

## DOCUMENT CONTROL PAGE

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## 1. Introduction

The North West Children's Major Trauma Network (NWCTN) 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) and 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.

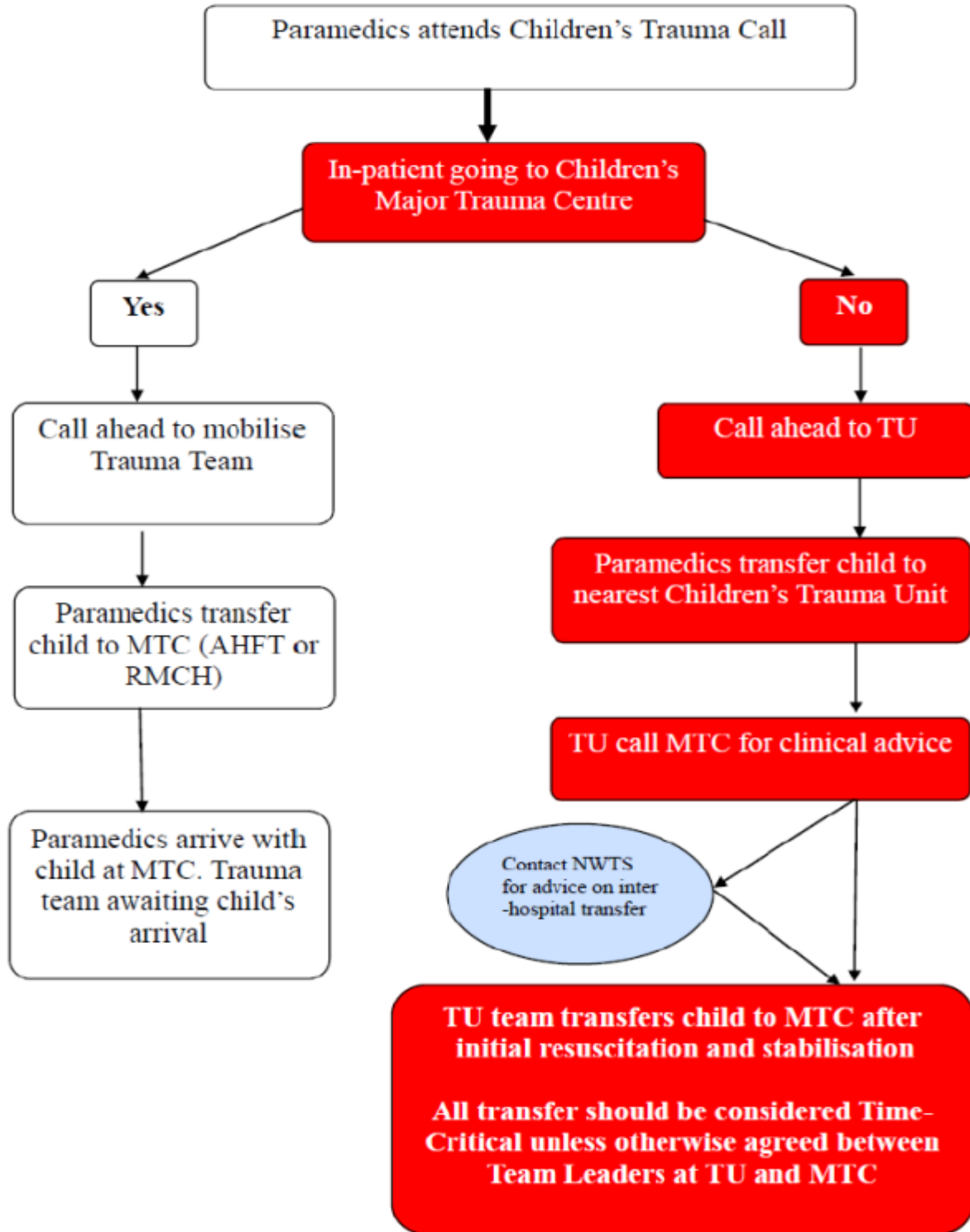
## 2. North West Children's Major Trauma Pathway

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
Preston Hospital (Adult MTC & TU)	Arrowe Park Hospital (TU)
Blackburn Hospital (TU)	Ormskirk Hospital
Wigan, Wrightington and Leigh (TU)	Blackpool Hospital (TU)
Royal Oldham (TU),	Countess of Chester Hospital (TU)
Salford Royal (TU)	Furness Hospital (TU)
Stepping Hill (TU)	Westmoreland (TU)
Chorley South Ribble (TU)	Lancaster Hospital (TU)
North Manchester	Leighton (TU)
Fairfield General Hospital	Warrington Hospital (TU)
Rochdale Infirmary	Whiston Hospital (TU)
South Manchester (TU)	Southport and Ormskirk Hospitals (TU)
Macclesfield District General	Walton Centre
Bolton	Aintree Hospital (Adult MTC)
Royal Albert and Edward Hospital (TU)	Royal Liverpool Hospital (Adult MTC)
Burnley General Hospital	Noble's Hospital, Isle of Man
Tameside Hospital	Halton General
	Ysbyty Gwnedd
	Wrexham Maelor Hospital
	Ysbyty Glan Clwyd

**Paediatric Trauma Pathway**



**North West Ambulance Service NHS Trust**  
Paramedic Pathfinder - Major Trauma in Children V 2.0 1 September 2015

This process applies to children who may have suffered major trauma

Complete Primary Survey  
ABCD

Unmanageable airway  
Unmanageable breathing  
Unmanageable catastrophic haemorrhage

Yes  
Activate Major Trauma Alert  
Immediate transport to nearest Trauma Unit or Trauma Centre

No

Respiratory rate abnormal for age  
Pulse abnormal for age or CRT > 3 sec  
GCS 12 or less

Yes

Activate Major Trauma Alert  
Prompt transport to nearest Trauma Centre if under 60 min drive otherwise proceed to nearest Trauma Unit

No

Flail chest  
Penetrating trauma to the head, neck, trunk or limbs proximal to elbow / knee  
Fractures to two or more long bones (humerus/femur)  
Amputation proximal to wrist/ankle  
Ischaemic limbs  
Suspected spinal injury with new onset motor deficit

Yes



Travel time increased from 45 to 60 minutes

No

Inappropriate behaviour post injury (too quiet or inconsolable)  
Dangerous or significant mechanism  
Death in the same passenger compartment  
Entrapment  
Complete or partial ejection from a motor vehicle  
Significant co-morbidities  
Pregnancy of 20 weeks or more  
Other clinician concern

Yes

Contact Trauma Cell for senior clinical advice  
Proceed as advised

No

Not high major trauma risk  
Apply Paramedic Pathfinder for Trauma

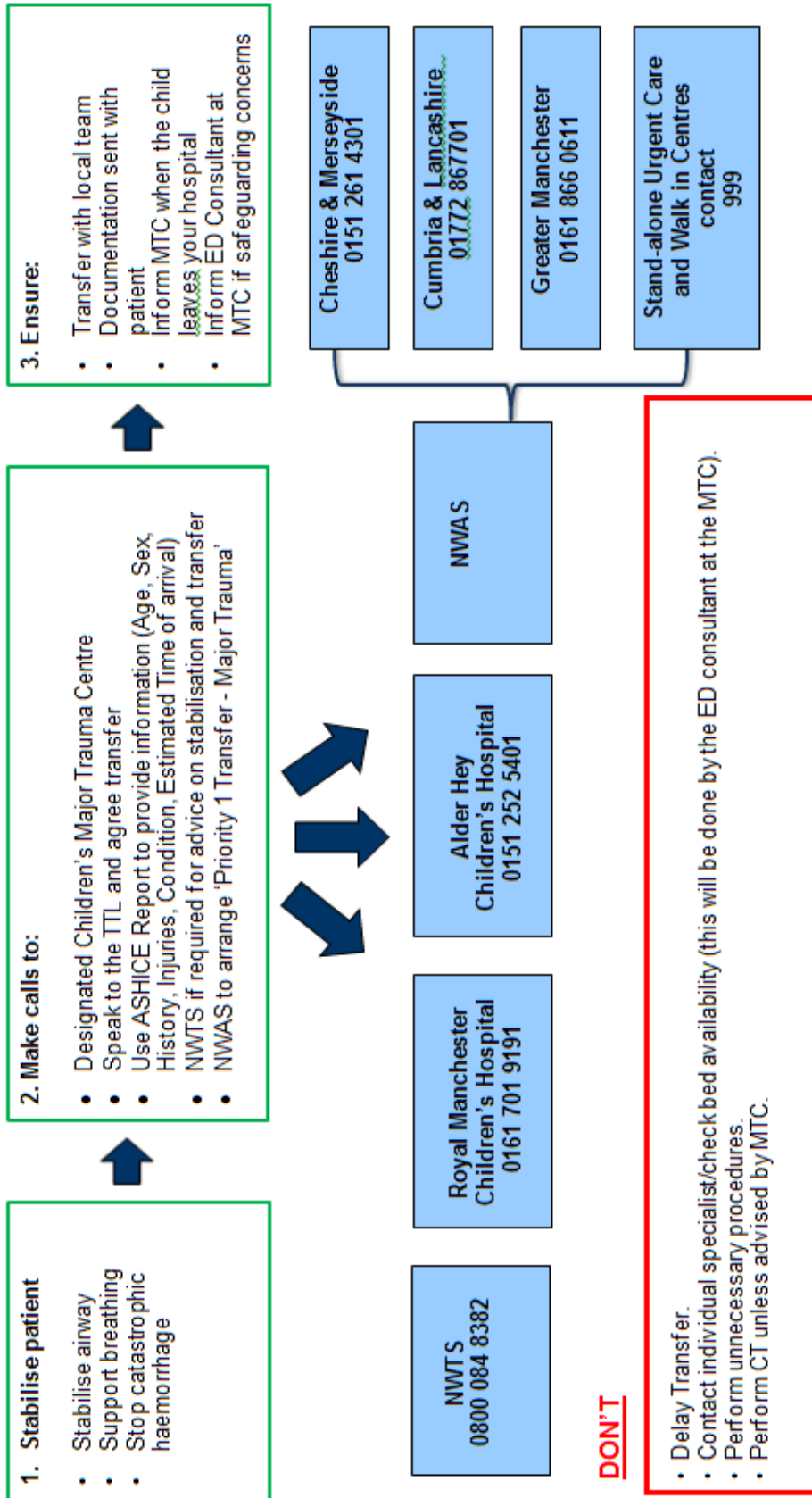
AGE	RR	PULSE
< 2 y	30 - 40	110 - 160
2 - 5 y	25 - 30	95 - 140
5 - 11 y	20 - 25	80 - 120
> 12 y	15 - 20	60 - 100

SEE NWAS PAEDIATRIC TAPE

Request senior clinical support (AP, Consultant Paramedic) early.  
However, do not delay transport.

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

DO



# PAEDIATRIC MAJOR TRAUMA OR TIME-CRITICAL TRANSFER GUIDELINES

## WHO DOES THIS APPLY TO?

All children under 16 years with one of:

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

## MAIN POINTS

<p><b>4 Do's.....</b>                  Stabilise the patient                  Stop major haemorrhage                  Organise transfer                  Documentation</p>	<p><b>4 Calls</b>                  Children's Major Trauma Centre                  (AHCH or RMCH)                  NWTS                  NWS                  Safeguarding Team</p>	<p><b>4 Don't's.....</b>                  Delay                  Undertake CT unless advised                  Forget C-spine immobilisation                  Do unnecessary procedures</p>
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- **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 NWS via 999 and ask for "Trauma Blue" 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 228 1235	<p><b>NWTS will....</b></p> 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 9115
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**For drug calculations use [www.crashcall.net](http://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](http://www.crashcall.net)

<p><b>Equipment required - everything must be securely fixed onto trolley (check battery life)</b>                  Use Critical care transfer trolley if available                  Appropriate portable ventilator (Babypac under 10kg, Ventipac &gt;10kg, Breas LTV or Oxylog 3000+ for &gt;5kg)                  Ensure enough oxygen for transfer                  Portable monitor (ECG, sats, ETCO<sub>2</sub> (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</p>
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A/B	Need for intubation: GCS < 8/15 or fluctuating LOC
	Aim Saturations > 98%
	Monitor and maintain end-tidal CO <sub>2</sub> 34-37 mmHg or 4.5-5 kPa
	ETT secured: <b>ORAL</b> , 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 2 <sup>nd</sup> 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
	<b>Major bleeding? Trigger local major haemorrhage guidelines (children) including Tranexamic acid</b>

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<sub>2</sub> 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](http://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



Stand-by / Pre-alert Record Sheet	
<b>Stand-by calls:</b> Ensure emergency vehicles are given priority access to the Emergency Department	
Date:        /        /	Time:        :        am / pm
Person taking call / completing form:	
Call from:	
Person	
Place:	Call back number:
<b>NWAS Pre-alert Category:</b> <b>Red</b> <b>Amber</b>	
<b>Pre-alert information (ASHICE format)</b>	
Age:	Sex:            Male            Female
History:	
Injuries / Illness:	
Condition (including interventions):	
Estimated Time of Arrival:	
<b>Additional information (if available / given)</b>	
Airway and Breathing	
Circulation (eg. BP/HR)	
Disability (eg. GCS)	
Exposure	
Family / Other	
Senior Doctor / TTL Informed:	
Time:	

