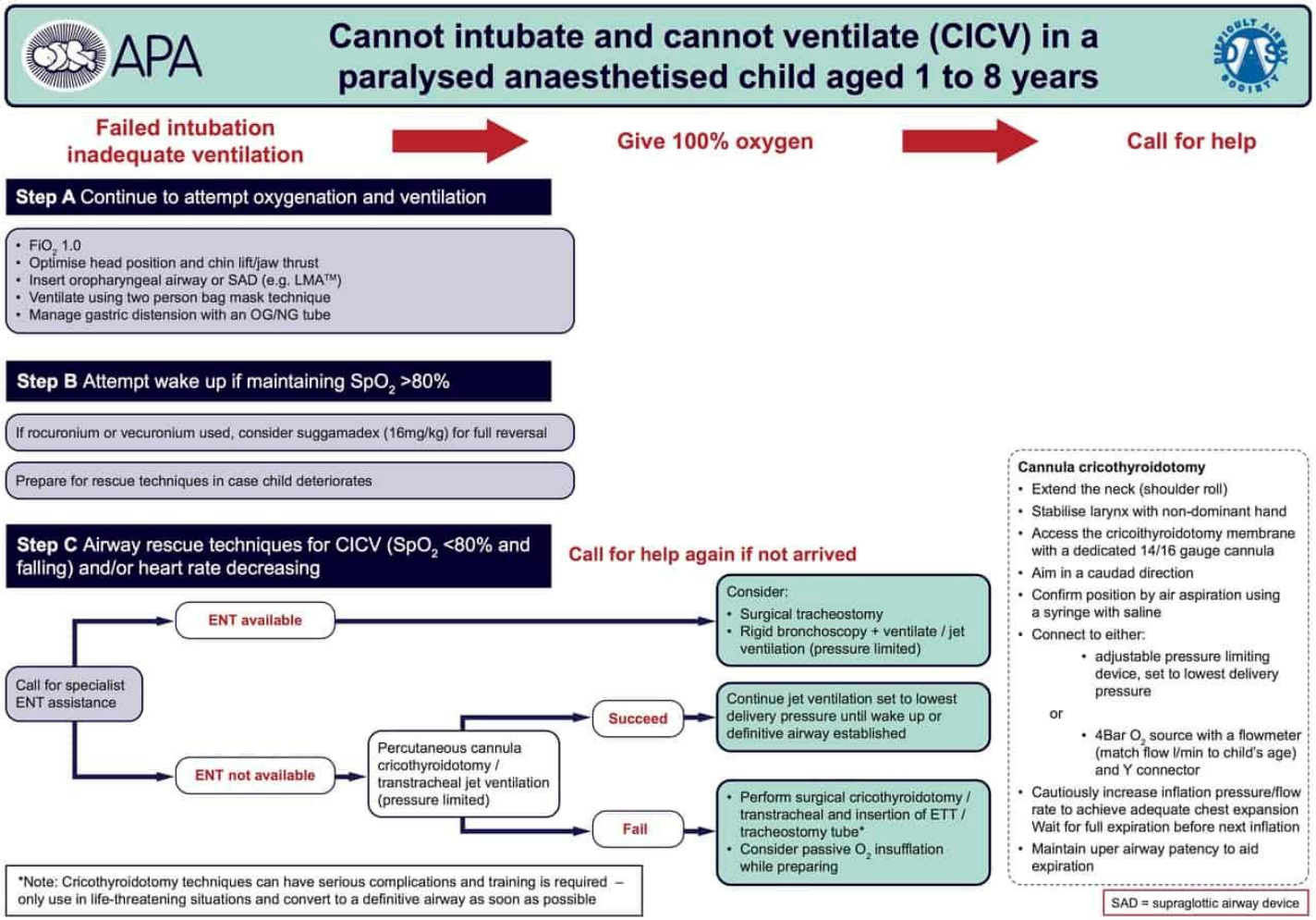
The North West and North Wales Transport Service (NWTS)
Advanced Paediatric Life Support. 6th ed. Blackwell Publishing Ltd. 2016.

- Direct/indirect video laryngoscopy should be the default technique for intubation in the AED if familiar with its use.
- 'Wake up patient' may not be a safe option. Consider benefits and risks.
- These guidelines are applicable to children under one-year and over eight-years-old.
- Older children may be suitable for DAS adult guidelines



Guidance for a cannot intubate and cannot ventilate situation

- Inform TTL of the situation. Call for an ENT surgeon
- Anaesthetic intervention in children over eight-years-old: Cricothyroid access as 1st line.
- Anaesthetic intervention in children under one-years-old: Tracheal access as 1st line.
- Older children may be suitable for DAS adult CICV guidelines: Scalpel cricothyroidotomy.



Head Injury

Overview

Head injuries are a common cause of morbidity and mortality in children, often due to falls or road traffic accidents. Most head injuries are minor and management at home. However, some children may require review in an emergency department.

Traumatic brain injury (TBI) is a significant factor in major trauma patients attending a Major Trauma Centre (MTC) or requiring transfer from a Trauma Unit (TU). Children can compensate for severe injuries until a rapid deterioration so caution should be taken to consider the mechanism of injury and adoption of suspicion with falls from height or high force injuries is appropriate.

Objectives

The management of head injuries depends entirely on the severity and the potential for deterioration due to secondary injury. It is imperative, therefore, to appropriately triage and assess a child following a head injury, understanding that there is potential to deteriorate following initial assessment.
The focus should be on:

- Initial assessment including appropriate analgesia
- Appropriate investigation
- Management of injury
    - Prevention of secondary injury
    - Appropriate on-going care

Grading of Head Injury

There are several grading systems for head injuries but the simplest is based on the Glasgow Coma Scale (GCS) after initial resuscitation. Mild head injuries can still be significant causes of morbidity and school absence. For children experiencing concussion symptoms please refer to the After Concussion, Return to Normality (ACoRN) Leaflet for ***concussion and return to activity advice*** for children and families (see appendix I on page 102 of this document) https://childbraininjurytrust.org.uk/wp-content/uploads/2019/07/ACORN-Blank-Template.pdf.

Moderate and severe head injuries will normally need hospitalisation and investigation, and many will need to be discussed with neurosurgery. This guideline is for management of these patients who represent approximately 5% of attendees. Penetrating injury through bone and dura will always need investigation and discussion with neurosurgery whatever the grade of injury.

Grade	GCS
Mild	13-15
Moderate	9-12
Severe	8 or less

Safeguarding Children

For all children presenting with a head injury, it is important to complete a safeguarding assessment as part of the initial and ongoing assessment (please see safeguarding section starting on page 86). The initial assessment should include consideration of:

- Injury incompatible with history
- Unexplained delay in presentation
- Change in mechanism of injury over time
- Injury in immobile child
- Risk taking behaviours causing injury
- Lack of supervision
- Neglect

Who requires imaging?

NICE guidelines exist to clarify this. NICE: criteria for CT head https://www.nice.org.uk/guidance/cg176/resources/imaging-algorithm-pdf-498950893

Criteria for performing a CT head scan

For children who have sustained a head injury and have any of the following risk factors, perform a CT head scan within 1 hour of the risk factor being identified:

- Suspicion of non-accidental injury.
- Post-traumatic seizure but no history of epilepsy.
- On initial emergency department assessment, GCS less than 14, or for children under 1 year GCS (paediatric) less than 15.
- At 2 hours after the injury, GCS less than 15.
- Suspected open or depressed skull fracture or tense fontanelle.
- Any sign of basal skull fracture (haemotympanum, 'panda' eyes, cerebrospinal fluid leakage from the ear or nose, Battle's sign).

- Focal neurological deficit.
- For children under 1 year, presence of bruise, swelling or laceration of more than 5 cm on the head.
- A provisional written radiology report should be made available within 1 hour of the scan being performed.

For children who have sustained a head injury and have **more than one** of the following risk factors (and none of those above) perform a CT head scan within 1 hour of the risk factors being identified:

- Loss of consciousness lasting more than 5 minutes (witnessed).
- Abnormal drowsiness.
- Three or more discrete episodes of vomiting.
- Dangerous mechanism of injury (high-speed road traffic accident either as pedestrian, cyclist or vehicle occupant, fall from a height of greater than 3 metres, high-speed injury from a projectile or other object).
- Amnesia (antegrade or retrograde) lasting more than 5 minutes.

Assessment of amnesia will not be possible in preverbal children and is unlikely to be possible in children aged under 5 years.

A provisional written radiology report should be made available within 1 hour of the scan being performed.

Children who have sustained a head injury and have **only 1** of the risk factors in this section should be observed for a minimum of 4 hours from the time of injury.

The minimum frequency of observations for patients with GCS equal to 15 should be as follows, starting after the initial assessment in the ED:

- Half-hourly for 2 hours
- Then 1 hourly for 4 hours
- Then 2 hourly thereafter

If during observation any of the risk factors below are identified, perform a CT head scan within 1 hour.

- GCS less than 15.
- Further vomiting.

- A further episode of abnormal drowsiness.

A provisional written radiology report should be made available within 1 hour of the scan being performed. If none of these risk factors occur during observation, use clinical judgement to determine whether a longer period of observation is needed.

For patients (adults and children) who have sustained a head injury with no other indications for a CT head scan and who have a high bleeding risk, perform a CT head scan within 8 hours of the injury. A provisional written radiology report should be made available within 1 hour of the scan being performed. (For advice on reversal of warfarin anticoagulation in people with suspected traumatic intracranial haemorrhage, see the NICE guideline on blood transfusion.)

Cervical Spine

For children who have sustained a head injury, perform a CT cervical spine scan only if any of the following apply (because of the increased risk to the thyroid gland from ionising radiation and the generally lower risk of significant spinal injury):

- GCS less than 13 on initial assessment.
- The patient has been intubated.
- Focal peripheral neurological signs.
- Paraesthesia in the upper or lower limbs.
- A definitive diagnosis of cervical spine injury is needed urgently (for example, before surgery).
- The patient is having other body areas scanned for head injury or multi-region trauma.
- There is strong clinical suspicion of injury despite normal X-rays.
- Plain X-rays are technically difficult or inadequate.
- Plain X-rays identify a significant bony injury.

The scan should be performed within 1 hour of the risk factor being identified. A provisional written radiology report should be made available within 1 hour of the scan being performed.

For children who have sustained a head injury and have neck pain or tenderness but no indications for a CT cervical spine scan perform 3-view cervical spine X-rays **before** assessing range of movement in the neck if either of these risk factors are identified:

- Dangerous mechanism of injury (that is, fall from a height of greater than 1 metre or 5 stairs; axial load to the head, for example, diving; high-speed motor vehicle collision; rollover motor accident; ejection from a motor vehicle; accident involving motorised recreational vehicles; bicycle collision).
- Safe assessment of range of movement in the neck is not possible.

  The X-rays should be carried out within 1 hour of the risk factor being identified and reviewed by a clinician trained in their interpretation within 1 hour of being performed.

If range of neck movement can be assessed safely in a child who has sustained a head injury and has neck pain or tenderness but no indications for a CT cervical spine scan, perform 3-view cervical spine X-rays if the child cannot actively rotate their neck 45 degrees to the left and right. The X-rays should be carried out within 1 hour of this being identified and reviewed by a clinician trained in their interpretation within 1 hour of being performed.

In children who can obey commands and open their mouths, attempt an odontoid peg view.

Management of Injury

Management of Moderate and severe head injuries involves prevention of secondary injury. This is done with a combination of medical management and, when appropriate, expedited surgical intervention. If in a centre without neurosurgery this will often require urgent transfer. Appropriate ongoing care minimises the impact of the primary injury.

Most moderate or severe head injuries will need to be discussed with the Trauma Team Lead (TTL) in the MTC. This would include:

- All patients with surgically significant abnormalities on imaging
- Regardless of imaging other reasons include:
  - Persisting coma (GSS ≤ 8) after initial resuscitation
  - Unexplained confusion for more than 4 hours
  - Deterioration of 2 or more points in GCS after admission (motor score more significant)
  - Progressive focal neurological signs
  - Seizure without full recovery

- Definite or suspected penetrating injury
- Cerebrospinal fluid leak

Prevention of secondary injury

Tranexamic acid

The CRASH 3 study has demonstrated a beneficial effect in giving tranexamic acid (TXA) to adults within 3 hours of mild to moderate traumatic brain injury. It is plausible that the same effect can be expected in children and TXA may be beneficial in preventing progressive intracranial haemorrhage in traumatic brain injuries without an increase in adverse effects.

TXA should be given to children with suspected head injury and reduced conscious level or those with intracranial bleed confirmed on imaging if started within 3 hours of the injury.

Patients under 16 years old:

Loading dose: Dilute 15mg/kg (max. 1g) in 10mL of sodium chloride 0.9% or glucose 5% and give via intravenous injection over 10 minutes (within 3 hours of injury).

followed by

Maintenance infusion: Dilute 1g to 500mL with sodium chloride 0.9% or glucose 5% and infuse intravenously at a rate of 2mg/kg/hr [1mL/kg/hr] (max. 125mg/hr [62.5mL/hr]) for 8 hours or until bleeding stops.

Patients over 16 years old:

Loading dose: Dilute 1g in 10mL of sodium chloride 0.9% or glucose 5% and give via intravenous injection over 10 minutes (within 3 hours of injury).

followed by

Maintenance infusion: Dilute 1g to 500mL with sodium chloride 0.9% or glucose 5% and infuse intravenously at a rate of 125mg/hr [62.5mL/hr] for 8 hours or until bleeding stops.

Secondary injury occurs due to raised intracranial pressure (ICP). This can be due to expanding haematomas or swelling of intracranial structures following diffuse injury. Ultimately this can lead to ischaemic injury, trans-tentorial herniation and death.

Signs and symptoms of raised ICP include:

- Reduced conscious level
- Vomiting
- Headache

- Visual disturbance
- Neurological symptoms (weakness, hypertonia)

And in severe cases:

- Pupil dilation
- Cranial nerve palsies
- Abnormal posturing

Treatment

The ultimate management is likely to involve neurosurgical and or Intensive Care management so timely transfer to a unit where this is available is a priority. Please follow the MT transfer policy. Patients in coma or with reducing GCS should always be transferred intubated and ventilated.

Prior to and during transfer, measures can be taken to reduce ICP and reduce the chance of deterioration. These are aimed at reducing secondary injury. These include:

- Ensure well oxygenated – maintain oxygen saturations 94-98%.
- Head tilt 20 degrees upwards (with appropriate caution about spine)
- Maintain blood glucose above 3mmol/L (give 3mL/kg of glucose 10% to correct hypoglycemia)
- Maintain blood pressure (aim for age-specific MAP targets as per table below; if unable to measure MAP aim for systolic BP > 95mmHg) using fluids and inotropes if required

Mean arterial pressure targets (age specific)	
Under 1 year	More than **50** mmHg
1-5 years	More than **60** mmHg
5-14 years	More than **70** mmHg
Over 14 years	More than **80** mmHg

- Treat pyrexia
- Treat seizures as they occur as per local guidelines (regional NWTS Guideline for Management of Generalised Convulsive Status Epilepticus in Children is available at https://www.nwts.nhs.uk/_file/QVBigoyxkF_309689.pdf)
- Treat pain using opiates.
- Insert urinary catheter unless urethral injury is suspected.