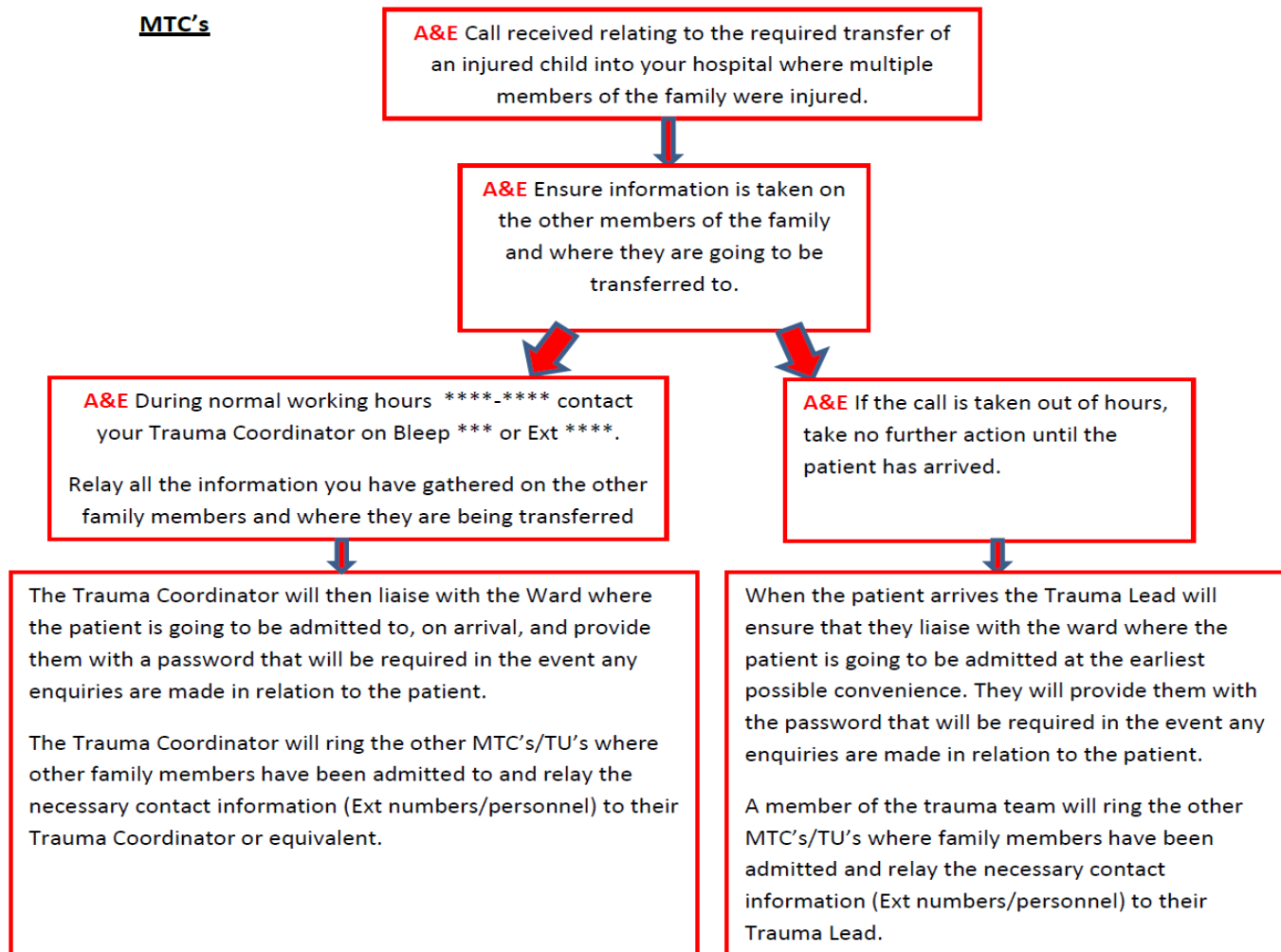
Checklist for Trauma Transfers into Children's MTC To Be Completed by Trauma Team Leader / Senior Doctor		
Action	Notes	Initial and Time
<b>Advised to contact NWTS if not already done</b>	<i>It is recommended that TUs contact NWTS prior to each transfer. NWTS will not undertake time-critical transfers but will advise on management of transfer.</i>	
<b>Airway safe and secure</b> <i>Intubate if GCS &lt; 9 or fluctuating /deteriorating or risk of progressive airway compromise (inhalational injury, facial or neck injury)</i>		
<b>Spinal immobilisation</b>		
<b>External haemorrhage controlled</b>		
<b>IV access</b>		
<b>Adequate blood pressure</b>		
<b>Tranexamic acid given</b>		
<b>Chest drain required</b>	<b>Yes / No</b>	
<b>Splints</b>	<b>Pelvic / Limb</b>	
<b>Open fractures covered</b>	<b>IV Antibiotic given if any delay in transfer</b>	
<b>Images transferred</b>	<b>PACS / IEP / Unencrypted CD</b>	
<b>Documentation</b>		
<b>PICU informed</b>	<b>Yes / Not for PICU</b>	
<b>Theatres informed</b>	<b>Yes / Not for Emergency Theatre</b>	
<b>Speciality team informed</b> (Speciality Team Consultant should be informed of all transfers in by Speciality Team Middle Grade)	<b>Neurosurgery / General Surgery / Orthopaedics / Other</b>  Name: Grade:	
<b>CT Radiographer called in</b>	<b>Yes / Not required</b>	
<i>Call CT Radiographer to be present by Expected Time of Arrival if CT imaging required or possibly required based on pre-alert information</i>		

## Sharing of Information in the Event of Family Separation

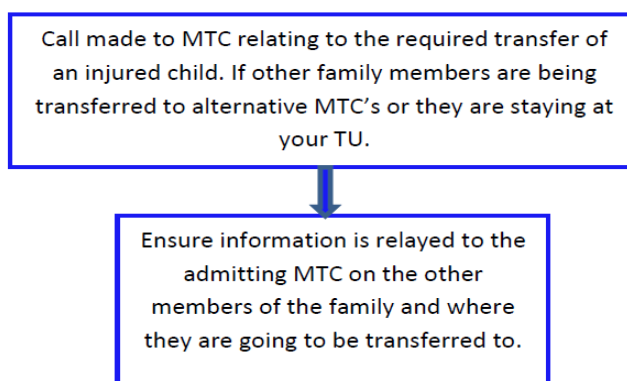
### Protocol for the sharing of information where families are split between MTC's/TU's.

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



#### TU's



**Trauma Team**

**Trauma Team Activation Criteria:**

- 1) On receipt of Major Trauma pre-alert from NWS or Trauma Unit
- 2) 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
	<i>Tachycardia</i>	<i>Bradycardia</i>		
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**

**Major Trauma Team Activation**

If a 'Paediatric Major Trauma Team' activation is required, switchboard will be contacted on **2222** with the phrase: **“Activate paediatric major trauma team, paediatric emergency department resus”**

Switchboard will then alert the members of the team through activating baton bleeps and Vodaphone pagers. The standard message will be the same for all activations:

**“Activate major trauma for paediatrics – immediately attend the paediatric emergency department”**

**PAEDIATRIC: IMMEDIATE RESPONSE**

Paediatric Emergency Department Consultant –  
 Trauma Team Leader

**Via Switchboard**

Paediatric General Surgical Registrar  
 Paediatric Anaesthetic Registrar  
 Paediatric ODP  
 Paediatric Radiographer  
 Radiology Registrar  
 Clinical Co-ordinator (RMCH)

**Baton Bleep 1454**  
**Baton Bleep 1538**  
**Baton Bleep 1715**  
**Baton Bleep 1300**  
**Baton Bleep 3377**  
**Baton Bleep 1545**

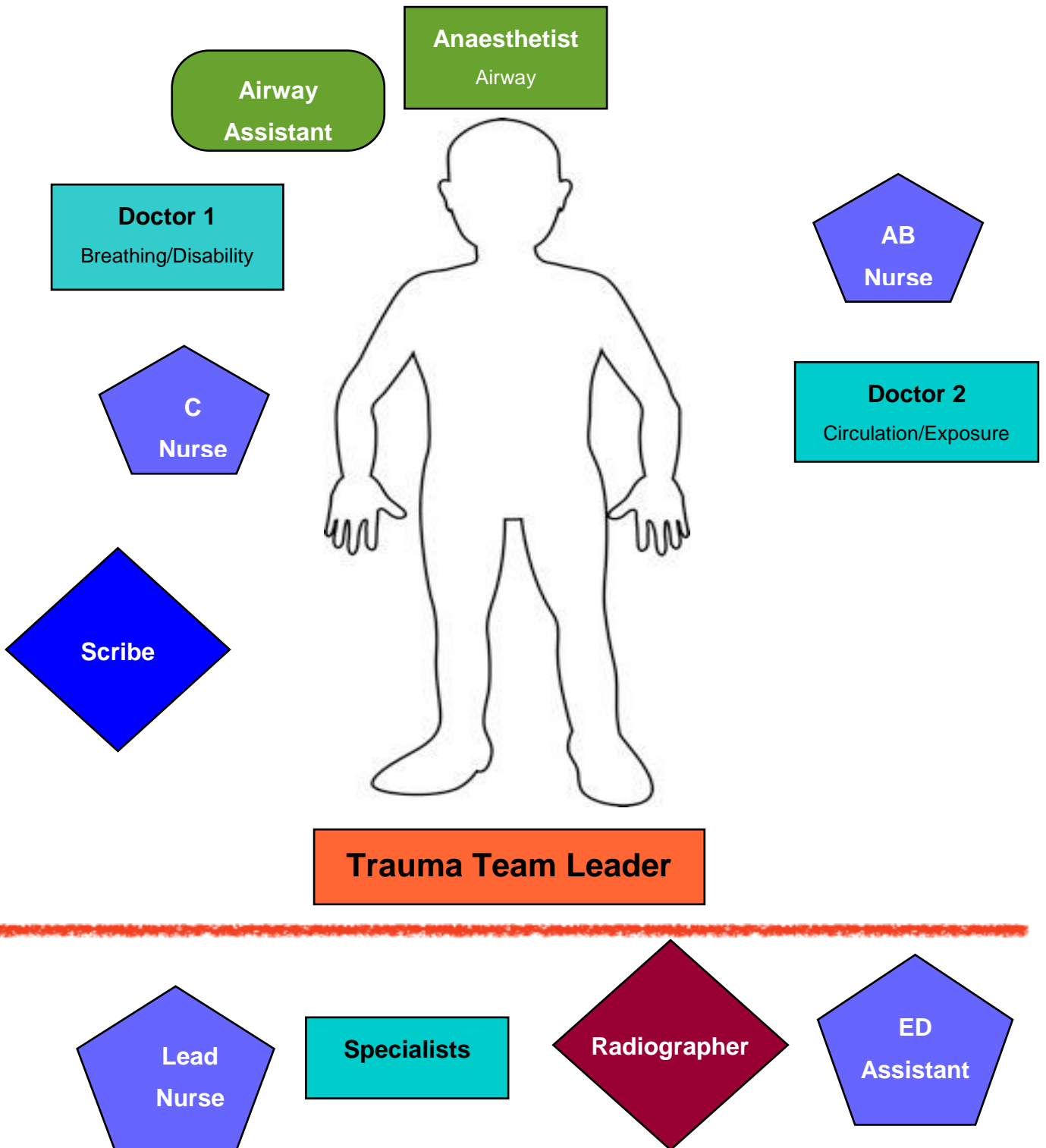
Once the above Paediatric 'Immediate Response' Team has been contacted, Switchboard will then contact the following Paediatric 'Pre-Alert' Team. The standard message will be: **“This is a paediatric major trauma pre-alert call. You are not immediately required. You may be contacted when there are further instructions”**

**PAEDIATRIC: PRE - ALERT**

Paediatric Neurosurgical Registrar  
 Paediatric Orthopaedic Registrar  
 Paediatric ICU Registrar  
 Paediatric Radiology Registrar  
 Paediatric Theatre Co-ordinator

On-call Bleep/Mobile  
 On-call Bleep/Mobile  
 On-call Bleep/Mobile  
 On-call Bleep/Mobile  
 On-call Bleep/Mobile

### Trauma Team



## Trauma Team

### Trauma Team

Trauma management is a team responsibility, which requires clear leadership by an experienced Trauma Team Leader 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 MIST. 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 Trauma Team Leader (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.