If signs of impending herniation, then consider:

- Hyperosmolar therapy (choice based on best availability)

  Hypertonic sodium chloride 2.7%: 3ml/kg via intravenous injection over 15 minutes; especially consider in multiple trauma where signs of hypovolaemia/haemorrhagic shock.

  or

  Mannitol 20%: 1.25-2.5 mL/kg via intravenous injection over 15 minutes; avoid in renal failure and caution in haemorrhagic shock; watch for hypovolaemia

  A second treatment may be given (either the same or the alternative therapy) if required but exercise caution. If using hypertonic saline, maintain serum sodium above 140mmol/l but less than 150mmol/l.
- Controlled hyperventilation

  Aim for end-tidal CO2 (EtCO2) between 3.5-4.0 KPa (equivalent to arterial PaCO2 4.0-4.5kPa or 30-35mmHg)

  Requires end tidal CO2 monitoring

Discharge advice

Patients can be discharged home following a head injury as long as they have:

- GCS 15.
- An appropriate head injury advice sheet.
- There is suitable care and supervision at home.
- No ongoing safeguarding concerns

For all CYP who have attended the emergency department with a head injury, their GP should be sent details of their clinical history and examination within 48 hours of their discharge. The discharge letter should be shared with the child's health visitor (for pre-school children) or school nurse (for school-age children). If appropriate, a copy of the letter should be shared with the patient and their family / carer. Patients and their families / carers should be provided advice about the possibility of persistent or delayed symptoms following head injury and whom they should contact if they experience ongoing problems.

Follow-up

When a patient has undergone imaging of the head and/or been admitted to hospital there must be an opportunity available for referral from primary care to an outpatient appointment with a professional trained in assessment and management of sequelae of brain injury (for example, clinical psychologist, neurologist, neurosurgeon, paediatrician) if the patient develops or experiences persisting problems related to their head injury.

Spinal Injury

Spinal injuries in children are extremely uncommon.

Children may present with full movement and sensation of all four limbs; however, they may have a vertebral fracture and, if handled incorrectly, the spinal cord may be damaged and the results could be devastating.

If you suspect a spinal injury, take all measures to protect the spine, remembering to do no harm in the combative child, and call the Neurosurgical registrar for injuries in the cervical spine and the orthopaedic registrar for thoracic or lumbar spine injuries.

In general, spinal injuries should be suspected in any patient who has been involved in:

- A road traffic accident
- A fall or jump from a height
- An accident resulting in impact or crush injuries
- An accident resulting in multiple trauma
- An accident resulting in the patient losing consciousness and if:
  - Following injury, the patient complains of back or neck pain and appears to be guarding their back or neck
  - The patient complains of any sensory changes or loss such as numbness or tingling
  - History of altered sensation, weakness or other signs of spinal injury
  - The patient is unable to pass urine
  - There is pre-existing pathology
  - Remember spinal shock - at the acute stage there may be total, flaccid paralysis of all skeletal muscle and loss of all spinal reflexes below the level of the lesion. It may last from several hours to several weeks depending on the severity.

Imaging

Refer to RCR Guidance on Imaging in Paediatric Trauma.

- **A Paediatric Musculoskeletal Radiologist is required for interpreting these scans**. It is not the role of the Spinal Consultant to exclude all aspects of the radiological images.
- Imaging the whole spine is essential usually with MRI of the whole spine particularly in the young child.
- Areas of concern may then require localised CT.
- In reduced consciousness, CT of the whole cervical spine (to T4) is mandated.
- The ETC/APLS protocols should be followed in major trauma.
- Soft tissue swelling must not be overlooked.
- CT of identified fractures is required.
- Young children may present without obvious bony injury of vertebrae; SCIWORA (SCI without radiological abnormality, though significant damage may be seen on MRI). A high index of suspicion is needed re disco-ligamentous injuries.

The exact timing of performing imaging has to be reviewed as access to the patient is poor in the scanner and careful assessment of clinical condition is needed. Younger children will require sedation or anaesthesia for imaging.

Cervical spine

Cervical Spine Injury (CSI) in children is very rare and becomes increasingly rare the younger the child.

The cervical spine attains its adult form from the age of about 8 years, and so CSI in children aged over 8 years tend to be in the adult pattern, i.e. mainly of the lower cervical vertebrae (C5-C7).

However, in children of 7 years and under, involvement of the atlas and axis with injuries is more common. These injuries are normally characterised by distraction of the osseous ring rather than compression or comminution seen in older children and adults. Fractures at one level should prompt a search for fractures elsewhere in the whole spinal column. The high-level cervical fractures are often fatal at the scene, so they may be under-represented in the hospital patient. Relative bradycardia for age and measured blood pressure might be a clue to upper cervical spinal cord injury.

Spinal Cord Injury without Radiological Abnormality (SCIWORA) is more common in children than adults. It is defined as objective signs of myelopathy as a result of trauma with no evidence of fracture or ligamentous instability on plain spine radiographs and tomography. There can be a delay of up to four days between the insult and developing the myelopathy. It is therefore recommended that neurologically normal children with a history of transient neurological symptoms should also be taken seriously.

The mainstay of treatment is immobilisation, and MRI can provide prognostic information.

Thoracic and Lumbar Spine

Thoracic and lumbar spine injuries in children are rare. The majority of injuries occur in the growth plates within the bones and at the thoracolumbar junction because of its increased mobility.

NICE Guidance 41, Spinal Injury: Assessment and Initial Management recommends that X-ray is the imaging modality of choice in children with a suspected thoracolumbar (T1 – L3) spinal column injury without neurological injury. A CT scan should be performed if the X-ray is abnormal or there is still a clinical suspicion of spinal injury. If an injury is identified, then the rest of the spinal column should be imaged.

Their pathomorphology, healing process and prognosis differs from those in adults, and is beyond the scope of this document.

The goals of initial management are to minimise further injury and resulting neurological deficit as for head injury.

Patients with an identified thoracic or lumbar spine injury on imaging should be kept on bed rest until a plan has been made by the spinal team.

Ongoing management

The continuing management of cervical spinal injuries will be directed by the Neurosurgical team with input from the Spinal team for thoracic and lumbar spine injuries.

The Spinal Cord Injury Centre at Southport Hospital should be contacted in the event of a spinal cord injury within the first 24 hours.

The SCI Centre encourages rapid referral, as soon as spinal cord injury is identified. Consultant to on-call doctor referral to the Centre is required for all new trauma cases. To contact the SCI Centre during office hours telephone 01704 704333, outside office hours, use telephone number 01704 704345 or the main hospital switch board on telephone number 01704 547471. All referrals **must also** be made via the NHS National Spinal Cord Injury Database https://nww.mdsas.nhs.uk/spinal/

A detailed assessment of neurological functional should be documented on an ASIA chart which is available on Neurosurgery and Neurology.

The North West Children's Major Trauma Network

British Orthopaedic Association

BOA STANDARD

BASS British Association of Spine Surgeons

BASCIS British Association of Spinal Cord Injury Specialists

The Management of Traumatic Spinal Cord Injury

November 2022

Background and justification

Acute Spinal Cord Injury (SCI) due to traumatic or vascular damage, resulting in neurological deficit is a rare but devastating injury. Spinal cord compromise can result in immediate or insidious onset of neurological symptoms. Appropriate urgent management from the time of diagnosis has been shown to reduce complications and improve outcomes.

Inclusions:

All patients (adults and children) with traumatic spinal cord injury resulting in complete or incomplete para- or tetraplegia.

Standards for Practice

1. All hospitals receiving patients with SCI must have a named linked Spinal Cord Injury Centre and named linked Specialised Spinal Surgery Centre (SSSC) which offers 24 hour consultant spinal surgeon availability. SCI Centres should provide 24 hour advice and support to the Major Trauma Network (MTN).
2. All hospitals within a MTN should have an agreed, common protocol for protecting the neck and spine and exclude injury in line with BOAST-2 (Spinal Clearance in the Trauma Patient (2015)).
3. Centres receiving patients with SCI require 24-hour access to CT and MRI. Initial trauma CT scanning must be followed by whole spine MRI scanning once safe.
4. Daily generalised neurological review should be recorded as part of the routine ward round or multidisciplinary assessment.
5. Full detailed neurological examination should be recorded on an ISNCSCI chart, within 2 hours of admission, in keeping with the International Standards for Neurological Classification in Spinal Cord Injury (ISNCSCI).* This should also occur weekly as well as before and after major interventions and/or surgical procedures.
6. ISNCSCI charts should be completed by clinicians trained in their use.
7. Protocols for skin care, gastric, bowel and bladder care, neuroprotection, joint protection and therapy requirements must be agreed with the linked SCI Centre and follow national guidance.
8. For patients requiring surgery, protocols for anaesthesia and spinal stabilisation must follow national guidance.
9. All major trauma and SSSCs should have dedicated link nurse and therapy arrangements to provide specialised care until transfer to SCI centre.
10. All patients with SCI in England must be submitted to the National Spinal Cord Injuries Database** within 24 hours of diagnosis. An agreed management plan between admitting unit and SCI centre must be formulated and recorded in the medical notes within 72 hours of diagnosis.
11. Transfer to a SCI Centre should take place within 24 hours, unless it is in the patient's best interest to remain locally. Regionally agreed support / liaison arrangements need to be in place in the event of a delay.
12. Appropriate psychological support should be provided for patients, family and carers.

* ISNCSCI chart (replaces ASIA chart) https://asia-spinalinjury.org/international-standards-neurological-classification-sci-isncsci-worksheet/
** National Spinal Cord Injuries Database: https://www.nscisb.nhs.uk

SCI referrals can be made via: https://referrals.mdsas.com

Thoracic Injury

Chest Trauma

In the event that a **penetrating chest trauma** is brought to the department, particularly where a cardiac injury is suspected, the paediatric surgical registrar/ consultant and team leader will decide on the urgency and the need for assistance from cardio-thoracic on call consultant. The cardiac surgeon should be made aware of exactly which theatre the patient is being transferred to and should go directly there to assess the patient. They should be met at the ambulance entrance and taken to theatre by portering staff.

Penetrating Trauma Chest – Cardiac Origin

If cardiac injury is suspected call the relevant **Consultant** Surgeon.

1. If the patient *arrests in ED, is peri-arrest, or has arrested within 5 minutes of hospital arrival and there is penetrating chest injury* then a thoracotomy performed in ED may be indicated

- The Paediatric Surgical SpR (if they have been trained in this procedure) or Consultant should undertake this procedure. Occasionally the ED Consultant may have started the thoracotomy before you arrive – assist them and take the lead as required
- The Consultant Surgeon must be called
- Ensure that you are trained to perform a thoracotomy and know what to do if you find injury
- There is appropriate equipment in ED - make sure you know where it is. It is your responsibility to familiarise yourself with the kit.
- The cardiothoracic surgeon on call should be contacted
- Many of the T&O SpR's will have some experience in thoracotomy, which is performed on a regular basis in spinal surgery. They may be able to help.

2. In patients who have not arrested but in whom there is suspicion of a cardiac injury:

The trauma team leader in association with the Surgical SpR/ Consultant and the Cardiothoracic Consultant on call will determine the best course of action. This will depend on other injuries (if present).

Penetrating Trauma Chest – Non-Cardiac Origin

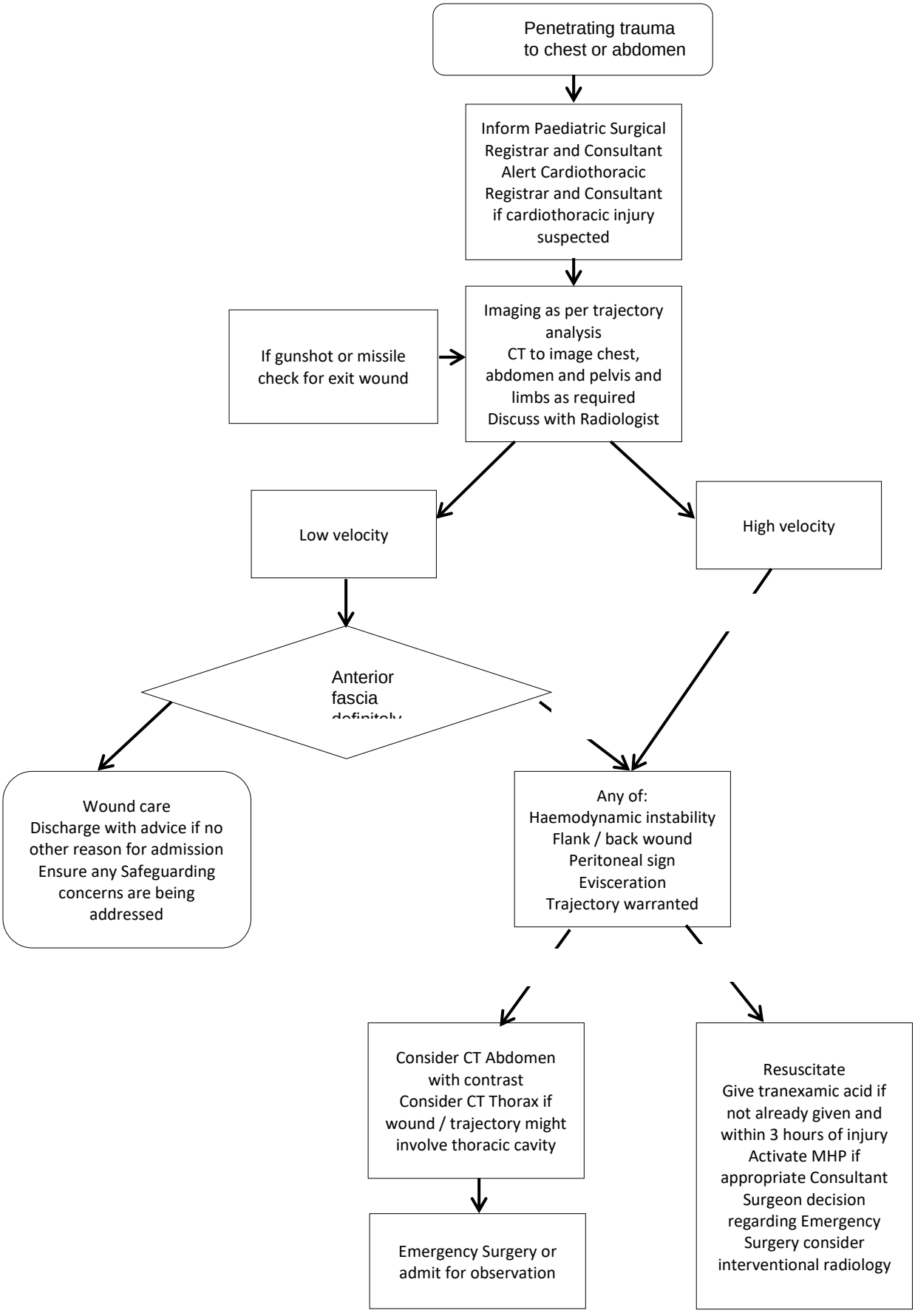
The Surgical/Cardiac SpR, Orthopaedic SpR or ED Registrar will be expected to perform thoracostomies/place chest drains in patients with diagnosed or suspected haemothorax in the trauma resuscitation

Unstable patients with significant haemothorax will require a thoracotomy. Call the appropriate Surgical Consultant.

In the peri-arrest / arrested patient then a thoracotomy will be required. Whenever possible thoracotomy should be performed in theatres.

- Definitive Surgery in Trauma Skills course recommends a left antero-lateral thoracotomy converted into a clamshell
- A decision on surgery should be undertaken between the Paediatric Surgical Consultant and Thoracic Surgical Consultant.
- In the more stable patient, on-going blood loss should be discussed with the Paediatric Surgical Consultant with a view to surgery.