### Paediatric Trauma Team Leader – Agreed actions

#### Pre arrival check list

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

- Team members 'book in' with scribe
- All members of the Trauma Team should be identified and key roles assigned
- Protective equipment including lead gowns worn by all key personnel
- Correct documentation collected
- Warmed fluid run through
- X-ray cassettes in place under trolley
- MIST documented on the trauma board

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

The key responsibilities of the TTL are to:

- Log your details with the scribe
- Ensures 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 paramedics
- 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 all results of investigations
- Consult with other specialties and make decisions in conjunction with other specialists

### Trauma Team

- Decide on appropriate disposition of the patient
- Speak to relatives
- Debrief team
- Check completeness of documentation

Also consider the following:

- Early calls to notify CT, interventional radiology, cardiac surgeon, specialty Consultants on call e.g. Neurosurgeon, Consultant General Surgeon if SBP<90
- Tranexamic acid up to 1g over 10 minutes if indication that a blood transfusion may be required (see Massive Transfusion Policy for appropriate weight dose)
- CT within 20 minutes, ensure lines secure and imminent life-threatening conditions treated
- Antibiotics, urinary catheter, arterial lines, tetanus all need early consideration
- Resuscitation is a continuum not dependent on geographical location
- The possibility of parents being present when patients are being resuscitated
- It will be relevant for trauma team to move to CT with patient, take blood products and airway kit
- It may be relevant for trauma team members to escort the patient to theatres; send someone ahead to hold the lift
- Inform blood bank of patient location and new clinical lead for massive transfusion protocol when patient is transferred, or stand down as appropriate
- Address any cultural and/or religious and pastoral issues

### **PED Registrar – Doctor 1 - Agreed Actions**

The key responsibilities of Doctor 1 are to:

- 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
- 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)
- Intravenous access
- Venous and arterial blood samples
- Thoracostomy or thoracotomy
- Undertakes secondary survey include tympanic membranes
- Administer drugs e.g. analgesia, antibiotics
- 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
- Patients cool very quickly and this can have profound effects on haemostasis; ensure patient is kept warm.



## Trauma Team

### **PED Doctor – Doctor 2 - Agreed Actions**

The key responsibilities of Doctor 2 are:

- 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
- IV access
- Venous and arterial blood samples
- Request investigations and chase results
- Prescribe medication and fluid
- Write in the notes and document all actions and findings

Also consider the following:

- 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

### **Paediatric Anaesthetist - Agreed Actions**

The key responsibilities of the anaesthetist are:

- 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
- 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
- Provide anaesthesia for surgical procedures
- Handover to second anaesthetist so clear on drugs given, blood products and fluids transfused, key allergies, PMH and diagnoses made
- 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
- It is usually appropriate for the anaesthetist to talk to the patient and provide on-going assessment of GCS

### Trauma Team

- 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

### Paediatric Anaesthetic Practitioner- Agreed Actions

The key responsibilities of the anaesthetic practitioner are:

- 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 the anaesthetist with their responsibilities
- ODP / Anaesthetist takes emergency airway equipment / drugs to CT and re-stocks key equipment
- Handover to second ODP so clear on drugs given, blood products and fluids transfused etc.

Also consider the following:

- ODP should be familiar with the PED environment before undertaking the trauma team role

### Paediatric Surgeon - Agreed Actions

The Paediatric Surgeon focuses on assessment of the abdomen and perineum.

The key responsibilities of the paediatric surgeon are:

- 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 abdomen and genitalia
- Secondary assessment of the abdomen
- 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 Paediatric 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
- Write in the notes and document all actions and findings with a clear plan

## Trauma Team

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

### **PED Nursing Staff – Nurse 1 and 2 Agreed Actions**

Two members of the PED nursing staff are allocated to the team. They should work with doctors 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 are:

- Identify yourself to the TTL and log your details with the scribe
- Wear personal protective equipment (including lead gown and sticker with assigned role)
- Collect data collection tablet and documentation from the files in resus room and give to scribe
- Prepare for the trauma call with warmed IV fluids run through, chest drain sets out if suggested, scoop stretcher, pelvic binder to hand etc.
- Agree which nurse will be 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
- Help with IV therapies including line set up, intraosseous devices etc.
- Draw up drugs / administer as prescribed
- Prepare for transfer to CT and/or theatre ASAP (within 10-20 minutes)
- Help with procedures as identified e.g. urinary catheter, chest drain, arterial line
- Ensure patient wrist labels are secured on the patient

Also consider the following:

- 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
- Identify any cultural, religious or pastoral issues

### **Scribe - Agreed Actions**

This role is invaluable to the team. 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 be situated near the TTL so that all information passing through the TTL is then passed to the scribe. They should use the identified Major Trauma Pathway document.

The key responsibilities of the scribe are:

- Ensure they have the data collection tablet and documentation
- Actively listen to the ambulance handover

North West Children's Major Trauma Network Clinical Guidelines	Page 19 of 100
See the Intranet for the latest version.	Version Number:-3.

### Trauma Team

- 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
  - Fluids administered
  - Drugs administered
  - Summary of injuries
  - Flag major trauma patient IT system
  - Disposal of patient

Also consider the following:

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

### Paediatric Orthopaedic Surgeon (Secondary Trauma Call) - Agreed Actions

The key responsibilities of the orthopaedic surgeon are:

- 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 stickers with assigned role)
- Actively listen to the ambulance handover if present
- Assessment of limbs, spine and pelvis including a neurological examination prior to muscle relaxants
- Application of external fixator or pelvic sling
- Assessment of limb injury
- Dressing of wounds and stabilisation of fractures
- Liaise with theatres and anaesthesia colleagues for patients needing theatre, as appropriate.
- 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

## Trauma Team

### 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 Guidelines.

In line with Trust policy, any changes to the Lead Consultant should only be made after approval from both the referring and receiving consultant and be documented clearly in the notes.

- To lead the team in the acute clinical management of the patient.
- 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 in RMCH
  - Completion of the Rehabilitation Prescription and discharge communications

### Additional Trauma Team Members.

In addition, the TTL may instruct that the following specialties are contacted via switchboard and asked to respond to a specified location or telephone extension:

- Orthopaedic Registrar On Call
- Neurosurgical Registrar On Call
- Plastic Surgery Registrar On Call
- Cardiothoracic Registrar On Call
- Anaesthetic Registrar On Call
- General Surgical Registrar On Call
- General Surgical SHO On Call
- Orthopaedic SHO On Call

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

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

In the event that the registrar 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

### Primary Survey

#### Aims

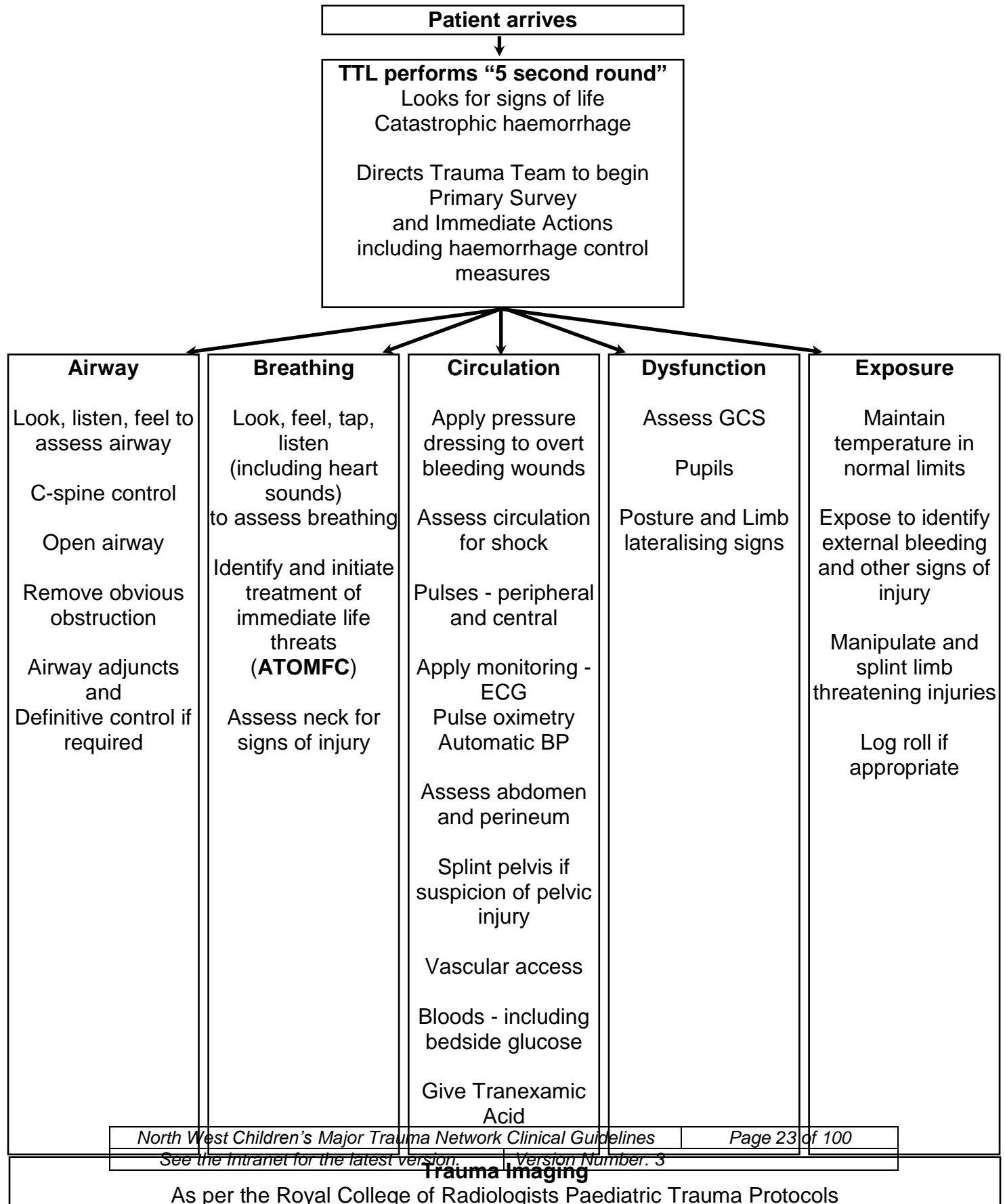
The primary survey aims to identify and treat immediate threats to life while ensuring airway and spine are protected from further compromise or injury. The patient thus assessed, vital functions stabilised and further deterioration prevented.

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:

- **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 minute of arrival into the department.

**Primary Survey**



**Primary Survey**  
**Assess, Intervene, Re-assess**

## Haemorrhage Control

- 5 'Bs' Sources of bleeding - "*Blood on the floor, and four more*":
  - Blood - obvious bleeding
  - Breast (chest)
  - Belly (abdomen)
  - Bum (pelvis)
  - Bones (limbs)
  - 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**
- Patients who have an inherent/drug induced (i.e. Warfarin/NDAC) 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 (excluding isolated head injuries) within 3 hours of injury (after this it may cause more harm).

- Give Tranexamic Acid to any trauma patient (again excluding isolated head injury) 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.

**Loading Dose:** 15mg/kg (max 1g) over 10 minutes in 10mls of 0.9% Saline or 5% Dextrose/Water (within 3 hours of injury).

**Maintenance Infusion:** 2mg/kg/hr (max 125mg/hr) over 8 hours or until bleeding stops. Make a 1mg per 1ml solution by adding 500mg in 500ml of 0.9% Saline or 5% Dextrose/Water.

- Use haemostatic agents



### Primary Survey

- **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-whilest 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/combatative 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 NW Paediatric Critical Care Network /NWTS Emergency Anaesthesia Guidelines

## Primary Survey

### 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 following 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 3 point immobilisation (appropriately-sized hard collar, blocks and tape) unless uncooperative child in which case hard collar alone or 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

## Primary Survey

### 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

### Primary Survey

- 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 15-30 degrees and head in midline
  - Ensure blood glucose above 3 mmol (give 5 ml/kg of 10% dextrose to correct hypoglycaemia)
  - Maintain blood pressure (aim for 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 (phenytoin or phenobarbitone)
  - Treat pain with opioid analgesia Intubate, paralyse and sedate
  - Specific measures for actual or impending herniation
    - Hyperosmolar therapy
    - Controlled ventilation

**Primary Survey**

**Dysfunction**

**Glasgow Coma Score**

Adult	Child	
<p><b>Best Eye Response (4)</b></p> <p>4. Eyes open spontaneously                      3. Eye opening to verbal command                      2. Eye opening to pain                      1. No eye opening</p>	<p><b>Best Eye Response (4)</b></p> <p>4. Eyes open spontaneously                      3. Eye opening to verbal command                      2. Eye opening to pain                      1. No eye opening</p>	
<p><b>Best Verbal Response (5)</b></p> <p>5. Orientated                      4. Confused                      3. Inappropriate words                      2. Incomprehensible sounds                      1. No verbal response</p>	<p><b>Best Verbal Response (5)</b></p> <p>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</p>	<p><b>Best Grimace Response (5)</b></p> <p><i>Use in pre-verbal or intubated patients</i></p> <p>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</p>
<p><b>Best Motor Response (6)</b></p> <p>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</p>	<p><b>Best Motor Response (6)</b></p> <p>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</p>	

## Primary Survey

### 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

- 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
- Blood gas to include lactate
- Biochemistry profile to include LFTs and Calcium
- Amylase
- Serum beta-HCG in girls of child-bearing age

## Trauma Imaging

### Children's Major Trauma Imaging Guidelines

The North West Children's Major Trauma Network (NWChMTN) 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](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.

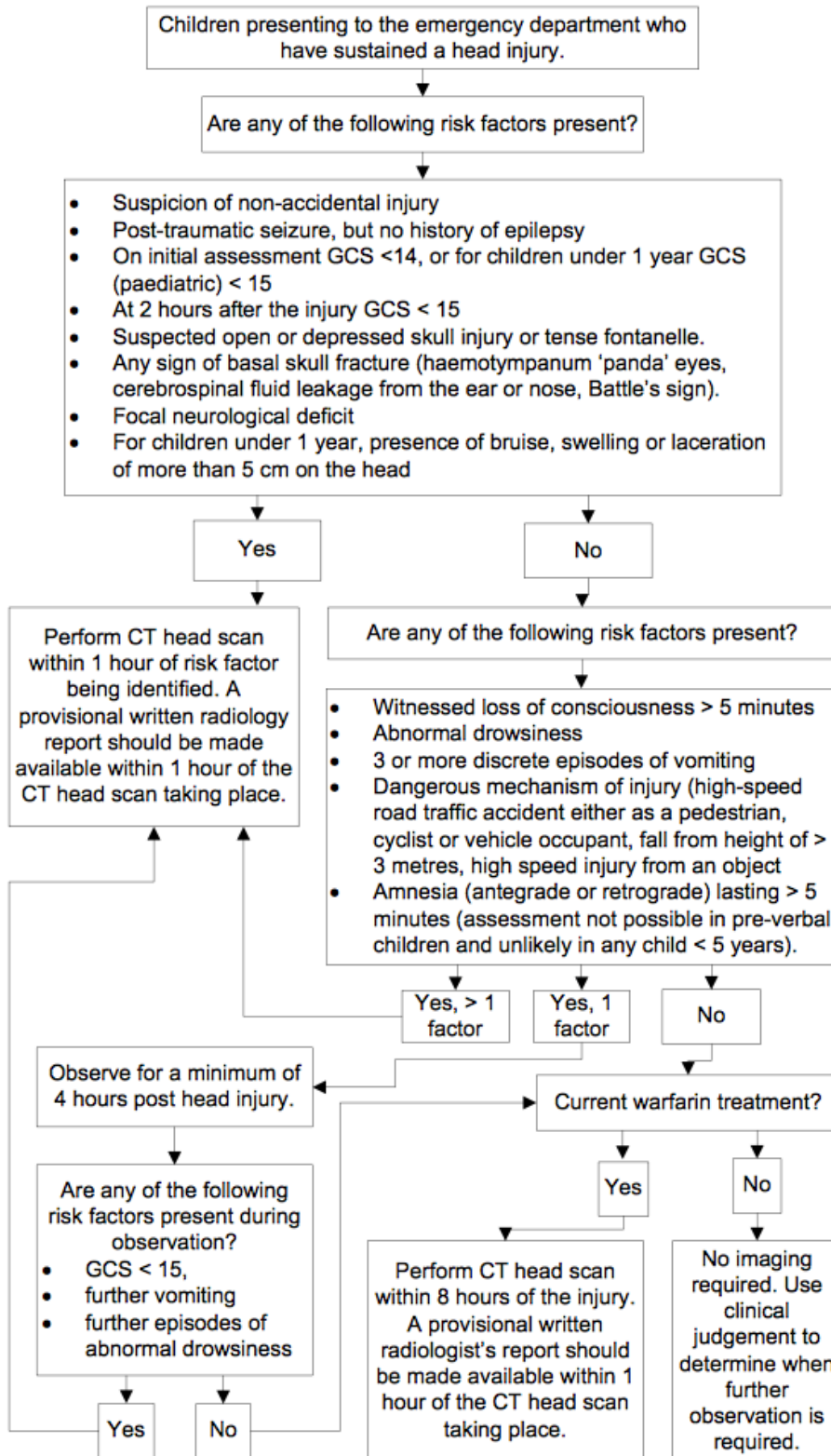
### Additional Guidance for Secondary Transfers

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 is rapidly transferred ("Trauma Blue"), 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.

## Trauma Imaging

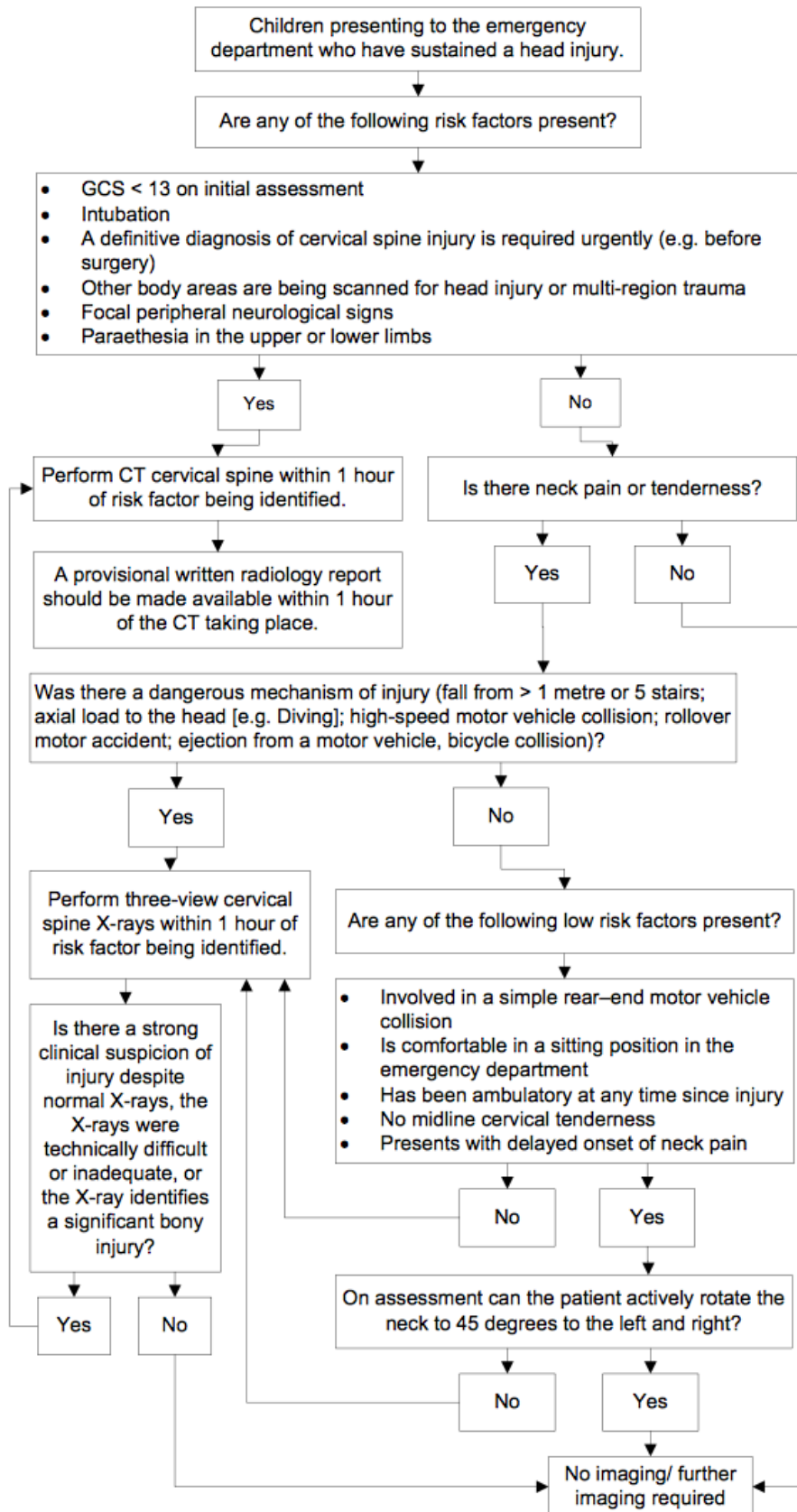
### Suspected Head Injury





## Trauma Imaging

### Suspected Cervical Spine Injury



## Trauma Imaging

### Indications for CT Thorax

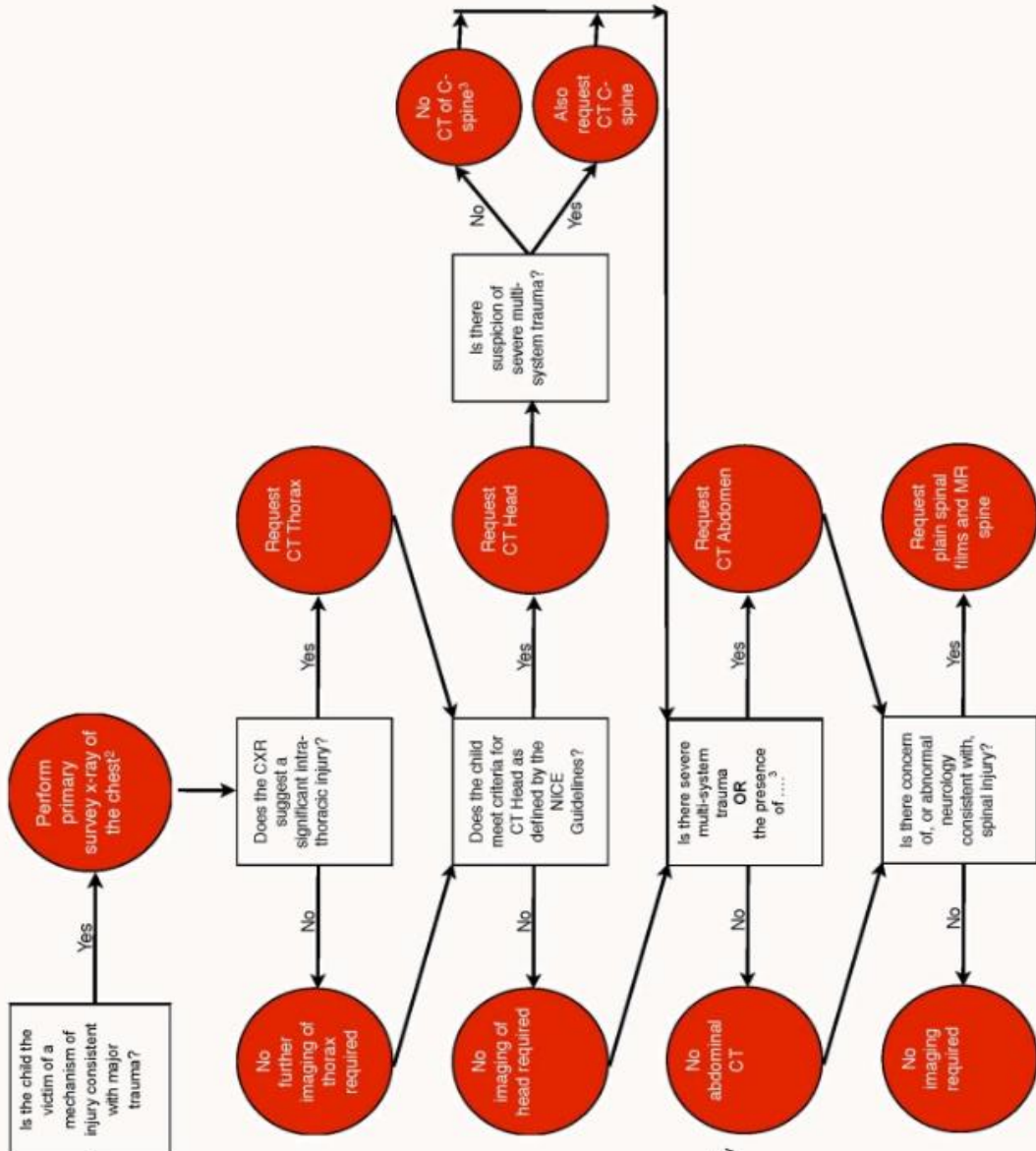
- Penetrating trauma - requires contrast enhanced CT
- Abnormal plain chest xray
- High clinical suspicion of injury. Consider in patient who has evidence of multisystem trauma and who is:
  - Patient intubated prior to hospital assessment
  - Unconscious patient
  - Haemodynamically unstable
  - Unable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

Trauma Imaging

Emergency department paediatric major trauma imaging decision tool



- 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**  
**Emergency Anaesthesia within the Emergency Department**

**Guidance for acute paediatric intubation**

**Think?**

Airway assessment?  
Most appropriate place that time allows?  
Most appropriate staff that time allows?  
Right equipment and drugs prepared?  
Monitoring (especially capnography)?  
Pre-intubation checklist before induction (page 5)