Suspected Penetrating Trauma Algorithm

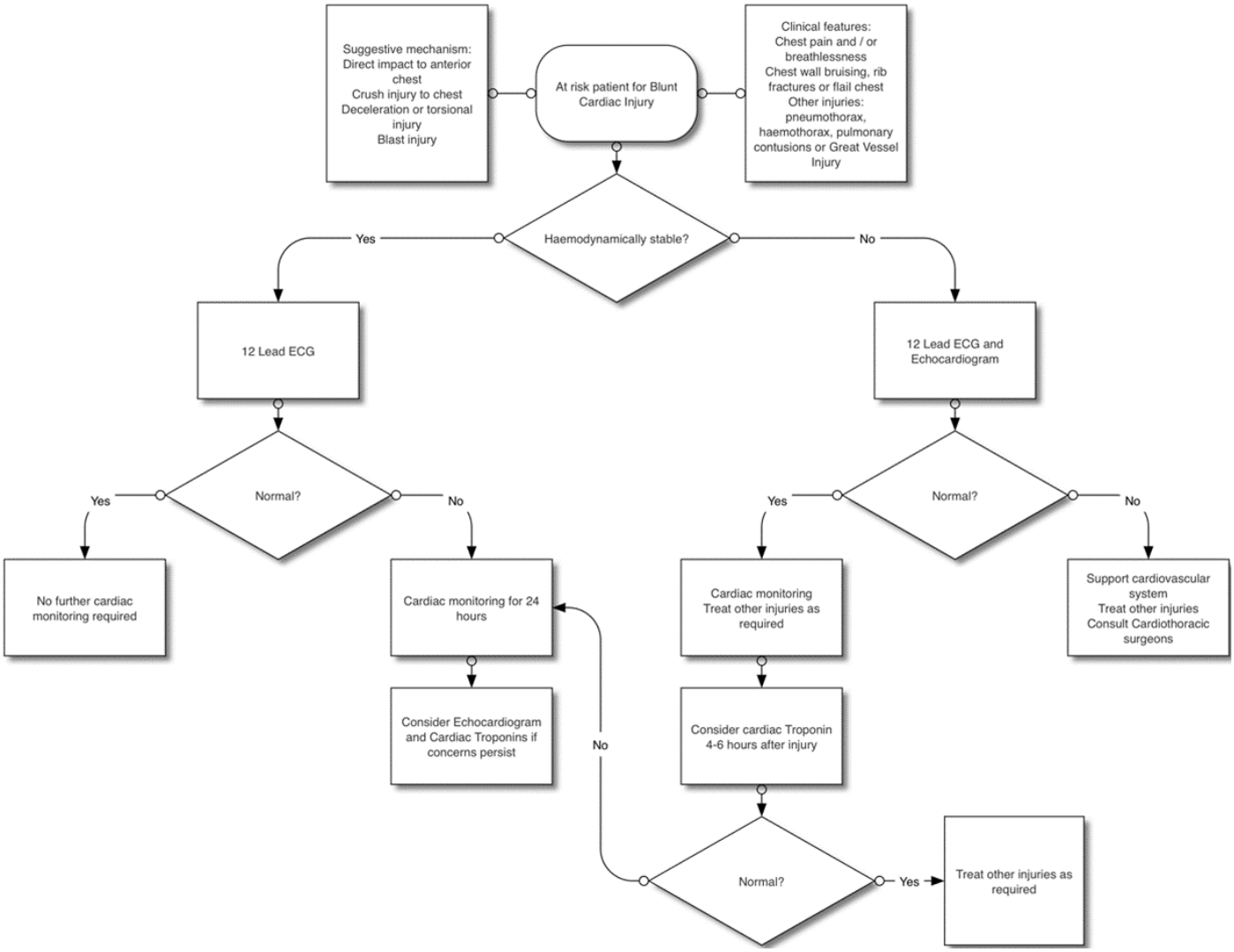


Blunt Chest Trauma

Thoracotomy in Blunt Thoracic Trauma

- The basic tenet is that there is no role for emergency thoracotomy in ED for *blunt* thoracic trauma
- The final decision will always rest with the ED Consultant and Surgical/ Thoracic / Cardiac Consultant if present
- Unstable patients with blunt chest trauma but with vital signs can be considered for thoracotomy but this should aim to be done in theatre
- **You must discuss with your Consultant -** be prepared to move the patient rapidly (see thoracotomy guideline in Circulation).

Blunt Cardiac Injury Algorithm



Paediatric Traumatic Cardiac Arrest

Emergency Thoracotomy Algorithm

Major Trauma Standard Operating Procedure
Paediatric Traumatic Cardiac Arrest (TCA)

Algorithm – see page 60
Thoracotomy guide – see page 62

Background

TCA is a low-frequency, high-acuity event associated with high mortality and morbidity. A significant proportion of cases are managed in trauma units.

- An analysis of TARN data revealed 275 children and young people < 18 years presented to hospital with TCA over 10 years (2006 – 2015). This accounted for 0.6% of paediatric patients included in TARN database and included non-energy transfer mechanisms such as drowning or electrocution, so the true number is lower. The median age was 11 years and the majority occurred from RTC. ISS was 25-34. Survival rate was 5%.
- In paediatric TCA, the focus is on delivering immediate, simultaneous life-saving interventions and treatments of reversible causes, which are prioritised over cardiac compressions and defibrillation.
- The response to TCA is time critical and success depends on a well-established chain of survival, including focused pre-hospital and specialised trauma centre care.
- TCA (hypovolemic shock, obstructive shock, neurogenic shock) is different from cardiac arrest due to medical causes; this is reflected in the treatment algorithm (Fig. 1).
- Use ultrasound to identify the underlying cause of cardiac arrest and target resuscitative interventions.
- Treating reversible causes **simultaneously** takes priority over chest compressions. Chest compression must not delay treatment of reversible causes in TCA.
- Control haemorrhage with external pressure, haemostatic gauze, tourniquets and pelvic binder.
- 'Don't pump an empty heart'.
- Resuscitative thoracotomy (RT) has a role in TCA and traumatic peri-arrest.

NB. Management of non-energy transfer traumatic cardiac arrest e.g. drowning, hanging, electrocution should be guided by standard APLS algorithms.

Management

Pre-Arrival:

1. **Put out a trauma call and activate the MHP** based on credible pre-hospital information (see paediatric code red protocol)

2. **Assemble team to include**

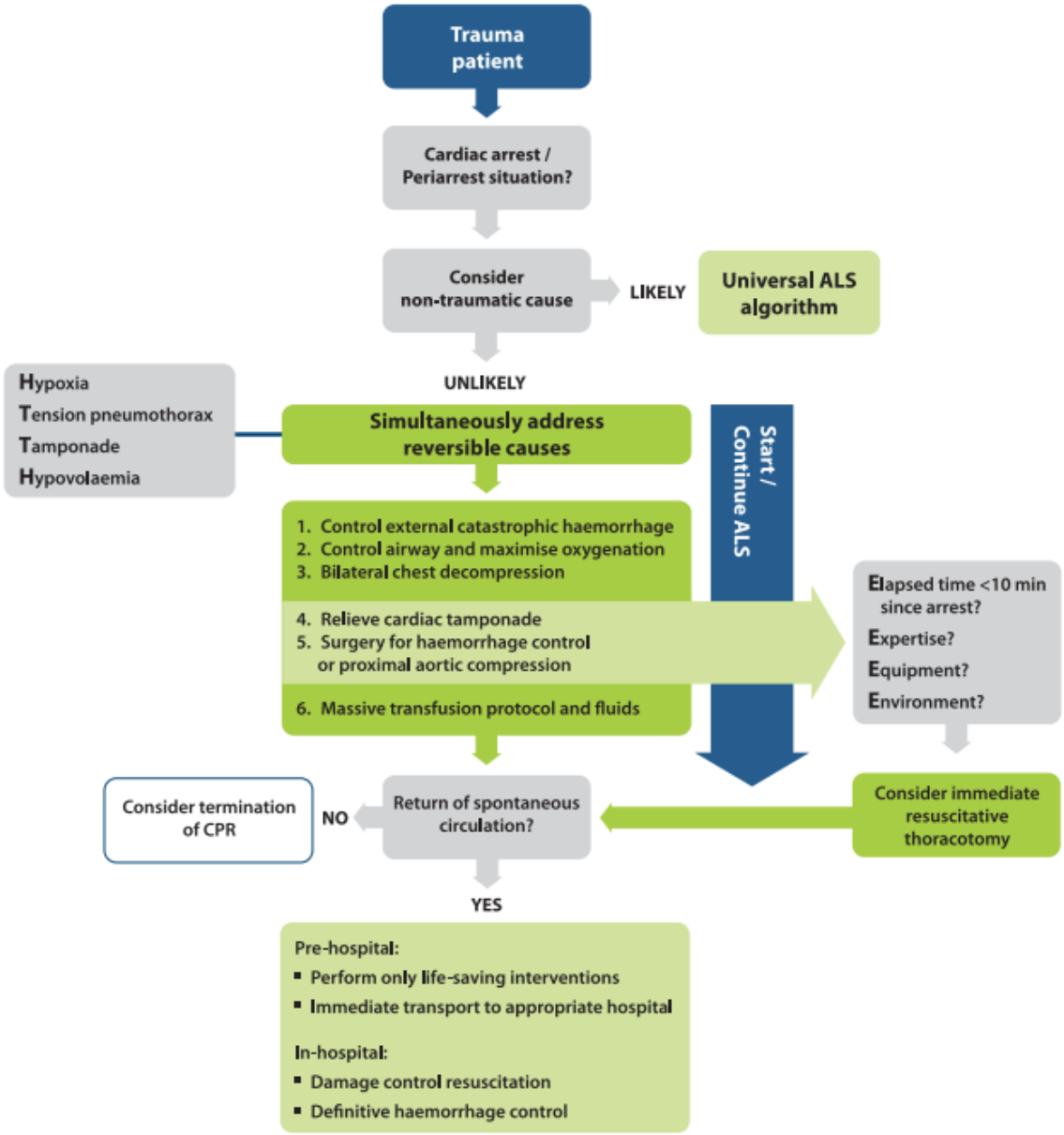
    - Trauma team leader (TTL)
    - Interventions clinician e.g. thoracostomies, thoracotomy
    - Interventions assistant e.g. pelvic binder application
    - Paediatric code red team: communication lead, blood coordinator, and porter
    - Cardiac arrest team members (airway, breathing, circulation)

On arrival to the ED, confirm cardiac arrest

- No signs of life
- No palpable pulses OR
- No cardiac activity on ultrasound scan (do not delay interventions to perform USS)

The bundle of life saving interventions in the algorithm is a guide. Not all interventions will be appropriate all the time e.g. if a reversible cause can be excluded or is considered futile e.g. non-survivable brain injuries..

Emergency Thoracotomy (ETC) Algorithm



Specific Management Points

- Effective oxygenation and ventilation should be given via an ETT or supraglottic device e.g. i-gel or LMA.
- Measurement of ETCO2 is a recommended adjunct to confirm ETT tube placement, and to assess effectiveness of chest compressions (if given). Although paediatric evidence is lacking, ETCO2 may also aid decisions around stopping resuscitation (persistently low ETCO2) or recognition of ROSC (sudden rise in ETCO2). External haemorrhage control will include tourniquets and haemostatic dressings as appropriate e.g. following traumatic amputation.
- Early IV / IO access is crucial. Follow the paediatric code red trauma call (massive haemorrhage) protocol for blood and blood products. This will advise on volumes and types of blood and blood products and will ensure that the transfusion lab have the required products available.
- If blood is not immediately available, use crystalloids until blood arrives.

- Use the Belmont warmer to avoid hypothermia.
- In PEA or in the presence of obvious thoracic trauma, external cardiac compressions may be omitted until all other interventions have been performed.
- There is no evidence to support use of adrenaline in paediatric TCA
- Bilateral finger thoracostomies are favoured over needle decompression for tension pneumothorax. If needle decompression is more familiar to the intervention clinician however, they may elect to do this over thoracostomies in the first instance. Clamshell thoracotomy should be strongly considered in the context of TCA with penetrating trauma if within 10 minutes of witnessed cardiac arrest.
- Evidence for use of thoracotomy in blunt trauma is limited, but should be considered, particularly if all other interventions have failed in the absence of an obvious non-survivable injury.
- The aim is to relieve tamponade, contain pulmonary bleeding and apply aortic compression for control of downstream haemorrhage, and if necessary, to provide internal cardiac massage.

When to stop resuscitation

- The decision to stop resuscitation is challenging and should be made by the most senior clinician (usually the TTL) in consultation with other team members.
- Factors which can influence the decision will include:
- Duration of cardiac arrest: resuscitation attempts beyond 20 minutes are unlikely to be successful in the absence of e.g. hypothermia or toxins
- Lack of response to the suggested interventions
- Persistently low ETCO2 (< 2 kPa): adult studies have shown persistently low ETCO2 levels have been associated with poor outcomes and can be used to assess futility of ongoing resuscitation. In the absence of paediatric evidence, ETCO2 levels can guide decisions but should not be the only driver to stop resuscitation.
- Cardiac standstill on USS: paediatric evidence is lacking and is based on adult studies.

Clam Shell Thoracotomy for Children with Major Trauma in the Emergency Department

Background

Primary aim is to treat cardiac tamponade.

Indications

- Cardiac arrest associated with penetrating thoracic trauma – success only likely if within 10 minutes of witnessed arrest
- May be considered in cardiac arrest associated with blunt trauma if all other interventions have failed and in absence of non-survivable injuries in order to:
  - Relieve cardiac tamponade
  - Occlude aorta to control distal bleeding provide internal massage

Contraindications

- Child with an effective cardiac output

Equipment

Thoracotomy
Scalpel
Forceps
Heavy scissors

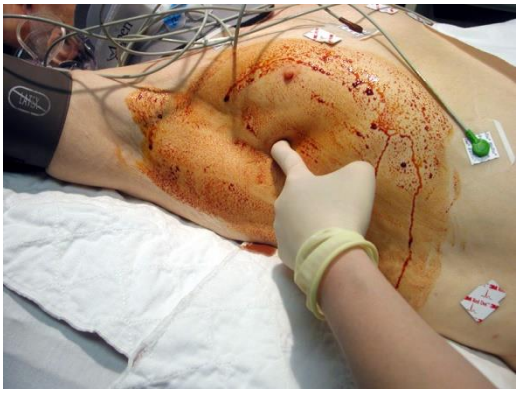
PPE
Gloves
Gown
Eye protection (glasses/goggles/shield)

Haemostasis
Suture on needle – silk or prolene, size 1/0
Foley catheter
Forceps x 4

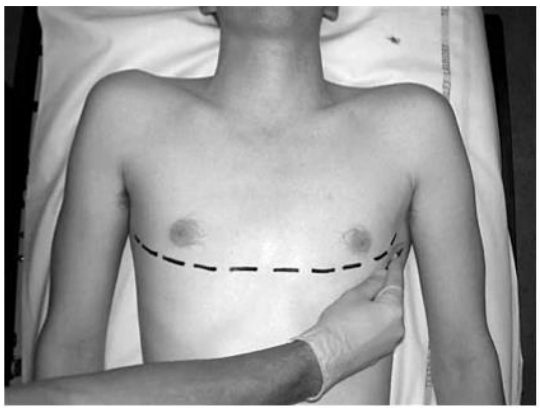
Procedure

1. Procedure must be done in the emergency department as soon as need identified by the TTL. Do not delay taking an arrested child to theatre. Procedure can be carried out by anyone trained to do it.
2. Intubation and ventilation plus other interventions should be done and must not delay thoracotomy.
3. Rapid access of skin preparation if available immediately e.g. 2% chlorhexidine / 70%alcohol preparation, otherwise can forego.
4. Using scalpel and blunt forceps (clip/clamp) make bilateral thoracostomies (through intercostal muscles and parietal pleura) in 5th intercostal space in mid-axillary line.