**Potential difficult airway?**

NO

YES

**Call senior anaesthetist and  
E.N.T. surgeon**  
Consider using theatre  
Consider volatile induction

**Cardiovascular risk?**

(Congenital heart disease or shock )

**Available:** Atropine 20microgram/kg (min 100 micrograms)  
& Adrenaline 10 microgram/kg (0.1 ml/kg of 1 in 10,000)  
& Fluid bolus 10ml/Kg

NO

Thiopentone 2-5 mg/kg  
OR Propofol 2-4 mg/kg

YES

**Ketamine 1-2 mg/kg +/-  
Fentanyl 1-2 micrograms/kg**  
Alternative: Thiopentone 1-2 mg/kg

**Aspiration risk?**

(Most sick children have gastric stasis)

NO

Atracurium 0.5 mg/kg  
OR Rocuronium 0.6mg/kg

YES

**Rapid sequence induction**  
(with cricoid pressure)  
Suxamethonium 1-2 mg/kg or  
Rocuronium 1 mg/kg (long acting)

**Success?**

Confirm clinically and E.T.CO2

NO

YES

**Secure tube, note length  
NGT / OGT and CXR**  
On-going sedation  
[www.crashcall.net](http://www.crashcall.net)

**Maintain oxygenation**

Follow "Unanticipated difficult intubation following RSI in paediatric patient" (page 3)

## Emergency Airway Management

### *Guidance for acute paediatric intubation— associated notes*

#### **Consider potential airway difficulties (problems with mask ventilation / laryngoscopy / intubation):**

Patient factors (syndromes / deformities etc.) – ensure thorough airway examination

Previous difficult intubation (check grade laryngoscopy in notes / method of intubation used)

Disease factors (infections/trauma/allergy/foreign bodies etc.) affecting the head, neck or airways

**WARNING: do not examine airway if patient has stridor—may cause deterioration pre-intubation**

#### **Consider significant deterioration on induction:**

Potential limited cardiac reserve e.g. sepsis, low output states, congenital heart disease, arrhythmias

Potential limited pulmonary reserve e.g. pulmonary oedema, chronic lung disease, asthma

#### **IF HIGH RISK DO NOT PROCEED WITHOUT CONSULTANT ADVICE (local and NwTS)**

If difficulty is anticipated and time allows move patient to the anaesthetic room / theatre or move equipment and personnel to patient: ensure consultant anaesthetist and ODP (or equivalent) present.

**Pre-oxygenation:** If possible pre-oxygenate with 100% oxygen for 3 minutes

**Rapid sequence induction** unless gas induction by senior anaesthetist indicated (difficult or obstructed airway)

**Cricoid pressure** by trained practitioner

**Modified RSI (infants and most sick children):** may need to give low tidal volume breaths with cricoid pressure on to preclude desaturation before intubation (low oxygen reserve/ high consumption and paralysis may take longer to take effect if any CVS compromise).

**Induction agents:** (Intraosseous route can be used safely for all induction agents and muscle relaxants)

**Cardiovascularly unstable patients:** consider ketamine +/- fentanyl (ketamine may (lacks evidence) increase intracranial pressure) balance risk/benefit in raised ICP

Thiopentone reduces intracranial pressure but causes hypotension.

**Neonates:** consider using fentanyl for unstable neonates as a sole induction agent (1-3microgram/kg)

**Inhalational anaesthetics:** only by doctors familiar with the anaesthetic machine and technique

**Inotropes:** should be immediately available to offset negative effects of induction agents (i.e. drawn up and in the infusion pumps or ready to bolus [www.crashcall.net](http://www.crashcall.net)) if not available then 1 ml aliquots of (0.1 ml/kg of 1:10,000 adrenaline solution made up to 10 mls total with 0.9% NaCl) is useful for hypotension

#### **Muscle relaxants:**

**Suxamethonium** is drug of choice for RSI (onset 30-45sec, duration 3-5 min) but many contra-indications (including hyperkalaemia, some neuro-muscular pathologies, suspected malignant hyperthermia or 24 hrs after burn or spinal injury).

**Rocuronium** - rapid onset of action at 1mg/kg (approx 1 min and no fasciculations) but a much longer duration (>40min). Can be reversed rapidly (if patient suitable to be woken up!) with sugammadex 16mg/Kg (but this is not widely available (especially outside theatre) and is **NOT** carried by NwTS)

**Post intubation checks:** See ET tube through cords, **E.T.CO<sub>2</sub>**, SpO<sub>2</sub> and auscultation

Check tube length, minimal leak, Melbourne strapping and CXR for ET tube position

**Cuffed endotracheal tubes:** Consider if poor compliance expected, airway soiling or difficulty sizing tube.

Microcuff<sup>®</sup> tubes are becoming more popular in >3Kg children but sizing and markings on tube are slightly different (careful with length). Ensure cuff is at minimum pressure possible (max 20 cm H<sub>2</sub>O).

**Oro/Nasogastric tube to decompress stomach:** contra-indications to NGT include basal skull fracture and coagulopathy.

#### **Maintenance of anaesthesia, sedation and ventilation:**

Consider morphine and midazolam infusion/boluses as per [www.crashcall.net](http://www.crashcall.net) guideline except:

Bronchospasm (consider ketamine / midazolam / fentanyl), renal / liver failure (fentanyl / midazolam).

Have post-procedure sedation and paralysis ready to commence prior to induction.

### **Failure to intubate - Maintain oxygenation**

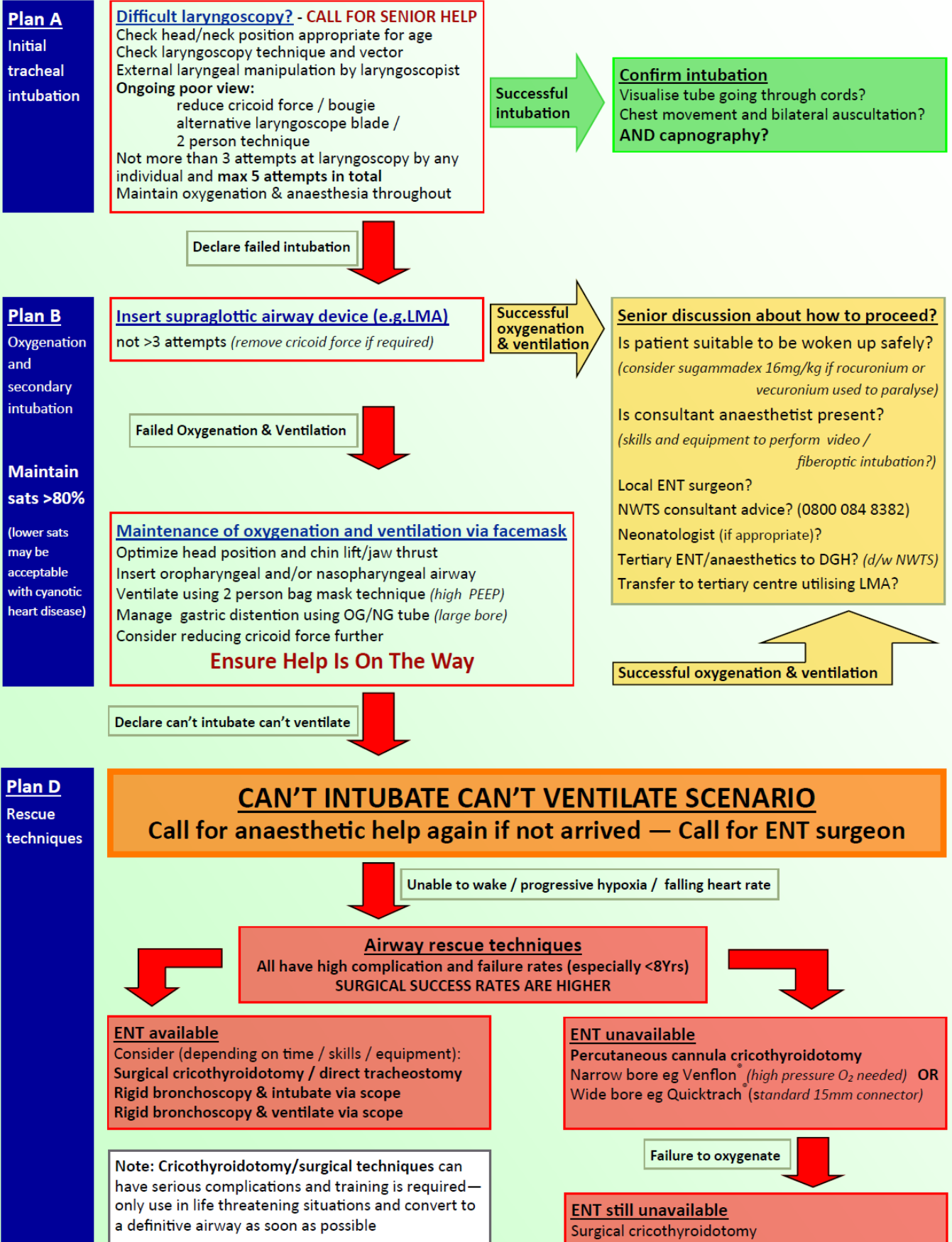
follow “Unanticipated difficult intubation following RSI in paediatric patient” guideline (page 3)

## Emergency Airway Management

### Guidance for acute paediatric intubation

#### Unanticipated difficult intubation following RSI in paediatric patient

(assumes pre-oxygenation performed and 100% O<sub>2</sub> used throughout)



## Emergency Airway Management

### Guidance for acute paediatric intubation

#### Unanticipated difficult intubation following RSI in paediatric patient

##### Notes and advice on procedures

###### Tips to achieve intubation:

- Check position of head and neck: aim for neutral alignment in neonates and infants, “sniffing the morning air” in the older child
- Check laryngoscope vector (midline) and technique (scope in vallecula or lifting epiglottis directly, try both)
- External laryngeal manipulation by the person doing laryngoscopy: use little finger in neonates and infants
- Cricoid pressure can distort/occlude the airway—reduce/remove and reassess change
- Consider alternative laryngoscope blade
  - Cardiff blade in neonates
  - McCoy blade in older children
- Consider a bougie if poor view of glottis. Do not seek hold up (adult technique of pushing bougie until it lodges in bronchi) as high risk of perforation/pneumothorax especially in neonates/infants
- Consider 2 person technique:
  - Operator 1 - laryngoscope + external laryngeal manipulation
  - Operator 2 - insertion of bougie/endotracheal tube over operator 1’s shoulder
- Bag mask ventilation to maintain oxygenation between attempts - use OG/NG tube to continually decompress stomach

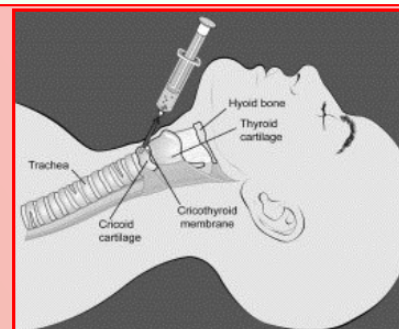
No more than 3 attempts at intubation by initial operator. A second operator (preferably consultant anaesthetist or someone more experience in paed airway management) may have further attempts at direct laryngoscopy up to a maximum of 5 in total (when combined with all previous attempts). If unsuccessful a different strategy should be employed to ventilate and secure the airway—repeated unsuccessful attempts at laryngoscopy will cause airway oedema and exacerbate the situation.

**If oxygenation and ventilation are not adequate at any point between attempts - proceed down failed intubation pathway - oxygenation is paramount.**

###### Percutaneous cannula cricothyroidotomy:

Stiffened cannulas (e.g. Ravussin<sup>®</sup>) better than standard cannula (e.g. Venflon<sup>®</sup>)  
Ravussin 16G Infant / 14G Child / 13G Adult

- Identify cricothyroid membrane (full head and neck extension, shoulder roll/head ring)
- Insert cannula through cricothyroid membrane (45° caudal angle)
- Confirm tracheal position by air aspiration
- Attach insufflation system to cannula using Luer-lock connector  
(Need high pressure source e.g. manujet injector / Enks oxygen flow meter)
- Commence cautious inflation (manujet colour coded / Enks—start with flow in L/min equal to age in years)
- Continue to increase pressure / flow until chest rise adequate (1L/min increments to max 15)
- Confirm inflation of lungs and exhalation through upper airway (upper airway patency is required for this technique to work)
- 1 second inflation - 4 second exhalation
- If inflation fails or surgical emphysema develops convert immediately to surgical cricothyroidotomy



###### Large bore cannula cricothyroidotomy:

VBM Quicktrach<sup>®</sup> 1.5mm I.D. Infant / 2mm I.D. Child / 4mm I.D. Adult (All 3 sizes carried by NWTs)

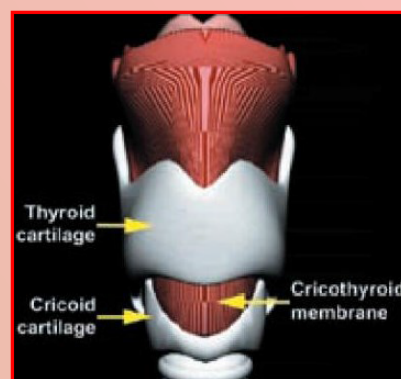
- Identify cricothyroid membrane (Full head and neck extension, shoulder roll/head ring)
- Hold syringe firmly and puncture skin at 90° angle with needle bevel facing caudally
- Once through skin, flatten needle to 60° angle
- Advance Quicktrach<sup>®</sup> into trachea up to stopper
- Aspirate - should freely aspirate air (if not reposition)
- Remove stopper
- Slide the plastic cannula over needle until flange is flush with skin
- Remove needle and syringe
- Secure cannula with tracheostomy tape
- Insufflate via anaesthetic circuit or self-inflating bag. Steadily increase pressure if no chest rise.
- 1 second inflation - 4 second exhalation  
(Depending on the degree of upper airway obstruction present, it may be necessary to occlude the patient’s mouth and nose to adequately inflate the lungs as most of the gas may escape through the upper airway during attempts at inflation). Exhalation must still take place via the upper airway



NB: VBM Quicktrach<sup>®</sup> 1.5mm I.D. also has a Luer-lock connection that can be attached to a high pressure O<sub>2</sub> source as well if low pressure is inadequate to inflate lungs.