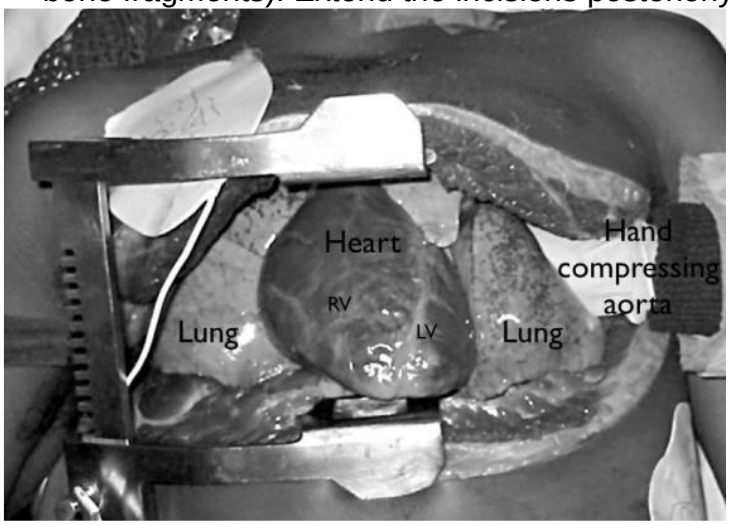
   NOTE – stop at this point if tension pneumothorax is relieved and cardiac output returns.



5. Connect the thoracostomies with a deep skin incision following the 5th intercostal space. Ensure the incision extends posteriorly bilaterally to the posterior axillary line – this allows adequate access when opening the clamshell.

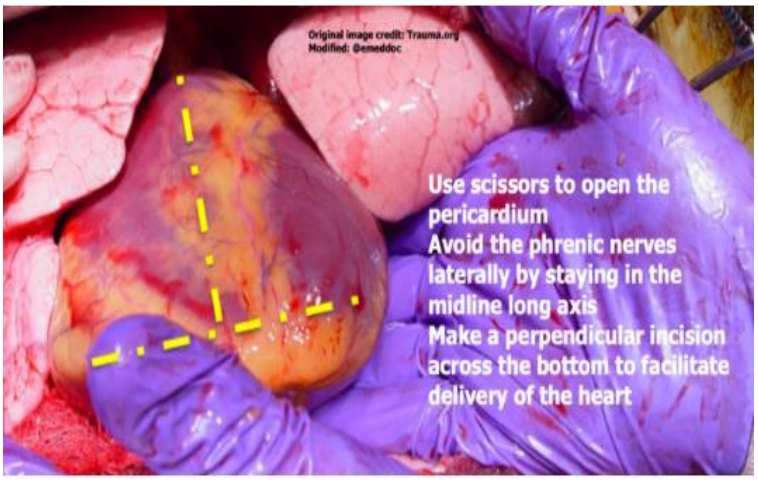


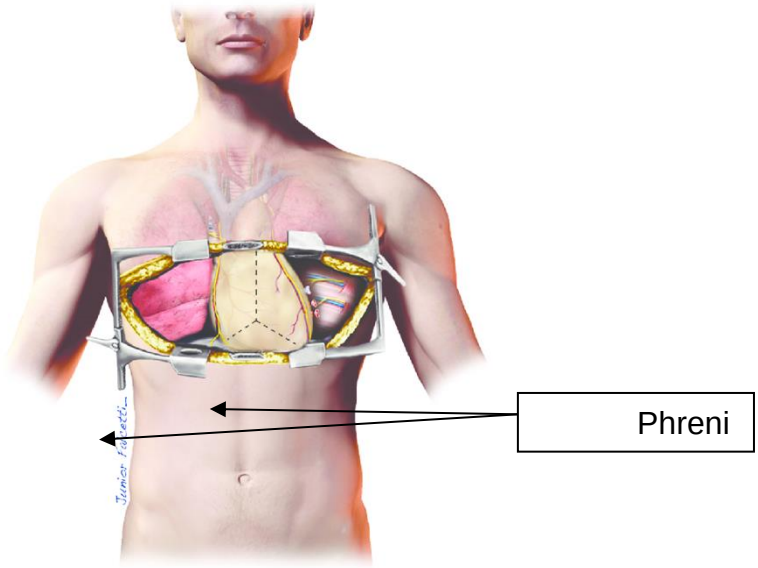
6. Insert two fingers into one side of the thoracostomies to hold the lung out of the way whilst cutting through all layers of the intercostal muscles and pleura towards the sternum using the heavy scissions via the skin incision already made.
7. Do above on the left and right sides to sternum.
8. Cut through sternum using the heavy scissors/gigli saw
9. Open the “clam shell” using one or two gloved assistants (using gauze to prevent injury from bone fragments). Extend the incisions posteriorly if exposure is inadequate.



10. Lift or tent the pericardium with forceps and make a large midline longitudinal incision using scissors.

This approach minimises risk of damage to phrenic nerves – run in the lateral walls of the pericardial sac. **The pericardium may appear normal despite the presence of tamponade. It must ALWAYS be opened.**





11. Take the heart out of the pericardium and evacuate all blood and clot present, then inspect the heart for site of bleeding.

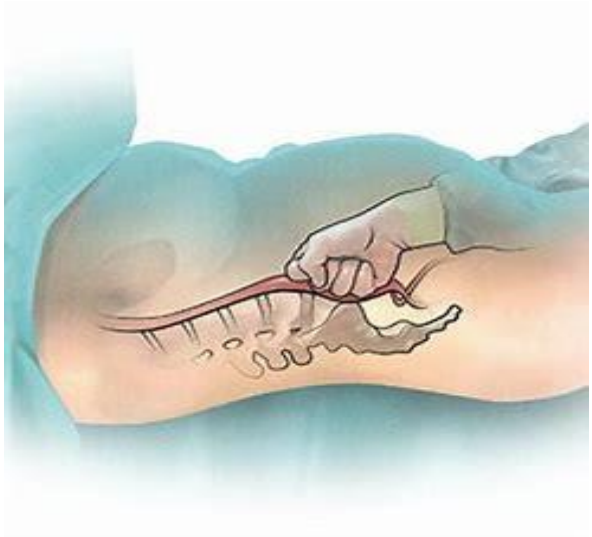
12. Cardiac wounds will need occluding:

- With a finger or piece of gauze if < 1cm If bleeding cannot be controlled with finger the defects will need sutures or staples (rarely foley catheter).
- This is a last resort due to risk of coronary artery occlusion.

Minimise the number of sutures as far as possible. Take 1cm ‘‘bites’’ – do not do this with wounds close to the right AV grove or near the (proximal) coronary arteries.

If evidence of significant blood loss or low cardiac output state after tamponade relieved and myocardium closed, manual occlusion of the aorta should be carried out whilst undertaking

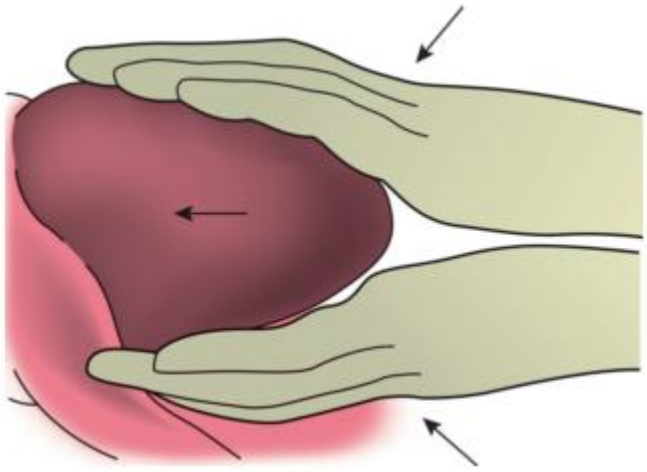
volume expansion. The descending thoracic aorta should occluded / compressed / clamped as low as possible – this can be most easily achieved compressing the aorta with a closed fist against the vertebral bodies.



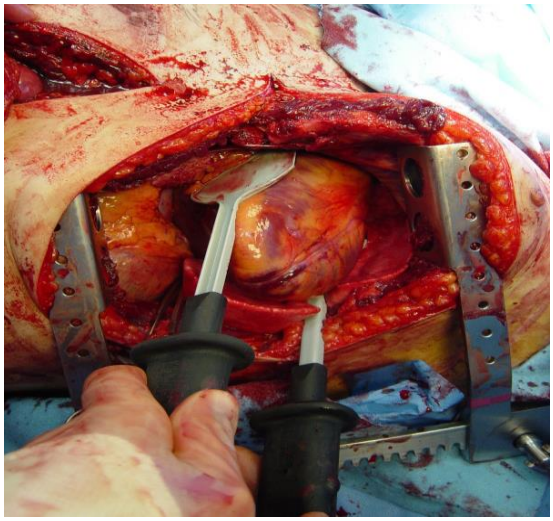
14. If internal cardiac massage is required, one flat hand is applied to the posterior surface of the heart and one on the anterior surface. Blood is ‘‘milked’’ from the apex upwards, aiming for complete ventricular emptying

    Avoid single handed cardiac massage as there is a significant risk of the operator’s thumb perforating the right ventricle.

    Ensure that the heart remains horizontal (in the anatomical intra-pericardial position) during massage – lifting the apex impairs venous filling.



15. If defibrillation is required, use the internal defibrillation paddles and 1J/kg shock.



16. Restoration of circulation may be associated with:

    a. **waking**, and the patient may require **immediate anaesthesia**.

    b. **bleeding**, particularly from the internal mammary and intercostal vessels, and may require **sutures or artery forceps**.

17. Once perfusion has been restored the patient should be moved to theatre immediately for definitive repair.

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1. Vassallo J, Nutbeam T, Rickard AC, et al. Paediatric traumatic cardiac arrest: the development of an algorithm to guide recognition, management and decision to terminate resuscitation. *Emerg Med J* 2018;**35**:669-674

2. Vassallo J, Webster M, Barnard EBG, et al. Epidemiology and aetiology of paediatric traumatic cardiac arrest in England and Wales. *Arch Dis Child* 2019;**104:**437-443

3. Resuscitation Council UK 2015. Traumatic cardiac arrest. Retrieved from https://www.resus.org.uk/resuscitation-guidelines/prehospital-resuscitation/ 21/2/2020

4. Royal College of Emergency Medicine 2019. Traumatic Cardiac Arrest in Adults. Retrieved from https://www.rcem.ac.uk/docs/RCEM%20Guidance/RCEM_Traumatic%20cardiac%20arrest_Sept%202019%20FINAL.pdf 21/2/2020

5. Wessex Children's Major Trauma Guidelines (Trauma Unit version) July 2017. Retrieved from https://www.piernetwork.org/trauma.html 24/02/2020

Analgesia following Chest Trauma/Rib Fractures

There are many options for pain control following chest trauma/rib fractures. Effective pain management is imperative to treatment as it improves pulmonary function and decreases the risk of pulmonary complications such as atelectasis, poor oxygenation, and respiratory compromise. Every child/young person with chest trauma should be assessed for individualised treatment based on age, level of pain, and extent of the injury. Local pain management guidelines should be referred to, to ensure effective pain management is achieved. Non-accidental injury should be considered in infants who present with rib fractures. A consultation to child protective services should be considered in all children with suspected physical abuse

Abdominal Trauma

Blunt Abdominal Trauma

Formal abdominal CT is usually first line investigation in children – discuss with the surgeon and the trauma team radiologist should be able to facilitate.

1. Clinical abdominal assessment **is difficult**. The paediatric surgical SpR /consultant should assist in the clinical assessment:

    - All patients will be assessed and the decision to proceed to laparotomy will be made by the Consultant Paediatric Surgeon.
    - Patients with head/chest injuries and lower limb/pelvis injuries require formal **exclusion** of abdominal injury regardless of absent physical signs as the risk of abdominal injury is significant.

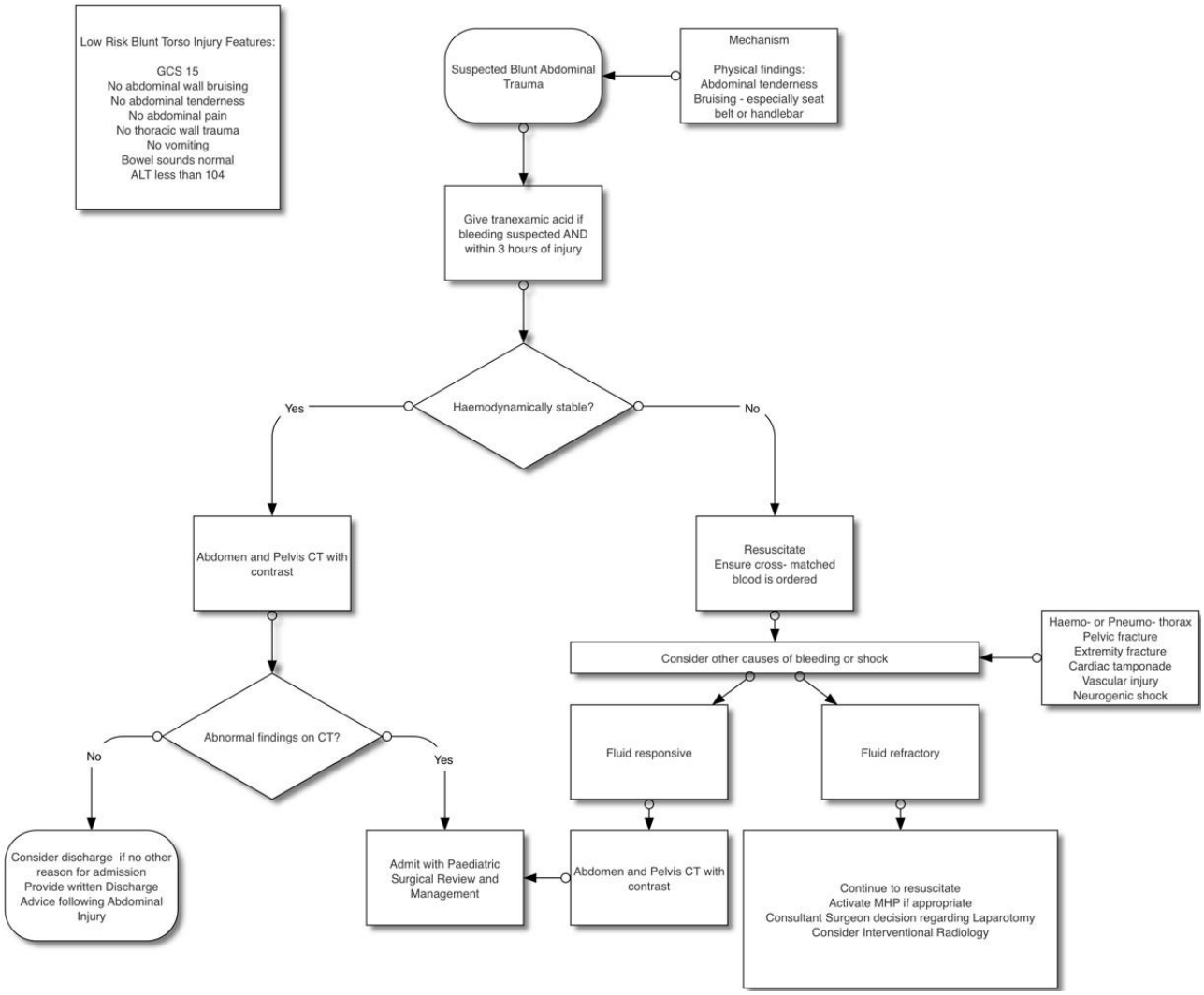
2. CT
    - Solid organ injury on CT in a stable patient may be managed conservatively in a critical care area with continuous observations and review by the Paediatric Surgical Registrar every 6 hours or earlier if requested to attend.
    - Development of peritonitis or cardiovascular instability requires resuscitation, further investigation and, if appropriate, laparotomy.
    - There is a 2-15% incidence of missed hollow viscus injury in patients with solid organ injury – **BEWARE**
    - The lack of free air on an abdominal CT does **NOT** rule out hollow viscus injury

The Paediatric Surgical Consultant should be present for all trauma laparotomies

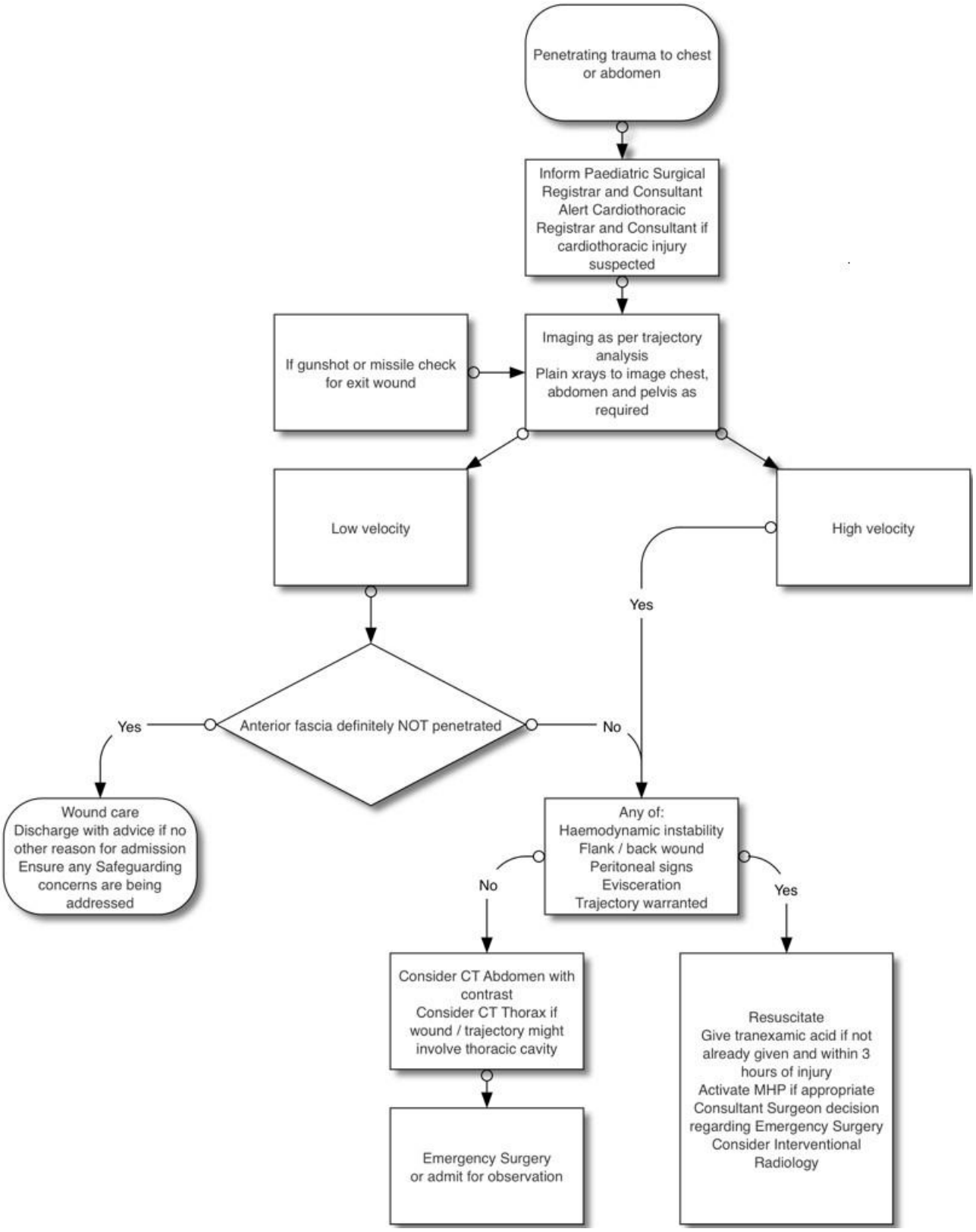
INDICATIONS FOR EMERGENCY LAPAROTOMY (WITH OR WITHOUT CT) (this list is not exhaustive):

1. Unstable patient, despite resuscitation, with abdominal trauma
2. Evidence of hollow viscus injury on imaging
3. Retained weapon
4. Gunshot wound abdomen
5. Evisceration

Blunt Abdominal Trauma Algorithm



Penetrating Abdominal Trauma Algorithm



Pelvic Injury

Emergency Management of Severe Pelvic Fracture

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.
3. Differentiate between pelvic and intra-abdominal bleeding.

The following is the Standard Operating Procedure

1. Low blood pressure and suspected pelvic injury: Apply pelvic binder.
2. Pelvic binder can be applied even if lateral compression injury is suspected.
3. The binder should be placed around the greater trochanters not the iliac crests.
4. Internally rotate both legs and bring both ankles together
5. Before placing the binder examine for:

- open wounds in the perineum, or over the area to be covered by the binder.
- presence of blood at external meatus
- signs of significant soft tissue injury around the pelvis

Examination to be done once by a senior member of the team to reduce the distress to the child.

If binder applied pre-hospital leave it, check position and obtain radiographs.

6. Hypotension: Activate massive transfusion protocol
7. Do NOT examine the pelvis for mechanical stability.
8. Do NOT logroll the patient until the pelvis is cleared or stabilised
9. Obtain an early pelvic radiograph (Appropriate AP view to start with, or immediate CT) to clear the pelvis
10. On the pelvic radiographs, particular attention should be made to the triradiate cartilage if present, as injuries can occur at this level and can be difficult to see.
11. In small children where a pelvic binder may not be available in the correct size, a sheet, towel or large BP cuff can be utilised.
12. Removing pelvic binder: For patients with suspected pelvic fractures and pelvic binders, remove the binder as soon as possible if:
    - There is no pelvic fracture
    - A pelvic fracture is identified radiologically as mechanically stable, or
    - There is no further bleeding or coagulation is normal.
    - Remove all pelvic binders within 24 hours of application

    Before removing the pelvic binder, agree with a pelvic surgeon how a mechanically unstable fracture should be managed.

If the radiograph is normal, the pelvis may still be fractured. An AP compression – open book – injury can be perfectly reduced by the binder so that the plain radiograph is normal.

A check radiograph after loosening of the binder will identify this problem. Only do this if there is haemodynamic stability. Unstable patients with suspected pelvic injuries should have CT pelvis.

If a pelvic fracture is present:

1. You can leave binder in place for up to 24 hours unless patient has severe neurological deficit (e.g. paraplegia).
2. Examine carefully for open wounds, especially in the perineum.
3. If there is an open wound, including vaginal lacerations, antibiotics must be administered. Unless contraindicated use co-amoxiclav, gentamicin and metronidazole.
4. Perform a log roll when the pelvis is stabilised. Even when stabilised with a binder, take extreme care
    a. If unilateral pelvic injury: log-roll to opposite side
    b. If bilateral pelvic injury: avoid log-roll if at all possible, use scoop stretcher.
5. Consider early catheterisation, but beware of urethral injury. Seek early consult from a Consultant Paediatric Urologist in the presence of possible urethral injury

Contrast Urethrogram/Cystogram

Discuss with Radiology Registrar / Consultant

These principles apply for children but always consult Consultant Paediatric Urologist prior to any investigation. It is rare this will be done in PED.

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. Sterile technique must be used and the procedure performed by an experienced surgeon: this is not the time to teach the technique.

- If clear urine drains, that is satisfactory
- If there is any element of blood staining in the fluid draining from the catheter then a contrast study (retrograde cystogram) is mandated.
- Retrograde cystogram: dilute 50mL of intravenous contrast medium with 50mL of sodium chloride 0.9% and administer 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: dilute 50mL of intravenous contrast medium with 50mL of sodium chloride 0.9% in a bladder syringe. Insert size 10 Foley catheter so that balloon is just past the meatus then gently inflate balloon with 5mL sodium chloride 0.9%. Hold in place whilst assistant injects contrast into catheter and take AP pelvis x-ray.

- Urethrogram positive: call Consultant Urologist. Decisions are 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 perform retrograde cystogram

ADDITIONAL DOCUMENTS Gänsslen A, Heidari N & Weinberg AM. Fractures of the pelvis in children: a review of the literature. Eur J Orthop Surg Traumatol. 2013; 23(8):847-61

The North West Children's Major Trauma Network

British Orthopaedic Association | OTS | Association of Surgeons of Great Britain and Ireland | The Association of Coloproctology of Great Britain and Ireland

BRITISH ORTHOPAEDIC ASSOCIATION AUDIT STANDARDS for TRAUMA JAN 2018

The Management of Patients with Pelvic Fractures

Background and justification
Pelvic fractures must be managed within a trauma system with defined referral pathways. They can be associated with significant haemorrhage, urological injury and other injuries. Specialist units, based at Major Trauma Centres, should have the ability to provide multidisciplinary care for these patients as well as specialist orthogeriatric care for those sustaining fragility fractures.

Inclusions:
Patients of all ages with fractures of the pelvic ring.

Exclusions:
Isolated acetabular fractures, isolated low energy pubic rami fractures and pathological fractures.

Standards for Practice

1. When there is a suspected active bleeding from a pelvic fracture, apply a pelvic binder in the correct position. Thisshould be applied pre-hospital.
2. Patients with suspected pelvic fractures with signs of haemodynamic instability should be transported directly to aMajor Trauma Centre in accordance with network guidelines. If received into a trauma unit then resuscitation shouldbe commenced followed by immediate transfer to the Major Trauma Centre for definitive treatment of active bleeding.
3. All patients require IV Tranexamic Acid as soon as possible and ideally within an hour of injury. In the presence ofhaemodynamic instability, patients should be urgently resuscitated using blood products according to MassiveTransfusion Protocols.
4. Patients with suspected pelvic fractures from high-energy trauma should have a CT scan with IV contrast including head,chest, abdomen and pelvis on admission. This should include a head to toe scanogram.
5. All patients with blunt polytrauma undergoing damage control laparotomy should have imaging of the pelvis beforesurgery (X-ray or CT). All patients should have a pelvic binder in-situ during surgery and this should not be removed fora post binder pelvic X-ray until the patient is haemodynamically stable.
6. Active bleeding from the pelvis in patients who do not respond to resuscitation can be managed by surgical packing ofthe pelvis or interventional radiology with selective embolization of active arterial bleeding vessels. Major TraumaCentres must have a clear protocol in place for managing this situation.
7. All polytraumatised patients require a post-binder X-ray after resuscitation, even in the presence of a 'negative' CT scanbecause a well-applied pelvic binder can mask a catastrophic pelvic ring injury.
8. Each trauma network must have a clear protocol for binder removal but, ideally, it should be removed within 24-hoursof injury.
9. External fixation should be considered for temporary mechanical stabilisation when early definitive surgery cannot beperformed.
10. In displaced vertical shear fractures, traction should be considered when early definitive surgery cannot be performed.
11. Potential injury to the bladder or urethra should be suspected, diagnosed and managed according to The Managementof Urological Trauma Associated with Pelvic Fractures BOAST.
12. Open pelvic fractures associated with wounds to the lower abdomen, groin, buttocks, perineum, anus (includingsphincters) and rectum require urgent assessment by a consultant general or colorectal surgeon and wounddebridement as per the Open Fractures BOAST. Clinically and/or radiologically proven or suspected injuries to the anusand/or rectum may initially require construction of a defunctioning stoma. Nursing care of wounds to the perineum orbuttocks may also require a defunctioning stoma, although this is unlikely to be necessary for open pelvic fracturesassociated with wounds to the groin or lower abdomen alone. Please see over for further guidance.
13. Patients who are admitted to Trauma Units and require surgical stabilisation should be referred and safely transferredto a specialist centre within 24 hours.
14. Reconstruction of the pelvic ring should occur within 72 hours of the stabilisation of the patient's physiological state ifassociated injuries allow.
15. Patients who suffer displaced low energy fragility fractures of the pelvic ring, who are unable to mobilise due to pain,should be discussed with the specialist centre for consideration of surgical stabilisation.
16. Specialised units should have written local policies for thromboprophylaxis for patients with pelvic fractures, whichshould be followed and documented in the medical records.
17. Each network should submit appropriate data to the TARN, monitor performance against national standards and audittheir outcomes.
18. Patient follow-up should occur in a specialist pelvic trauma unit or rehabilitation clinic, to ensure full advice is availablefor the pain, physical, psychological, and urological disabilities, which are common adverse outcomes.
19. All patients who may be sexually active should receive written advice on sexual dysfunction in accordance to theguidelines from the British Association of Urological Surgeons.Each hospital should submit data to national databases (NHFD, FLS-DB and TARN) to monitor its performance against national benchmarks and quality standards.

Evidence base:
Professional Consensus. NICE Complex Trauma Guidelines: www.nice.org.uk/guidance/ng37; The Management of Urological Trauma Associated With Pelvic Fractures BOAST

Guidance for stoma formation with open pelvic fractures from the Association of Coloproctology of Great Britain and Ireland and the Association of Surgeons of Great Britain and Ireland:

- Each case should be considered carefully on its merits with regard to both the need for a stoma and optimum timing, as stoma formation is not without morbidity.
- Whenever possible, arrangements should be made to obtain and document informed consent beforehand. Stoma formation is usually not appropriate at initial damage control laparotomy.
- When a defunctioning colostomy is required simply for diversion after distal injury, the stoma may be created laparoscopically, depending upon available surgical expertise.
- A double barrelled, or a loop stoma with the distal end stapled off (to minimise overspill) is acceptable. In either case, the gastrointestinal tract distal to the stoma should be irrigated thoroughly, in order to reduce the risk of contamination resulting from retained stool.
- The position of the stoma should be determined, whenever possible, in conjunction with the orthopaedic surgical team. It should usually be sited in the upper abdomen, to ensure that it is sufficiently remote from the site of potential definitive pelvic surgical fixation.
- Injuries to the colon or rectum associated with open pelvic fractures should be treated, where possible, by resection or repair, defunctioning, irrigation of the distal bowel segment and pelvic drainage.

Retrograde Urethrogram:

- Usually in Resuscitation room.
- X-ray plate under pelvis.
- 20 ml dilute IV contrast medium (10 ml contrast + 10 ml saline).
- Balloon of small Foley catheter into penile meatus and gently inflated.
- Hold catheter in place and inject contrast.
- AP Pelvis x-ray taken. Additional lateral if possible.

Catheter Cystogram:

- Usually in Resuscitation room.
- X-ray plate under pelvis.
- 300ml dilute IV contrast medium (150 ml contrast + 150 ml saline).
- Push catheter in a further 2-3 cm so balloon not blocking bladder neck.
- Inject contrast down catheter with bladder syringe and clamp catheter.
- AP Pelvis x-ray taken. Additional lateral if possible.
- Evacuate contrast and repeat AP Pelvis x-ray.