###### Surgical cricothyroidotomy:

- Identify cricothyroid membrane (full head and neck extension, shoulder roll/head ring)
- Single stab incision through skin and membrane using scalpel
- Enlarge incision using blunt dissection
- Insert tracheal or tracheostomy tube of appropriate size (a bougie can be used to hold open tract and act as a guide)
- Secure tube and ventilate (capnography to confirm ventilation)
- Ventilate via anaesthetic circuit or self-inflating bag.



**These techniques have serious complications - use only in life threatening situations.**

**Convert to definitive airway as soon as possible**

(Ultrasound can be used to assist above techniques if available/trained/no delay)

## Emergency Airway Management



Acute paediatric intubation checklist (ensure all equipment is size appropriate before starting)

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 sizes / distances are guides and should be confirmed clinically and by CXR

Microcuff tubes not recommended by manufacturer <3Kg Check compatibilities of your equipment as manufacturers vary

<p><b>PLANNING / PREPARATION / LOCATION</b></p> <p>Alternative airway plan discussed in case of difficulties? Do you need ENT? <input type="checkbox"/></p> <p>C-spine stable? Positioning optimised for age / condition? <input type="checkbox"/></p> <p>Plan for cardiac decompensation? <input type="checkbox"/></p> <p>NG tube / PEG aspirated? <input type="checkbox"/></p> <p>IV/IO—working? <input type="checkbox"/></p> <p>Team roles - Intubator <input type="checkbox"/></p> <p style="padding-left: 20px;">Cricoid / airway assistant <input type="checkbox"/></p> <p style="padding-left: 20px;">Drugs / runner (minimum 3 people required for RSI) <input type="checkbox"/></p> <p>HELP—who / how / where will it be coming from? <input type="checkbox"/></p> <p>Pre-oxygenation <input type="checkbox"/></p>	<p><b>EQUIPMENT</b></p> <p>Face mask / airways (oral and nasal)? <input type="checkbox"/></p> <p>Laryngoscope type/size and checked? (preferably 2) <input type="checkbox"/></p> <p>ETT— above and below expected size available (consider microcuff)? <input type="checkbox"/></p> <p>Breathing circuit? (Bag-valve mask available) <input type="checkbox"/></p> <p>Tube tapes / ties? <input type="checkbox"/></p> <p>Bougie / introducer / Magill's? <input type="checkbox"/></p> <p>Suction (Yankauer and catheter)? NGT / OGT (if not in already)? <input type="checkbox"/></p> <p>Monitoring— Capnography, SPO2, stethoscope, BP, ECG? <input type="checkbox"/></p> <p>Alternative airway plan / rescue devices (e.g LMA / cricothyroid etc.)? <input type="checkbox"/></p>	<p><b>DRUGS</b></p> <p>Check drug doses and labelling (<a href="http://www.crashcall.net">www.crashcall.net</a>) <input type="checkbox"/></p> <p>Induction agent: / paralysis (sux/roc)? <input type="checkbox"/></p> <p>Ongoing sedation/anaesthesia? <input type="checkbox"/></p> <p>Fluids drawn up? / vasopressor required? / inotrope required? <input type="checkbox"/></p> <p>Crash drugs— adrenaline/ atropine drawn up? <input type="checkbox"/></p>
<p>Patients Name: _____ Date: ___/___/___ Team signature: _____</p>		



## Emergency Airway Management Emergency Airway Procedures Guidelines

### Needle Cricothyroidotomy

#### Indications:

Life-threatening hypoxia and the inability to oxygenate by any other means.

#### Equipment for needle cricothyroidotomy

- 14, 16g cannulas or specialised needle
- 10ml syringe
- Antiseptic skin prep solution
- High pressure oxygen supply and connectors

#### Procedure:

- Check all equipment is present and functioning (see above).
- Attach syringe to cannula
- In the absence of trauma to the cervical spine, extend the patient's head.
- Identify the cricothyroid membrane.
- If time permits, prepare the skin with antiseptic solution.
- Stabilise the thyroid cartilage with one hand and insert the cannula through the skin and cricothyroid membrane in a slightly caudal direction, aspirating on the syringe.
- Free-flow of air indicates the tip of the needle in the cannula is in the trachea.
- Advance the cannula a further 5mm to ensure the cannula body is in the trachea.
- Advance the cannula off the needle into the trachea, keeping the needle within the cannula to splint the plastic cannula.
- Reattach the syringe and confirm free aspiration of air.
- While holding the cannula in place, attach ventilating device and start ventilation

#### Confirmation of position:

- Look out for symmetrical movement of the chest wall with ventilation;
- Listen in both axillae for breath sounds and over the stomach for absence of sounds.

#### Complications:

### **Emergency Airway Management**

- Barotrauma and pneumothorax;
- Haemorrhage;
- Oesophageal injury;
- Surgical emphysema;
- Kinking and obstruction of the cannula;
- Lack of effectiveness in patients with severe chest trauma.

## Emergency Airway Management

### Surgical Cricothyroidotomy

#### Indications:

Life-threatening hypoxia and the inability to oxygenate by any other means.

#### Equipment for surgical cricothyroidotomy

- Antiseptic skin prep solution
- Scalpel
- Tracheal dilators
- Selection of cuffed tracheostomy and tracheal tubes; 4.0mm-6.0mm
- Syringe
- Tapes/ties
- Ventilating device and monitoring

#### Procedure:

- Check all equipment is present and functioning (see above)
- In the absence of trauma to the cervical spine, extend the patient's head.
- Identify the cricothyroid membrane
- If time permit, prepare the skin with antiseptic solution and, if appropriate, infiltrate the skin over the cricothyroid membrane with 1% lignocaine with adrenaline (1:100,000).
- Stabilise the thyroid cartilage with one hand and make a 2-3cm incision through the skin.
- Identify the membrane and incise it transversely.
- With the scalpel blade in situ insert a pair of tracheal dilators and open up the incision.
- Remove the scalpel and insert the well-lubricated tracheal tube or tracheostomy between the tracheal dilators.
- Remove the tracheal dilator, inflate the tube cuff and attempt ventilation of lungs.
- Confirm the correct position by checking for exhaled CO<sub>2</sub> and observing chest movement, listen for breath sounds.
- Secure the tube and suck any secretions from the lungs.
-

## Emergency Airway Management

### Complications:

- Damage to the posterior tracheal wall by deep penetration with the scalpel blade;
- Haemorrhage;
- Misplaced tube outside the trachea (causing surgical emphysema);
- Incision too small to admit the tube.

## Head Injury

### Head Injury

Traumatic brain injury (TBI), often following falls or road traffic accidents, is one of the commonest injuries sustained by children following major trauma.

Injured children presenting with GCS less than 13 may have moderate or severe head injury and should be managed as per the Major Trauma Guidelines in conjunction with current NICE Head Injury Guidance (NICE Guidelines, 2014).

For imaging in suspected head and cervical spine injuries refer to the Trauma Imaging Guideline (Royal College of Radiologist, 2014).

### Objectives in Management of Head Injuries:

- Diagnose the primary injury and treat promptly.
- Provide prompt and effective pain relief.
- Prevent secondary damage from hypoxia, infection and hypotension.
- Recognise complications such as intracranial haemorrhage, cerebral oedema and infection early and treatment promptly.

Following assessment of the patient by the trauma team, if a head injury is present and the patient is in the MTCs the Neurosurgical registrar and consultant on call should be informed. If the patient is in a Trauma Unit or Local Emergency Hospital the Trauma Team Lead at the TU should contact the Trauma Team lead at the Children's MTC for further management advice as per Major Trauma Transfer in Pathway (see page \*\*).

### When to Involve the Neurosurgeon

- Discuss the care of all patients with new, surgically significant abnormalities on imaging with a neurosurgeon (definition of 'surgically significant' to be developed by local neurosurgical unit and agreed with referring hospitals).
- Regardless of imaging, other reasons for discussing a patient's care plan with a neurosurgeon include:
  - persisting coma (GCS  $\leq$  8) after initial resuscitation
  - unexplained confusion for more than 4 hours
  - deterioration in GCS after admission (pay greater attention to motor response deterioration)
  - progressive focal neurological signs
  - seizure without full recovery
  - definite or suspected penetrating injury
  - cerebrospinal fluid leak.

## Head Injury

### Criteria for admission

- New, clinically significant abnormalities on imaging.
- Not returned to GCS 15 after imaging, regardless of the imaging results.
- Criteria for CT scanning fulfilled, but scan not done within appropriate period, either because CT not available or because patient not sufficiently co-operative to allow scanning.
- Continuing worrying signs (for example, persistent vomiting, severe headaches).
- Other sources of concern (for example, drug or alcohol intoxication, other injuries, shock, suspected non-accidental injury, meningism, cerebrospinal fluid leak).

- **Patient with a head injury:** admit under the care of a team led by a consultant trained in head injury management during higher specialist training (see page 4 for full recommendation).
- **Patient with multiple injuries:** admit under the care of the team trained to deal with most severe and urgent problem.

### Frequency of Observations:

- Observations should be performed and recorded on at least a half-hourly basis until GCS equal to 15 and has been achieved. 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

For low risk patients a full set of neurological observations should be documented at triage. Thereafter at half hourly intervals record GCS, note any further vomiting, onset of headache for 1 hour after injury if these remain normal the patient can be re-triaged as green and seen in time order.

Should the patient with GCS equal to 15 deteriorate at any time after the initial 2-hour period, observations should revert to half-hourly and follow the original frequency schedule.

### Patient changes necessitating review while under observation:

- Any of the following examples of neurological deterioration should prompt urgent reappraisal by the supervising doctor:
  - Development of agitation or abnormal behaviour.
  - A sustained (that is, for at least 30 minutes) drop of one point in GCS level (greater weight should be given to a drop of one point in the motor score of the GCS).
  - Any drop of greater than two points in GCS level regardless of duration of GCS sub-scale.
  - Development of severe or increasing headaches or persisting vomiting. New or evolving neurological symptoms or signs such as pupil inequality or asymmetry of limb or facial movement.

## Head Injury

### Discharge (From NICE Clinical Guideline 176, January 2014)

- Patients may be discharged even after a normal CT Scan as long as:
- GCS 15.
- With appropriate advice sheet.
- There is suitable care and supervision at home.
- No ongoing child protection issues.

### Follow up (From NICE Clinical Guideline 176, January 2014)

GP follow up within 1 week for all those requiring CT Scan.

A letter with details of the injury, history, examination and investigations should be sent to GP with a copy to family. As long as you code the ED card correctly, this will automatically be generated.

Copy of above to be sent on all those requiring imaging to Community Paediatrics, school nurse/health visitor.

Also consider notifying health visitor for pre-school children attending with head injury.

## Head Injury

### Protocol for Management of Actual or Impending Cerebral Herniation following Traumatic Brain Injury (TBI) in the Emergency Department

**Note: This protocol is only to be used under the specific guidance of a senior Emergency Department doctor (Consultant, Associate Specialist, Specialty Doctor or Registrar)**

#### Signs of raised intracranial pressure (ICP)

- Altered consciousness (irritable, drowsy, coma)
- Focal Weakness
- Hyperreflexia and/or hypertonia
- Full or bulging fontanel (“tense”fontanel” is rare to palpate if so patient will already have a very low GCS)

#### Signs of impending transtentorial herniation

- Rapid deterioration of an already abnormal GCS
- Unequal, Dilated or irregular pupil
- Sluggish or unreactive pupil
- Nystagmus
- Bradycardia
- Hemiparesis / hemiplegia
- Abnormal posturing - extensor or decorticate
- Cushing response - bradycardia, hypertension, altered (reduced) respirations (late sign)

#### Management of raised ICP

##### General measures

- Ensure good oxygenation
- Head tilt 15-30 degrees and head in midline
- Ensure blood glucose above 3 mmol (give 5 ml/kg of 10% dextrose to correct hypoglycemia)
- Maintain blood pressure (aim for 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 (phenytoin or phenobarbitone)
- Treat pain with opioid analgesia, intubate, paralyse and sedate
- Insert urinary catheter unless urethral injury is suspected.

##### Specific measures for impending herniation:

- Hyperosmolar therapy

Mannitol 20% 1.25-2.5 ml/kg over 20 minutes; avoid in renal failure and caution in haemorrhagic shock; watch for hypovolaemia

or

Hypertonic saline 3% 5 ml/kg over 20 minutes; especially consider in multiple trauma where signs hypovolaemia/haemorrhagic shock.



## Head Injury

A second treatment may be given (either the same or the alternative therapy) if required but exercise caution.

- Controlled hyperventilation

Aim for PaCO<sub>2</sub> between 25-30 mmHg (requires end tidal CO<sub>2</sub> monitoring)

- PICU and the Neurosurgical team must be aware of this patient, and a CT scan must be organised

### References

Wakai A, Roberts IG, Schierhout G. Mannitol for acute traumatic brain injury. Cochrane Database of Systematic Reviews 2007, Issue 1. Art No.:CD001049.

DOI: 10.1002/14651858.CD001049.pub4

Use of hyperosmolar therapy in the management of severe pediatric traumatic brain injury. Chapter 11 in: Guidelines for the Acute Medical Management of Severe Traumatic Brain Injury in Infants, Children and Adolescents. Pediatric Critical Care Medicine July 2003; 4(3 Suppl).

DOI: 10.1097/01.CCM.0000067635.95882.24

### For further information please see:

Head Injury: Triage, assessment, investigation and early management in children, young people and adults. NICE Guideline CG176, January 2014.

## Spinal 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.

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.**

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. A paediatric musculoskeletal radiologist is required for interpreting these scans.

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.

## Spinal Injury

### 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. 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.

### Ongoing management

The continuing management of spinal injuries will be directed by the Neurosurgical team with input from Orthopaedics and the Spinal Cord Injury Centre at Southport Hospital as necessary.

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 newly traumatised 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.

## Spinal Injury



### BRITISH ORTHOPAEDIC ASSOCIATION STANDARDS for TRAUMA (BOAST) ©

## BOAST 8: THE MANAGEMENT OF TRAUMATIC SPINAL CORD INJURY

### Background and Justification:

Spinal cord injury resulting in neurological deficit is a rare but potentially devastating injury. Compromise to the spinal cord may be due to trauma, vascular injury or other disease process and can result in immediate or insidious onset of neurological symptoms including loss or reduction of voluntary motor function, sensory impairment, bowel or bladder dysfunction and loss of autonomic function. The incidence in the United Kingdom is estimated at 12-16 per million population with about 75% of cases due to trauma. Appropriate management from the time of diagnosis of cord injury has been shown to have significant effect on the long-term outcome for patients and reduce short and long-term complications.

### Included Patients:

All patients with traumatic spinal cord injury resulting in complete or incomplete para- or tetraplegia. The audit standards apply to those with polytrauma and those with isolated spinal cord injuries but do not apply to patients with spinal column injury without cord involvement. These audit standards apply to adults and children.

### Standards for practice audit:

1. All Major Trauma Centres and Trauma Units must have a named, linked Spinal Cord Injury Centre.
2. All hospitals within a major trauma network should have an agreed, common protocol for protecting the neck and spine together with an agreed, common protocol to exclude significant injury (clearance of the neck and spine eg BOAST-2).
3. Centres managing patients with spinal cord injury require 24-hour access to CT and MRI.
4. Clinical evaluation of injured patients must include appropriate and repeated examination of the peripheral nervous system which should be recorded in the medical notes on an ASIA chart in keeping with the International Standards for Neurological Classification in Spinal Cord Injury.
5. Protocols for resuscitation and acute management including skin care, gastric, bowel and bladder care and neuroprotection must be agreed with the linked Spinal Cord Injury Centre and available in all Emergency Departments that may receive patients with spinal cord injury.
6. Centres treating these injuries must have the capability of performing specialist spinal surgery within 4 hours of injury. For those requiring surgery, protocols for anaesthesia and spinal stabilisation must be agreed with the linked Spinal Cord Injury Centre.
7. Protocols for nursing, joint protection and therapy requirements must be agreed with the linked Spinal Cord Injury Centre.
8. Management of the spine must follow written, agreed protocols with the linked Spinal Cord Injury Centre, or alternatively the on call consultant at that centre should be contacted within 4 hours of injury.
9. An early, joint management plan must be formulated and recorded in the medical notes within 12 hours.
10. Once the patient is fit for transfer to a Spinal Cord Injury Centre this should take place within 24 hours, unless it is agreed that it is the patient's best interest to remain in a Major Trauma Centre or Trauma Unit.
11. Spinal Cord Injury Centres should provide an outreach visit within 5 days of referral for patients unfit for transfer, and then follow-up contact (or visit) at least weekly until the patient is transferred.
12. Appropriately trained psychological support must be available for patients, family and carers.
13. All patients with new spinal cord injuries in England must have referral data submitted to the National Spinal Cord Injuries Database. The referral website is found at [www.spinalcordinjury.nhs.uk](http://www.spinalcordinjury.nhs.uk)

### References:

References are found at [www.spinalcordinjury.nhs.uk/docs.aspx](http://www.spinalcordinjury.nhs.uk/docs.aspx)

Management of People with Spinal Cord Injury. NHS Clinical Advisory Groups Report (August 2011)

The Initial Management of Adults with Spinal Cord Injuries (May 2012)

ASIA Protocol

Professional consensus

## 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

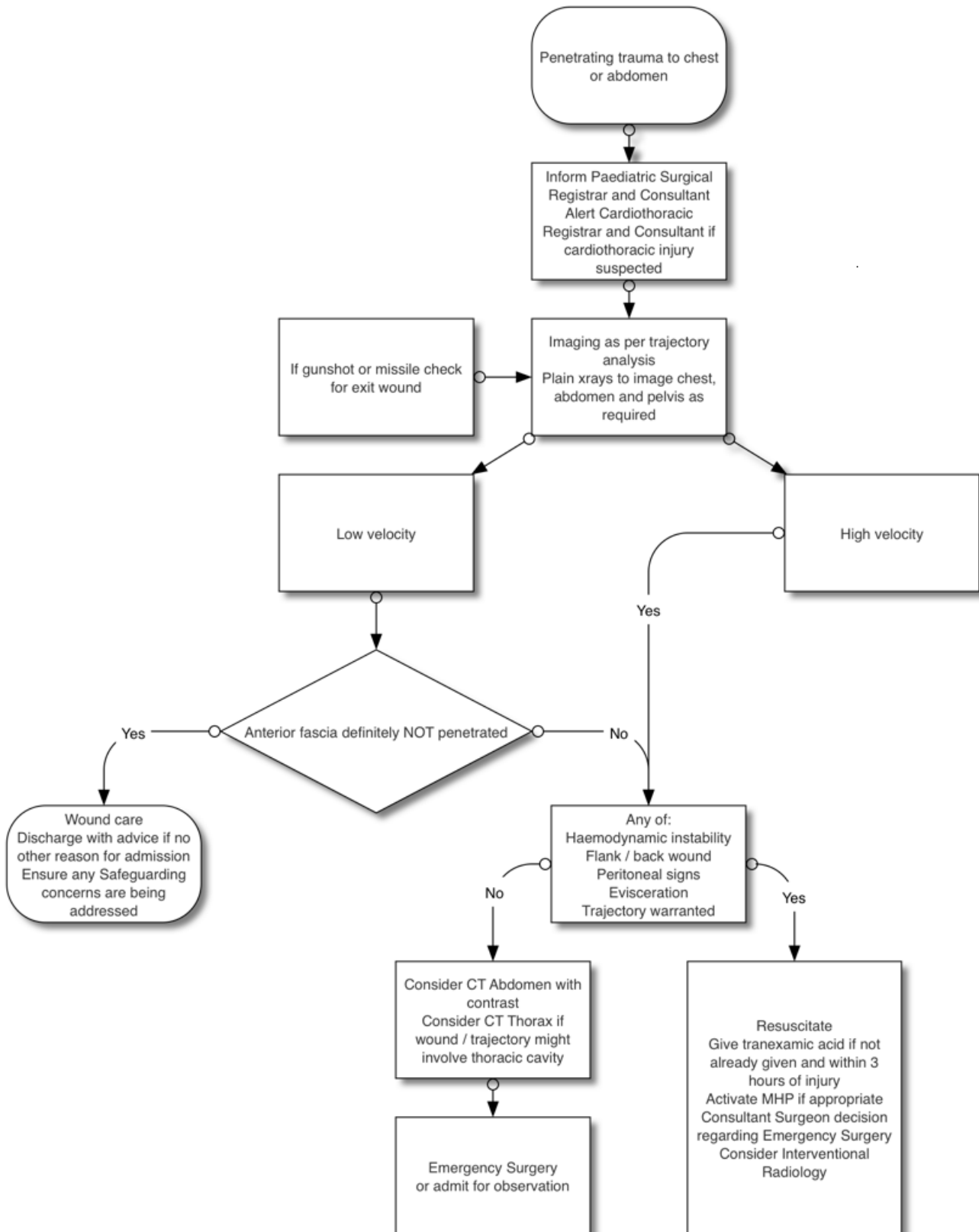
Unstable patients with significant haemothorax will require a thoracotomy. Call the appropriate Surgical Consultant.

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

### **Thoracic Injury**

- 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.

## Thoracic Injury Suspected Penetrating Trauma Algorithm



## Thoracic Injury

### Blunt Chest Trauma

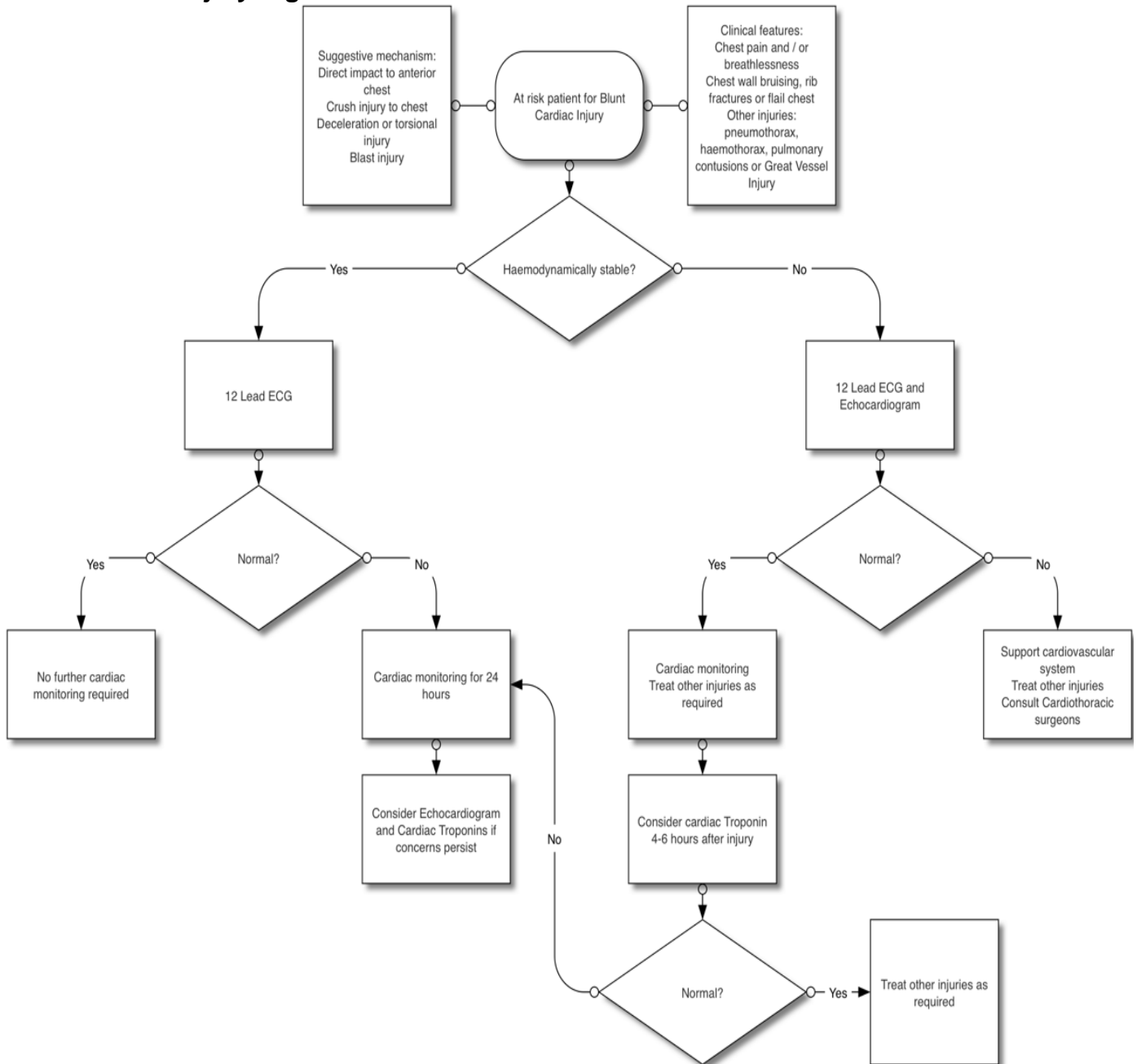
#### Thoracotomy in Blunt Thoracic Trauma

- 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).