Limb Injury

Emergency Management of Open Fractures

Aims of treatment:

1. Control haemorrhage.
2. Minimise soft tissue injury.
3. Prevent infection, non-union, deformity and limb length discrepancy
4. Reduce / Treat pain

Treatment Algorithm

1. Initial primary survey assessment
2. Control external haemorrhage
3. Administer analgesia
4. Establish IV access and obtain samples for basic blood tests including group and save.
5. Assess and document Neurovascular status
6. Remove GROSS contamination from wound*
7. Photograph and cover wound
8. Straighten and align limb (if appropriate and indicated)
9. Splint fracture
10. Administer IV antibiotics +/- tetanus prophylaxis*
11. Obtain radiographs
12. Notify:
    - Orthopaedic Registrar
    - Plastics
    - +/- Vascular surgery”

*Please note there is a global shortage of immunoglobulin products and tetanus immunoglobulin should only be used when indicated in accordance with this guidance https://www.gove.uk/government/publications/tetanus-advice-for-health-professionals. Supply may be required from Pharmacy.

Post exposure management for Tetanus Prone Wounds

Immunisation Status	Immediate treatment				Later treatment
	Clean wound[1]	Tetanus Prone		High risk tetanus prone	
Those aged 11 years and over, who have received an adequate priming course of tetanus vaccine[1] with the last dose within 10 years	None required	None required		None required	Further doses as required to complete the recommended schedule (to ensure future immunity)
Children aged 5-10 years who have received priming course and pre-school booster					
Children under 5 years who have received an adequate priming course					
Received adequate priming course of tetanus vaccine[3] but last dose more than 10 years ago	None required	Immediate reinforcing dose of vaccine		Immediate reinforcing dose of vaccine	One dose of human tetanus immunoglobulin[2] in a different site
Children aged 5-10 years who have received an adequate priming course but no preschool booster					
(Includes UK born after 1961 with history of accepting vaccinations)					
Not received adequate priming course of tetanus vaccine[3] (Includes uncertain immunisation status and/or born before 1961)	Immediate reinforcing dose of vaccine	Immediate reinforcing dose of vaccine	One dose of human tetanus immunoglobulin[2] in a different site	Immediate reinforcing dose of vaccine	One dose of human tetanus immunoglobulin[2] in a different site

1 Clean wounds are defined as wounds less than six hours old, non-penetrating with negligible tissue damage.

2 If TIG is not available, HNIG may be used as an alternative.

3 At least three doses of tetanus vaccine at appropriate intervals. This definition of "adequate course" is for the risk assessment of tetanus-prone wounds only. The full UK schedule is five doses of tetanus containing vaccine.

Patients who are severely immunosuppressed may not be adequately protected against tetanus, despite having been fully immunised and additional booster doses or treatment may be required.

1. Control haemorrhage with direct pressure, or as a last resort in torrential haemorrhage apply a tourniquet. If arterial injury is suspected early involvement of a vascular surgeon is essential to avoid irreversible tissue damage. Never try to clamp bleeding vessels blindly in ED.

2. Palpate and mark dorsalis pedis +/- posterior tibial pulses in lower limbs and radial in upper limbs. If difficult to palpate use a handheld Doppler probe. Assessment of compartment syndrome should be part of this evaluation and should be considered in the presence of pain out of proportion to the injury, or on passive movement of the muscles of the associated compartment. Any concerns should warrant immediate involvement of the on call orthopaedic team

3. Use a sterile saline-soaked gauze (**NOT** betadine) and cover with an adhesive dressing (e.g. tegaderm/opsite).

4. **REASSESS AND DOCUMENT NEUROVASCULAR STATUS**

5. Administer IV/IO antibiotics as per local guidelines

Timely plastic surgery involvement is essential in severe soft tissue injury or the presence of peripheral nerve injury. Peripheral nerve injury is suspected when a wound is near a nerve or associated with objective neurological deficit.

The North West Children's
Major Trauma Network

British Orthopaedic Association

BAPRAS
British Association of Plastic Reconstructive and Aesthetic Surgeons

BRITISH ORTHOPAEDIC ASSOCIATION & BRITISH ASSOCIATION OF PLASTIC, RECONSTRUCTIVE & AESTHETIC SURGEONS AUDIT STANDARDS for TRAUMA

DEC 2017

Open Fractures

Background and justification
Open fractures may require timely multidisciplinary management. The consequences of infection, can be great both for the individual patient and the community. Trauma networks and hospitals require the appropriate pathways and infrastructure, to manage these patients, to enable optimum recovery and to minimise the risk of infection.

Inclusions:
All patients with open fractures of long bones, hind foot or midfoot (excluding hand, wrist, forefoot or digit).

Standards for Practice

1. Patients with open fractures of long bones, hind foot or midfoot should be taken directly or transferred to a specialist centre that canprovide Orthoplastic* care. Patients with hand, wrist, forefoot or digit injuries may be managed locally following similar principles.
2. Intravenous prophylactic antibiotics should be administered as soon as possible, ideally within 1 hour of injury.
3. There should be a readily accessible published network guideline for the use of antibiotics in open fractures.
4. The examination of the injured limb should include assessment and documentation of the vascular and neurological status. This shouldbe repeated systematically, particularly after reduction manoeuvres or the application of splints. Management of suspectedcompartment syndrome should follow BOAST guidelines.
5. The limb should be re-aligned and splinted.
6. Patients presenting with arterial injuries in association with their fracture should be treated in accordance with the BOAST for arterial injuries.
7. In patients where an initial "Trauma CT" is indicated there should be protocols to maximise the useful information and minimise delay:
   - The initial sequence should include a head to toes scanogram. This should be used with clinical correlationto direct further specific limb sequences during that initial CT examination.
   - There should be a local policy on the inclusion of angiography in any extremity CT related to open fractures.
8. Prior to formal debridement the wound should be handled only to remove gross contamination and to allow photography, thendressed with a saline-soaked gauze and covered with an occlusive film. 'Mini-washouts' outside the operating theatre environmentare not indicated.
9. All trauma networks must have information governance policies in place that enable staff to take, use and store photographs of openfracture wounds for clinical decision-making 24 hours a day.
10. Photographs of open fracture wounds should be taken when they are first exposed for clinical care, before debridement and at otherkey stages of management. These should be kept in the patient's records.
11. The formation of the management plan for fixation and coverage of open fractures and surgery for initial debridement should be undertaken concurrently by consultants in orthopaedic and plastic surgery (a combined orthoplastic approach).
12. Debridement should be performed using fasciotomy lines for wound extension where possible (see overleaf for recommendedincisions for fasciotomies of the leg)
    - Immediately for highly contaminated wounds (agricultural, aquatic, sewage) or when there is an associatedvascular 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.
13. Once debridement is complete any further procedures carried out at that same sitting should be regarded as clean surgery; i.e. thereshould be fresh instruments and a re-prep and drape of the limb before proceeding.
14. Definitive soft tissue closure or coverage should be achieved within 72 hours of injury if it cannot be performed at the time ofdebridement
15. Definitive internal stabilisation should only be carried out when it can be immediately followed with definitive soft tissue cover.
16. When a decision whether to perform limb salvage or delayed primary amputation is indicated, this should be based on amultidisciplinary assessment involving an orthopaedic surgeon, a plastic surgeon, a rehabilitation specialist, the patient and theirfamily or carers.
17. When indicated, a delayed primary amputation should be performed within 72 hours of injury.
18. Each trauma network should submit appropriate data to the TARN, monitor its performance against national standards and audit its outcomes.
19. All patients should receive information regarding expected functional recovery and rehabilitation, including advice about return to normal activities such as work and driving.

*The BAPRAS/BOA group recommend that for clarity the narrative description of an Orthoplastic Service by NICE is broken into its component parts as follows: a combined service of Orthopaedic and Plastic Surgery Consultants; sufficient combined operating lists with consultants from both specialties to meet the standards for timely management of open fractures; scheduled, combined review clinics for severe open fractures; specialist nursing teams able to care for both fractures and flaps. In addition, an effective orthoplastic service will also: submit data on each patient to the national trauma database (TARN) and hold regular clinical audit meetings with both orthopaedic and plastic surgeons present. Please note: the definition of an Orthoplastic Centre was updated in November 2019.

Evidence base:
NICE Complex fracture guideline https://www.nice.org.uk/guidance/NG37/chapter/recommendations

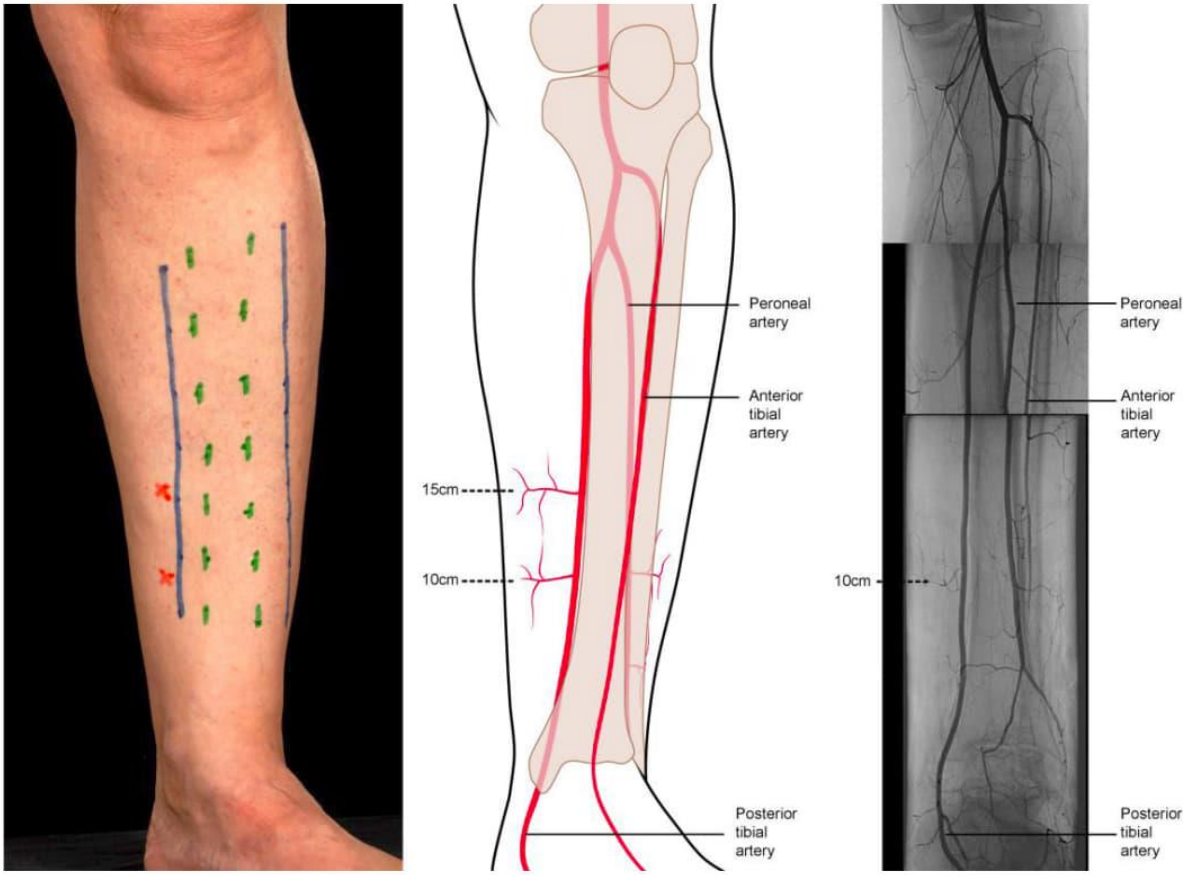


Figure showing recommended incisions for wound debridement and fasciotomies in the leg. The medial incision alone is usually sufficient for debridement and preserves the perforators arising from the posterior tibial vessels, which form the basis of local fasciocutaneous flaps. It also provides access to the posterior tibial artery and venae commitans when required as recipient vessels for free flaps. The lateral incision is used for decompression of the anterior and peroneal compartments in patients with compartment syndrome. (A) Margins of subcutaneous border of the tibia marked in green, access incisions marked in blue and perforators arising from the medial side as red crosses. (B) Line drawing depicting the location of the perforators, with approximate indicative distances from the tip of the medial malleolus. (C) Montage of arteriogram.

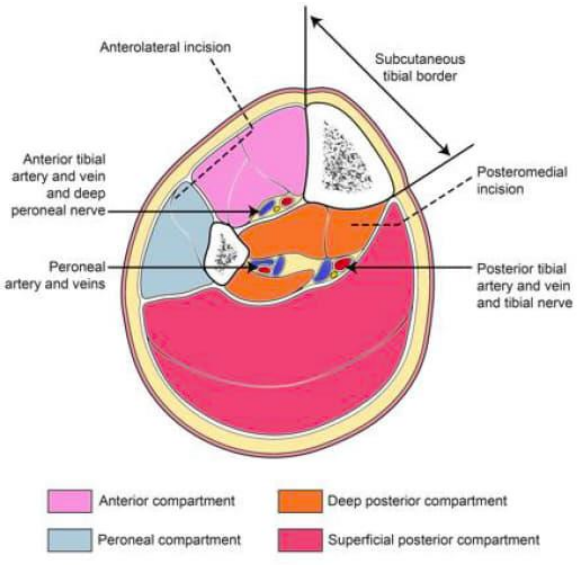


Figure showing cross section through leg showing incisions to decompress all four compartments

The North West Children's Major Trauma Network

British Orthopaedic Association

BAPRAS British Association of Plastic Reconstructive and Aesthetic Surgeons

BSSH The British Society for Surgery of the Hand

OTS

BOA STANDARD

Peripheral Nerve Injury

Dec 2021

Version 2.0

Background and justification

All clinicians undertaking musculoskeletal care may be involved in the management of peripheral nerve injury, either as a complication of surgery or as the result of primary trauma. The consequences of a missed peripheral nerve injury carry considerable impact for the patient. Achieving the best result will require that first the injury is identified and then that the management is directed and delivered by the right clinician at the right time. Establishing pathways which lead to early identification and timely management of injured nerves is key to optimal patient outcome.

Inclusions:

All patients with musculoskeletal trauma and surgery where there is the potential for peripheral nerve injury.

Exclusion:

Birth injuries.

Standards for Practice

Identification of peripheral nerve injury

1. An examination to assess and document all the functions of a peripheral nerve:

    1.1. should be carried out and recorded:
        1.1.1. at the first opportunity after injury
        1.1.2. after any intervention to the limb such as injection, manipulation or application of cast
        1.1.3. pre-operatively, by the operating surgeon prior to any procedure where nerve injury is a recognised risk
        1.1.4. post-operatively, by the operating surgeon following any procedure where nerve injury is a recognised risk
        1.1.5. in accordance with any written management plan

    1.2. the examination should:
        1.2.1. be sufficiently general to elucidate unexpected nerve deficit
        1.2.2. be specific enough to identify deficit likely with the nature of the injury or procedure
        1.2.3. be expanded to greater detail if concern over nerve injury is raised
        1.2.4. be recorded in sufficient detail to allow confident comparison with preceding and subsequent examinations

2. Every unit receiving injured patients should maintain a policy in which training in and assessment of competence in the above examination standards is contained. This should be integrated with the wider regional trauma network referral processes.

Response to identification of peripheral nerve injury

3. There should be a clear and accessible pathway for suspected peripheral nerve injuries including a single point of contact to guide further management.

4. The single point of contact should provide a consistent route into a network approved pathway of management and must be accessible twenty-four hours a day.

5. When a nerve injury is associated with a dislocation, the joint should be reduced immediately. In an unstable fracture, reduction and provisional stabilisation should be carried out as soon as it is safe to do so.

6. Formal advice should be sought:
    6.1. Within twenty-four hours when a laceration or penetrating injury is associated with a neurological deficit.
    6.2. Immediately when a nerve is seen to be damaged during surgery.
    6.3. Prior to surgery when internal fixation of a fracture associated with a nerve injury is to be performed, as part of multidisciplinary care.
    6.4. Within twenty-four hours for any peripheral nerve injury if operative management of the associated fracture is not indicated.
    6.5. Immediately when a new nerve deficit is identified following surgery and appropriate measures such as loosening of bandages, splitting Plaster of Paris splints to the skin and gentle repositioning of the limb have proved ineffective.

7. When a nerve is exposed during fracture surgery, this should be clearly documented in the operation note including a description of the nerve's relationship to any internal fixation device.

8. When a damaged nerve is found at surgery and the single point of contact is unavailable, the operation should be completed and the nature of nerve injury clearly documented. The patient should then be discussed with the single point of contact at the first opportunity.

Audit

9. The local network should collate data on the number and nature of nerve injuries referred to the service. Delayed diagnosis or iatrogenic nerve injury should be the subject of documented local network review. Feedback and case discussion should be used to further build best practice in nerve injury management.

The North West Children's Major Trauma Network

British Orthopaedic Association

BAPRAS British Association of Plastic Reconstructive and Aesthetic Surgeons

VASCULAR SOCIETY The Vascular Society for Great Britain and Ireland

BOA STANDARDS

Dec 2020

Diagnosis & Management of Arterial Injuries Associated With Extremity Fractures and Dislocations

Version 2.1*

Background and justification
Rapid, accurate diagnosis of arterial injuries to the extremities is crucial for optimum outcome with immediate referral to, and joint management with, a surgeon capable of performing vascular repair.

Inclusions
Patients of all ages with vascular injuries to the extremity associated with musculoskeletal trauma.

Standards for Practice

1. All hospitals and networks that are responsible for the management of injured patients must have clear emergency referral and transfer protocols that should include a single point of contact.
2. Centres providing definitive care must have an agreed protocol and pathway standardising the management of these complex injuries.
3. This protocol should include combined review and decision making in person by Consultant surgeons skilled in vascular repair and skeletal trauma on reception of the patient.
4. Haemorrhage should be controlled immediately by direct pressure or tourniquet. Blind clamping should not be undertaken.
5. A pulseless, deformed limb should be re-aligned, splinted and the vascular examination repeated and documented at the time of diagnosis and prior to transfer.
6. Neurological examination must be documented as a timed entry in all patients with extremity trauma; associated nerve injury should be presumed until disproven.
7. Any patient undergoing CT scan following major trauma should have a head to toe scanogram.
8. CT angiography of the extremity should occur immediately following the scanogram, without requirement for patient repositioning.
9. The ischaemic limb should be revascularised within four hours from injury.
10. Where rapid definitive restoration of arterial flow cannot be achieved, arterial shunts should be used to restore flow (eg while skeletal stabilisation is placed).
12. Definitive repair or direct interposition grafts are preferred to bypass grafts.
13. Where cognition allows, patients must be made aware of the possibility of amputation. Any decision to perform early amputation must be made by two consultants and clearly documented.
14. Fasciotomies should always be considered. They should either be performed or the decision not to perform documented with the name of the senior decision maker. There is a low threshold for fasciotomy in these cases.
15. Post-operative care should be delivered in an appropriate area with nursing and medical staff competent in the assessment of the critically injured limb.

Evidence base
Studies with level-1 evidence are lacking. Predominantly retrospective series, with some good prospective studies, meta-analyses, reviews and expert opinion

* On 30th April 2021, the BOAST was updated to remove bullet point 11 that had appeared in the earlier version in error. We have preserved the numbering on all other bullet points for consistency with the previous version

The North West Children's Major Trauma Network

BRITISH ORTHOPAEDIC ASSOCIATION STANDARDS FOR TRAUMA (BOAST) ©

BAPRAS British Association of Plastic Reconstructive and Aesthetic Surgeons

Royal College of Nursing

BOAST 10: DIAGNOSIS AND MANAGEMENT OF COMPARTMENT SYNDROME OF THE LIMBS

Background and Justification Acute compartment syndrome of a limb is due to raised pressure within a closed fascial compartment causing local tissue ischaemia and hypoxia. In clinical practice, it is most often seen after tibial and forearm fractures, high-energy wrist fractures and crush injuries. Other important causes include restrictive dressings or casts, prolonged immobilization and reperfusion of ischaemic limbs. Early diagnosis and treatment is vital to avoid severe disability. Pulses are normally present in compartment syndrome. Absent pulses are usually due to systemic hypotension, arterial occlusion or vascular injury.

Inclusion Patients of all ages.

Standards for practice audit:

1. Assessment for compartment syndrome should be part of the routine evaluation of patients who present with significant limb injuries, after surgery for limb injuries, and after any prolonged surgical procedure which may result in hypoperfusion of a limb.
2. Clear documentation should include: the time and mechanism of injury, time of evaluation, level of pain, level of consciousness, response to analgesia and whether a regional anaesthetic has been given.
3. The key clinical findings are pain out of proportion to the associated injury and pain on passive movement of the muscles of the involved compartments. Limb neurology and perfusion, including capillary refill and distal pulses, should be clearly documented but do not contribute to early diagnosis of the condition.
4. Patients documented to be at risk of compartment syndrome should have routine nursing limb observations for these early signs and these should be recorded. These observations should be performed hourly whilst the patient is deemed still to be at risk. If pain scores are not reducing, then senior clinical review is mandated.
5. In high-risk patients, regional anaesthesia should be avoided as it can mask the symptoms of compartment syndrome. In addition patient-controlled analgesia with intravenous opiates can also mask the symptoms. When evaluating these patients, the rate and dose of opiates and other analgesics must be taken into consideration and recorded in the medical records.
6. Patients with symptoms or clinical signs of compartment syndrome should have all circumferential dressings released to skin and the limb elevated to heart level. Measures should be taken to maintain a normal blood pressure. Patients should be re-evaluated within 30 minutes. If symptoms persist then urgent surgical decompression should be performed. Alternatively, in situations where the clinician is not completely convinced by the clinical signs, compartment pressure measurements should be undertaken. All actions should be recorded in the medical records.
7. Compartment syndrome is a surgical emergency and surgery should occur within an hour of the decision to operate.
8. For patients with diagnostic uncertainty and those with risk factors where clinical assessment is not possible (e.g. patients with reduced level of consciousness), hospitals should have a clear, written management policy.
9. All hospitals treating patients with significant injuries should have the capability to perform intracompartmental pressure monitoring. The pressure sensor should be placed into the compartment(s) suspected of being abnormal or at risk.
10. All patients having compartment pressure measurements should have their diastolic blood pressure recorded; a difference between the diastolic blood pressure and the compartment pressure of less than 30 mmHg suggests an increased risk of compartment syndrome. It is recommended these should either proceed to surgical decompression or continue to be monitored depending on the consultant decision.
11. If the absolute compartment pressure is greater than 40 mmHg, with clinical symptoms, urgent surgical decompression should be considered unless there are other life-threatening conditions that take priority.
12. Surgery should involve immediate open fascial decompression of all involved compartments, taking into account possible reconstructive options. Necrotic muscle should be excised. The compartments decompressed must be documented in the operation record. All patients should undergo re-exploration at approximately 48 hours, or earlier if clinically indicated. Early involvement by a plastic surgeon may be required to achieve appropriate soft tissue coverage.
13. For lower leg fasciotomies it is recommended to perform a two-incision four-compartment decompression (BOAST 4).
14. There is no consensus for the management of foot compartment syndrome.
15. Patients with late presentation or diagnosis (greater than 12 hours) have a high risk of complications with surgery. Decision-making is difficult and should involve two consultants. Non-operative management is an option.

Evidence base Studies with level-1 evidence are lacking. Predominantly retrospective series, with some good prospective studies, meta-analyses and reviews.

Review date: December 2016. For correspondence, contact: policy@BOA.ac.uk

Burn Injury

Management of Burns Patients

Referral to Specialist Burns Service

Northern Burn Care Network - https://www.northern-burncare-network.nhs.uk/

Electrical Injury

Low voltage (less than 1000V) injuries cause skin burns but rarely cause other problems such as dysrhythmia or myocardial injury. They tend to be household accidents in toddlers.

High voltage burns (greater than 1000V) are more common in adolescents indulging in risky behaviour such a playing on railway lines. Significant problems, other than the obvious skin burns, can occur including:

- Asystolic cardiac arrest
- Tetany causing respiratory arrest, or fractures and dislocations
- Tissue necrosis and rhabdomyolosis
- Renal failure secondary to myoglobinuria
- Altered consciousness
- Seizures
- Spinal cord injury

These complications must be managed appropriately. Admission and monitoring is advised following high voltage injury. Internal tissue damage is not accounted for in fluid resuscitation formulae. Requirements usually exceed those calculated by Parkland formula and should be based on urine output.

An asymptomatic child who has sustained a low voltage injury and has a normal ECG is unlikely to deteriorate and may safely be discharged.

Drowning Injury

Drowning

In 2013 there were a total of 381 drownings and water-related deaths from accidents or natural causes in the UK. The 0-19yr olds accounted for 12 percent of deaths (46), of which more than half were teenagers aged 15 to 19. 10 children under 4 yrs drowned (WAter Incident Database – WAID 2013)

Children are more likely to die following drowning than adults.

Important interventions at scene are early institution of CPR, an ABC approach, warming and right lateral decubitus position in the spontaneously breathing victim or rapid sequence induction and intubation in the apnoeic patient.

Emergency Department management should focus on correction of hypoxia, acidosis and hypothermia. Consider early intubation with a cuffed endotracheal tube as vomiting and subsequent aspiration are common.

If the patient is ventilated, deliver PEEP starting at 5 cm H_2O and increasing as necessary to manage pulmonary oedema and avoid hypoxia.

Aggressive fluid resuscitation should correct acidosis. Inotropic support may be required.

If core temperature is below 32^{o}C, use active warming measures. Above 32^{o}C, warm passively.

Rate of warming should be 1^{o}-2^{o} per hour until core temperature is 33-36^{o}C.

If patient is in Ventricular Fibrillation with core temperature below 30^{o}C, only 1 defibrillation should be delivered. If there is no response continue CPR and warming until temperature rises above 30^{o}C before defibrillating again.

Consider other injuries (especially c-spine), intoxication and the possibility of seizure causing drowning.

Please see NWTS regional Guideline for Management of Paediatric Drowning Regional Guidelines A-Z | North West & North Wales Paediatric Transport Service (nwts.nhs.uk)

Trauma in Pregnancy

The priority is to resuscitate the mother. Uterine compression of the inferior vena cava can occur from 20 weeks gestation. If there are signs of shock, it is essential to manually displace the uterus to the left. Spinal precautions should always be maintained.

There is an increased intravascular volume in pregnancy, so a significant amount of blood can be lost before the mother's vital signs appear to have changed below normal.
Depending on the degree of trauma and the age of the patient it may be appropriate to use the maternal early warning score.

Abdominal exam must include examination of the uterus to determine if there is evidence of uterine rupture or placental abruption in particular. The vagina should also be examined to exclude vaginal bleeding.

If the patient is being actively resuscitated the obstetric crash team should be summoned, refer to local standard operational policy. In the case of the patient requiring advanced life support the aim would be to begin to perform a peri-arrest or perimortem caesarean section within four minutes of the arrest with delivery by five minutes refer to local standard operational policy.

Foetal heart sounds can be auscultated using a Doppler in gestations >12weeks but this must be done by someone experienced in its usage as it is not uncommon for a maternal tachycardia to be interpreted as a foetal heartbeat.

Any girl who is greater than 12 weeks gestation and Rhesus negative will need anti-D prescribed if there is any evidence of bleeding/ significant trauma. A Kleihauer should be taken prior to administration and sent to haematology.

If the patient is Rhesus negative, she is likely to require anti-D. This will need to be administered as per the Anti D Immunoglobulin Prophylaxis for Rhesus D Negative Women which can be found on the intranet under maternity policies. In order for the arrangements to be made for the timely administration of anti-D please refer to local standard operational policy.

NHS
Cheshire & Merseyside
Strategic Clinical Networks

NHS
Cheshire & Mersey Operational Delivery Networks
Major Trauma & Adult Critical Care

The North West Children's
Major Trauma Network

The Pregnant Major Trauma Patient – applies to Cheshire & Mersey Major Trauma Network ONLY

Principles:

Obstetric & paediatrics presence in all Trauma Units (TUs) 24/7.
Level 3 critical care in all TUs.
Rapid Response Obstetric & Neonatology in-reach from LWH into Major Trauma Centre Collaborative (MTCC) trauma team available 24/7.
Trauma patients must not go to LWH.
Support for trauma team with training and maintenance of specialist equipment at MTCC from LWH.
Consider best interests of the patient and viability of baby throughout
Explore possibility of additional training e.g. MTCC general surgeons (only) to perform emergency Caesarean Section?
NWAS Pathfinder to include obvious signs of pregnancy

***To call for help from LWH ring**
1. **0151 702 4494** (obstetrics24/7 'hot line') or (if no response)
2. 0151 702 4413 (maternity assessment triage unit).
Clearly state the urgency and who you need to respond to your call.

NWAS patient transfer. If signs of pregnancy are apparent or reported on-scene transfer to Aintree **with pre-alert to Aintree and LWH including request for obstetric & (if gestation known or appears to be ≥23 weeks) neonatal teams from LWH to attend A & E immediately** as part of MTCC trauma team.

a. ED, MTCC If patient arrives via NWAS and pregnancy becomes apparent OR patient self presents at MTCC with known pregnancy or pregnancy becomes apparent then **trauma team call to LWH for obstetrics and neonatology team to attend immediately. 0151 702 4494***

b. ED, TU or MTCC. Patient arrives with **severe major trauma** with known pregnancy or pregnancy becomes apparent during assessment or treatment. **Immediate trauma call to on-site obs & paeds (TU) or obs &, if gestation known or appears to be ≥ 23 weeks, neonates at LWH (MTCC) (if not done at time of pre-alert. If known state gestation period. 0151 702 4494***

c. ED, TU i) If arrival via NWAS with pre-alert for immediate care at TU, **ensure trauma team call includes obstetrics and paediatrics (consultant or registrar),** stabilise patient according to major trauma standards and process.

ii) If patient self presents at TU repeat of i) except that **A & E staff must be empowered to call for obs & paeds as part of that trauma call. 0151 702 4494***

Ensure trauma team call includes obstetrics and neonatology (consultant or registrar) midwife and neonatal nurse, stabilise patient according to major trauma standards and process.

a. ED, MTCC Does patient need on-going definitive care at MTCC?

Yes → Complete definitive care with MDT outreach team input

No → **Is patient stable for transfer?**

Yes → **Is pregnancy viable without need for further in-patient obstetric input?**

Yes → **Transfer to DGH** (with in-patient maternity services)

No → MDT call consider urgent delivery of baby (if not already done) & reassess

No → MDT call consider urgent delivery of baby (if not already done) & reassess

b. ED, TU or MTCC Is pregnancy viable given nature &/or extent of trauma sustained or effects of treatment required? Stabilisation of patient successful?

Yes → **Follow pathway a or c**

No → **Immediate delivery by perimortem caesarean section**

c. ED, TU. Does patient require transfer to MTCC for definitive care?

Yes → **Is patient stable for transfer?**

Yes → **Is pregnancy viable without need for further in-patient obstetric input?**

Yes → **Transfer to MTCC**

No → **Retain at TU, consider need for urgent delivery of baby & reassess**

No → **Retain at TU, consider need for urgent delivery of baby & reassess**

Safeguarding

Introduction

In the assessment of children where there are potential safeguarding concerns, please refer to local policies and guidance.

Indictors of potential safeguarding concerns

1. Injuries in infants, particularly non-mobile infants
2. Implausible or absent explanation, taking in consideration developmental ability of the child
3. Alcohol/Drug fuelled violence or assault
4. Injury because of intoxication or being high/disinhibited
5. Sexually transmitted infection / pregnancy due to unprotected sexual relations
6. Potential criminality including knife crime
7. Disclosure of assault
8. Multiple injuries/ presentations
9. Delay in presentation
10. Concerns around the interactions between carer and child
11. Concerns related to adult/carers behaviour, such as intoxication, domestic

It is the responsibility of the referring doctor to explain the reason for referral to the parents / carers. If a child protection medical assessment is required in addition to referral to another clinical specialty for specific management, (e.g. orthopaedics, burns), it is the responsibility of the referring doctor to make the referral to the Paediatric Registrar/Consultant responsible for Safeguarding concerns for consideration of a child protection assessment (refer to local Standard Operational Policy).

Assessment

The history and context in which children and young people present with injuries should also be considered. **The importance of thorough history taking, being professionally curious and respectfully challenging are key to considering safeguarding risk**

- Could the laceration be related to knife crime / involvement with organised crime groups?
- Could the assault be linked to Honour based violence?
- Could a pregnancy be linked to child sexual exploitation?
- Any injuries noted just be carefully documented with the use of body maps if possible.

Detailed history of the event should include:

- When, where and how it occurred.

- Who was present at the time of injury and who accompanied the child to ED with clear documentation of names.
- The developmental ability of the child.

- Careful documentation of history provided by the carers and the child.

- Record of injuries on body maps where possible.

Actions

a) If any member of staff has safeguarding/child protection concerns about any child or young person attending the ED, the ED senior doctor and nursing shift leader on duty must be informed.

b) If a child or young person is seen in the ED requires a medical paediatric opinion for child protection concerns, it is the responsibility of the referring doctor to explain the reason for referral to the parents / carers.

c) If a child protection medical assessment is required in addition to referral to another clinical specialty for specific management, (e.g. orthopaedics, burns), it is the responsibility of the referring doctor to make the referral to the Paediatric Registrar/Consultant responsible for Safeguarding concerns for consideration of a child protection assessment (refer to local Standard Operational Policy).

d) If a child is transferred to another hospital any safeguarding concerns should be clearly documented and the information given to both the transfer team and the team receiving the patient.

e) Refer to children's Social Care as per local policies

Sudden unexpected death in childhood

There are national and local policies on the actions to take following the death of a child or young person.

Please refer to local policies for guidance in relation to reporting responsibilities and actions.

SAFEGUARDING CONCERNS

Please ensure you have considered the following actions before your referral to Social Care

Concern

- **A professional or someone caring for a child or young person has safeguarding concerns about them**

Discuss

- **The professional or individual staff member discusses concerns with a senior member of the team and the lead consultant for the child or young person**

Check

- **Check with Social Care, GP, HV, SN (in working hours) to see what information is known about the child/young person**
- **Have they been on a CPP,CIN, LAC? Are there any current known risks?**

NB

- **Referrals to Social Care or Police should not be delayed if information about a child/young person is not immediately available.**
- **Please document that this information will need to be documented when available in hours**

Assess

- **Consultant to undertake a full assessment, utilising good practice checklist (see below)**

Decision

- **Following assessment a decision should be made related to agreed referral to Social Care &/or Police based on findings and history available. This would usually be with parental consent**
- **NB It is best practice to share with parents that a referral will be made to CSC, however you do not need this where there is evidence that a child or young person is at risk of potential harm**

Document

- **Ensure documention of concerns, assessment and any pertinent investigations are complete and transferred with the child or young person**

Handover

- **Verbal handover of concerns, assessment and any actions to be handover between the referring and receiving consultant**

GOOD PRACTICE CHECKLIST - SAFEGUARDING	
Have you been able to speak to the child/YP alone? Can you still do this?	
Is the child/YP as immediate/imminent risk of harm? **Physical, Emotional, Neglect, Sexual Harm information should never prevent a timely referral being made when there is identified safeguarding risk or need**	
Are there any other children or vulnerable adults to consider? (siblings, peers, adults with identified learning need or vulnerabilities)	
Is there a parent or carer at risk? Is there an identified safety plan for all family members?	
Is it safe to discuss your concerns with the parents or carers? By doing so, may you place the child/YP at additional risk of harm?	
Is there a reason why the child/YP may resist efforts to safeguard him/her? (Dependency on drug supply, fear of repercussions to self/others, previous experience of services)	
Have you recorded everything that has been said to you by the child/YP?	
Have you recorded everything said to you by parents/carers/professionals and others?	
Have you discussed your concerns with your agency nominated safeguarding lead? You can also discuss with a peer/colleague or Children Social Care	
If consent for a referral has not been provided The Children Act enables professionals to make a referral to Children Social Care when there is evidence and concern that a child or young person is at significant risk of harm. Parental request is NOT a requirement. It is best practice to inform a parent/guardian that a referral will be being made	
Have you complied with all your agencies safeguarding procedures?	
Is there a need to inform the Police because a crime has been committed? This may be via 111, unless it is in an emergency (999)	

Have you considered Early Help (EHAT)/Team Around the Family (TAF) for the child, young person and family? **Has a pre EHAT or TAF assessment been completed?**	

Information from local and national safeguarding practice learning reviews continues to highlight that when faced with complex circumstances of a child or young person's life, professionals find it difficult to keep the focus on the child/young person and the key elements which should contribute to his or her safety. Professionals should regularly consider checking their actions against this checklist as a good practice prompt.

Professionals should also utilise any opportunity to reflect and access safeguarding supervision where the trauma relates to safeguarding or child protection.

Tertiary Survey

Tertiary Survey Following Major Trauma

The tertiary trauma survey is a patient evaluation that identifies and catalogues all injuries after the initial resuscitation and operative intervention. Tertiary surveys must be completed for all major trauma patients admitted to the MTC's 24 hours after admission and is repeated when the patient is awake, responsive, and able to communicate any complaints. The tertiary trauma survey is a comprehensive review of the medical record with emphasis on the mechanism of injury and pertinent co-morbid factors such as age. It includes the repetition of the primary and secondary surveys, a review of all laboratory data, and a review of radiographic studies. Any new physical findings require further studies to rule out missed injuries.

The physical assessment is a complete "head to toe" evaluation with a focus on mechanism of injury. All radiographic imaging and laboratory value trends are then reviewed. If a new injury is suspected then further studies are obtained. A standardised worksheet that becomes part of the patient's hospital record is completed to catalogue all injuries.

Recommended Paediatric Major Trauma Psychology Standards

- Within each paediatric major trauma team therefore should be a designated clinical psychologist who is embedded within the team. It is recommended that there is at least 1 WTE clinical psychologist who provides at least 5-day cover and oversight of all elements of psychological rehabilitation in major trauma.
- Clinical psychologists should be core members of the MTC multidisciplinary team (MDT) and may take a leading role within the MDT.
- The clinical psychologist should offer both inpatient and outpatient services (including assessment, formulation, and intervention), enabling acute and later psychological therapy and input. Psychological interventions should follow appropriate manualised treatment protocols.
- All children and young people who have sustained a head injury should have specific access to neuropsychology for follow up assessment and/or review and intervention of cognitive problems.
- Appropriate screening measures should be utilised for all children and young people, including those with mild traumatic brain injury, to ensure that they are offered appropriate and timely support.
- Follow-up screening measures should be sent to all children and young people who have been involved in a traumatic event after 3 months.
- During inpatient stays consultation and liaison to review (neuro) psychological status and functioning for identified children and young people and their parent/carers/ siblings should occur at least on a weekly basis.
- A pathway must be in place to enable documentation of screening, assessment, triage and onward referral where appropriate.
- Clinical psychology should provide regular teaching and training to trauma MDT staff.
- Clinical psychologists should consider the whole environment in which care is provided and promote psychologically informed environments. This includes offering consultation, case discussion and supervision to staff around the psychological wellbeing of patients.
- Clinical psychologists should support rehabilitation and discharge/onward care planning (including referral to liaison psychiatry for patients who have self-harmed/attempted suicide and working with systems such as schools and social care.
- Clinical psychologists should be available to provide support and critical incident debriefs to all members of staff in the MTC.
- Clinical psychologists should engage in psychological research, audit and service evaluation relevant to the trauma service.

Rehabilitation and Communication

BRITISH ORTHOPAEDIC ASSOCIATION
AUDIT STANDARD for TRAUMA (BOAST)
August 2016

BOAST 13: REHABILITATION AND COMMUNICATION WITH TRAUMA PATIENTS

Background and Justification:

Rehabilitation is the process of restoration of a patient to their pre-injury state. A rehabilitation Prescription starts by identifying the components of the injury and the interventions required. These interventions may include acute management, surgery and therapies. Trauma can be a sudden and life changing event that may have a devastating effect on patients, their families and friends. Since the advent of trauma networks, the most appropriate care may require transfer and treatment away from the nearest hospital. It is recognised that recovery from injury requires multidisciplinary coordinated care including good communication and rehabilitation from the time of injury.

Included Patients: All patients admitted to hospital after trauma.

Standards for practice audit:

1. A rehabilitation prescription should be initiatied within 24 hours of admission and would be anticipated to evolve.
2. A rehabilitation prescription should be standardised to include information such as diagnosis, treatment, management plan, transfer/discharge plan, medication, thromboprophlyaxis, expected goals, therapy requirements, out-patient visits, wound care and referral for further care (including psychological support).
3. The rehabilitation prescription should accompany the patient on transfer or discharge. In addition when inter-hospital transfer occurs, there must be documented liaison between trauma coordinators and treating specialty teams.
4. The patient's management plan, and any changes to this, should be communicated to the patient and relatives/carers in a timely fashion.
5. Each unit should have a designated coordinator, who is responsible for communication and liaison. This person should be identified to the patient and or relatives/carers, within 12 hours of admission.
6. Within 24 hours of admission there should be a written summary which gives the diagnosis, management plan and expected outcome, aimed at the GP but written in plain English, understandable by patients and carers, and available in the patients records.
7. Issues with regard to safeguarding, comorbidities, falls risk and future bone health should be addressed.
8. After major trauma, all patients and carers should have at least one face-to-face meeting with the Major Trauma Coordinator.
9. Written information should be provided about ward and hospital services, including visiting hours, parking, where to eat, rest areas, in-house and local hotel services and religious support. If requested, additional information on travel expenses from social services must be available.
10. Patients should be given advice on when they would be expecting to return to previous function, including employment, driving and recreational activities.
11. There should be a contact number made available if there are further queries.
12. All healthcare practitioners must have access to all records to ensure consistent information is provided, respecting patient confidentiality at all times.
13. A system should be in place to identify and contact patients with complex needs, within 14 days of discharge, to discuss their progress and on-going physical, psychological and social needs. Issues identified must be communicated with their general practitioner.

Evidence base:

Consensus statement based upon the views of patients, families and carers plus professional guidelines for doctors and nurses.

www.nice.org.uk/guidance/ng40

Death of a Child in the Emergency Department

When a child dies unexpectedly from traumatic injuries, the local SUDiC policy should be followed.

In the unfortunate case of an unexpected death of a child each emergency department must have their own local standard operating procedures which should include:

- A standard operating procedure for supporting parents who witness resuscitation with an experienced member of staff.
- A local checklist based on national recommendations
- The consultant paediatrician on call is advised as soon as possible about an unexpected child death
- There is co-operation with Joint Agency Response (JAR) Team and Child Death Overview panels
- A clearly delineated process on how they manage cases of Sudden Unexpected Death in Childhood (SUDC) – this should involve liaison between a specialist team and/or the acute medical team and the Police and Children's Social Care (this makes up the JAR Team). This guidance should relate closely to minimum statutory obligations and the recommendations laid out in Working Together to Safeguard Children (2018).
- The family should be allocated a 'key worker' to support them and help guide them through the processes after their child has died. The key worker should be identified at the JAR meeting
- Every hospital trust should have access to some form of bereavement support for family's and a process by which parents can meet with a relevant Paediatric Consultant to discuss any aspects of their child's care or death, if they wish to do so.

It is important to recognise the importance of supporting staff in managing the death of a child and supporting bereaved parents. All staff involved should be given the opportunities for:

- Debrief,
- Personal reflection
- Supervision (individual or group supervision)

(Intercollegiate Committee for Standards for Children and Young People in Emergency Care Settings, 2012)

Please inform the North West Children's Major Trauma Network Manager of all trauma related child deaths within your department.

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WAter Incident Database – WAID (2021) https://www.nationalwatersafety.org.uk/

Appendices

Appendix I – Acorn (After Concussion, Return to Normality) Leaflet

ACORN-Blank-Template.pdf (childbraininjurytrust.org.uk)

Appendix 2- Form 1: Record of the equality impact assessment screening decision

Form completed by:	Name:	Helen Blakesley	
	Job Title:	Network Manager - North West Children's Major Trauma Operational Delivery Network	
	Hospital Site/MCs or Division or Directorate or Function:	RMCH Management Strategy and Networks	
	Decision making group(s) or committee(s)	North West Children's Major Trauma Operational Delivery Network	
Equality impact assessment of	North West Children's Major Trauma Operational Delivery Network (ODN) Clinical Guidelines		
	Yes - New Policy ☐	No - A Reviewed Policy ☒	
Purpose	This document has been developed to provide guidance on the safe clinical management of children who sustain major trauma injuries or those who are triaged onto the major trauma pathway throughout the North West Children's Major Trauma Network.		
Was the decision reached to proceed to full equality impact assessment?			
Yes	Tick here and complete Forms 1, 2 and 3. ☐		
No Write in existing equality impact assessment registration number ion this box if there is one.	☒ This document has been developed to provide guidance on the safe clinical management of children who sustain major trauma injuries or those who are triaged onto the major trauma pathway throughout the North West Children's Major Trauma Network. It aims to ensure equity of access to Major Trauma services across the NW region.		
Do you have a deadline by which you need a response to this equality impact assessment?	ASAP		

Appendix 3 – Contributors

The following people attended the guidelines away day in March 2022 and contributed to the development of the updated guidelines:

Adel Fattah, Amy Bulmer, Amy Humphreys, Anju Bendon, Bimal Mehta, Caren Landes, Caroline Rushmer, Catherine Creed, Chris Parks, Christopher Prior, Clare O'Leary, Colin Whiley, Daena Daly, Dave McWilliam, David Wilson, Faye Stanley, Fiona Murphy, Fraser Horwood, Gemma Foat-Smith, Hannah Coles, Helen Blakesley, Joanne Richardson, Jodie Wilkinson, Joseph Hobson, Julie Grice, Kirsten Kind, Kirsty Jackson, Lorcan Duane, Martin Rolls, Matthew Wray, Michelle Ireland, Mike Wafer, Naomi Davis, Nicholas Sutcliffe, Paul Farrelly, Rachel Jenner, Ralph MacKinnon, Rebecca Anelli, Sarah Kisseh, Sarah Stibbards, Shirley Mulvaney, Simon McDonald, Steve Bell, Stewart Rust, Suzy Emsden,Tim Smith.