## Thoracic Injury

### Blunt Cardiac Injury Algorithm

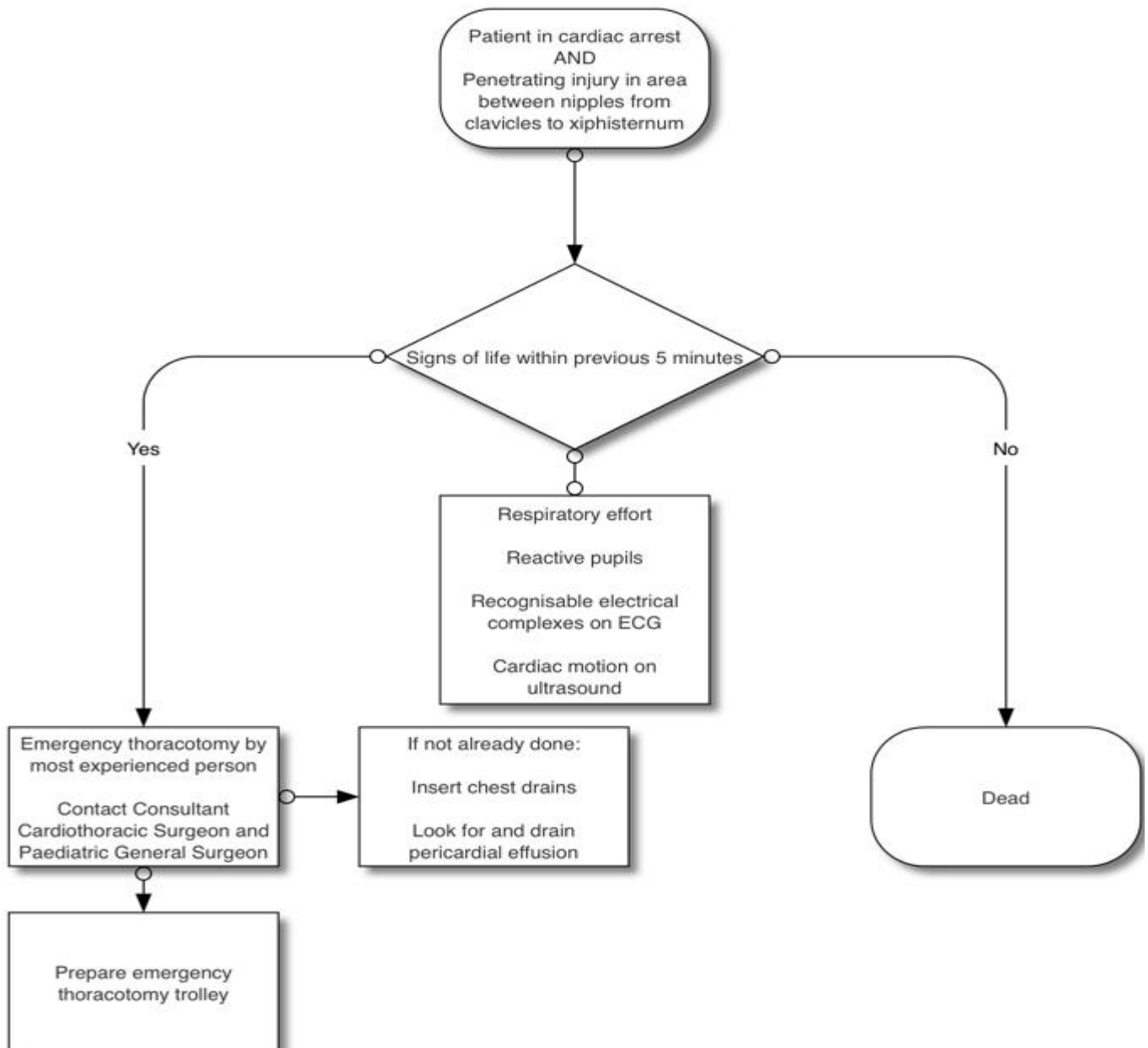


### Indications for Emergency Thoracotomy

The need for emergency thoracotomy in the context of paediatric trauma is rare despite the mortality associated with many thoracic injuries. In the patient with blunt injury without vital signs, thoracotomy does not improve outcome. The sole indication for emergency department (ED) thoracotomy in children is the child with penetrating chest trauma who loses vital signs either immediately prior to arrival in the ED or during resuscitation (remember to exclude tension pneumothorax first). The aims would be to drain cardiac tamponade, repair cardiac laceration, control hilar or pulmonary haemorrhage, cross clamp the aorta or perform open cardiac massage.

## Thoracic Injury

### Emergency Thoracotomy Algorithm



### 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

## Thoracic Injury

### Emergency Chest Procedures

#### Needle Thoracocentesis

##### Indications

Emergency decompression of a tension pneumothorax when no scalpel is available to perform a thoracostomy.

##### Equipment for Needle Thoracocentesis

- 14, 16g cannulas or specialised needle
- 10ml syringe
- Saline
- Antiseptic skin prep solution
- Adhesive tape

##### Procedure:

- If conscious, inform patient about the procedure and obtain verbal consent.
- Ensure arrangements are being made for a thoracostomy.
- Attach a 14 or 16g IV cannula into a 10ml syringe, with the needle still within the cannula.
- Fill the syringe with a few ml of air or saline.
- In view of the urgency of the situation when this this procedure is carried there will not be time for using local anaesthetic, but the skin should be quickly cleaned.
- Identify the mid-clavicular line at the 2<sup>nd</sup> intercostal space (just above the upper margin of the lower (3<sup>rd</sup>) rib).
- An alternative site is the 5<sup>th</sup> intercostal space, in the anterior axillary line.
- Insert the cannula perpendicularly into the chest.
- Once in place, inject 1-2 ml of air or saline to expel any tissue that may have blocked it on insertion.
- Attempt aspiration-if the syringe fills easily with air or bubbles are seen, the cannula is likely to be correctly located in the pleural space. Remove the syringe, a significant improvement of the patients cardiovascular and respiratory status confirms the diagnosis. Occasionally, a jet of air maybe felt in the cannula.

### **Thoracic Injury**

- Extract the inner metal needle and fix the cannula in place by adhesive tape making sure that it does not kink .
- Continue immediately to a tube thoracostomy; a needle thoracocentesis only provides temporary relief.
- The inability to aspirate air means either the cannula is blocked, it is not in the pleural cavity or the diagnosis is incorrect. Definitive chest drain drainage is therefore urgently required.

### Complications

- Needle is too short: in up to 30% of patients, the length of commonly used IV cannulas (4.5cm) may well not be sufficient to fully penetrate the chest wall.
- Life-threatening haemorrhage (due to perforation of the internal thoracic and subclavian blood vessels or poor location of landmarks).
- Cardiac tamponade.
- Pneumothorax
- Infection

## Thoracic Injury

### Tube Thoracostomy

#### Indications:

Pneumothorax (simple and tension), haemothorax.

#### Equipment for tube thoracostomy

- Local anaesthetic, needle and syringe
- Skin cleansing solution
- Artery forceps
- Surgical drapes
- Scalpel
- Chest drain (28-32Fr Gauge)
- Suture
- Tape
- Dressings
- Underwater drainage system, filled and correctly assembled

#### Procedure:

- Check presence and function of all equipment.
- If conscious, inform patient about the procedure and obtain verbal consent.
- Ensure IV access has been secured.
- Confirm correct side for insertion and identify the 5<sup>th</sup> intercostal space (ICS) or higher, 1cm anterior to the mid-axillary line.
- Fully abduct the patient's arm to allow a clear approach to the axilla and lateral chest wall;
- If trained, use sonography to confirm the correct site for insertion if immediately available. This minimises the risk of placing the tube sub-diaphragmatic;
- When sonography is not available or possible, identify the sternal angle and the medial end of the 2<sup>nd</sup> costal cartilage. Count down to the correct level and make a mark 1cm anterior to the mid-axillary line;
- If it is not possible to identify the ribs, use the width of the patient's hand (i.e. the distance across the 2<sup>nd</sup> - 5<sup>th</sup> metacarpophalangeal joints) below the inferior anterior axillary border to estimate the 6<sup>th</sup> ICS. The skin mark for the incision should therefore be made at least one intercostal space higher than this point. In cases

### Thoracic Injury

where the patient's upper limb cannot be used due to associated injuries, estimate the correct level by using the operator's own hand.

- Clean the area fully and isolate with sterile drapes.
- If the patient is conscious, infiltrate the area for insertion with local anaesthetic; the skin, subcutaneous tissue, down to the pleura ad area around the skin mark.
- Ensure local anaesthetic has worked.
- If present, remove the metal trocar from the drain.
- Attach a clamp or artery forceps through the distal side hole in the drain but ensure no metal projects distal to the tube – this will enable you to direct the tip into the pleural cavity.
- Make a 3-5cm incision along the line of rib.
- Use a blunt dissection to deepen the track through the intercostal muscles down to the pleura. Beware that the neuro-vascular bundle runs along the lower border of the rib, therefore make the track over the superior border of the rib.
- Pierce the pleura using artery forceps
- Insert a finger along the track into the pleural cavity and sweep around the space to detect the presence of any adhesions or bowel (in case of a ruptured diaphragm). Take care in doing this as rib fractures may be present.
- The tube is then directed through the incision into the pleural cavity and digitally advanced posteriorly and superiorly. This is to ensure it does not run into the horizontal fissure.
- Fogging, blood or condensation, caused by ward air escaping down the drain confirms placement in the pleural cavity.
- The proximal end of the drain is then connected to the underwater drainage system.
- The chest drain is then secured by tape, and/or anchoring sutures, and an appropriate dressing. Knots tend to slip on the plastic tubing so use tape as well as sutures unless you are proficient in this technique.
- Re-examine the chest to ensure the patient has not deteriorated.
- Repeat the chest radiograph to confirm correct tube placement with all the side holes inside the pleural cavity, no kinking and resolution of the pneumothorax. If required, remove the dressing and/or sutures and reposition the drain.
- Do not clamp the drain when there is a massive haemothorax; this does not reduce bleeding but does reduce lung expansion.
- Give prophylactic antibiotics (a cephalosporin or clindamycin depending on local policy), at the time of insertion and for the first 24 hours afterward. This will reduce

### **Thoracic Injury**

the incidence of both emphysema and all other infectious complications by around 10%.

#### Complications:

- Bleeding (most commonly from injury of an intercostal artery);
- Malposition;
- Side hole in the subcutaneous tissue causing subcutaneous emphysema;
- Insertion into the peritoneum, bowel, liver, spleen
- Slippage out of the pleural cavity;
- Infection
- Damage to: lung parenchyma; mediastinal contents; neurovascular bundle; abdominal organs
- Bronchopleural fistula.

## Thoracic Injury

### Needle Percardiocentesis

#### Indications

Emergency decompression of a cardiac tamponade, ideally confirmed by echocardiography, no team member is competent to perform a thoracotomy and the patient is in extremis (i.e. about to die).

#### Equipment for Needle Percardiocentesis

- 14, 16g cannulas or specialised needle
- 20ml syringe
- 10 ml Saline
- Antiseptic skin prep solution
- ECG Monitor
- Three way tap
- Adhesive tape

#### Procedure

- If conscious inform patient about the procedure and obtain verbal consent.
- Ensure arrangements are being made for a thoracotomy.
- Connect a 20ml Syringe containing 10ml saline to a long 14-16g cannula with the needle still in place.
- Ensure IV access has been secured and the patient is connected to an ECG monitor.
- Clean and drape the chest wall and if time permits infiltrate local anaesthetic into the skin to the left of the xiphisternum, the subcutaneous tissue and the surrounding area.
- The skin is punctured 1-2cm below and left of the xiphoid process, using a long needle and cannula, at an angle of 45°.
- While aspirating continuously, advance the needle towards the tip (inferior angle) of the left scapula, watching the ECG.
- If the ECG monitor shows an injury pattern (e.g. ST depression or elevation) or an arrhythmia (e.g. ventricular ectopics), this indicates that the needle has been advanced too far and is touching the myocardium.
- Remove the metal needle and re-attach the syringe. If the injury pattern remains, withdraw the cannula (whilst aspirating) until a normal ECG is restored.



### **Thoracic Injury**

- Once in the pericardial sac, as much blood as is possible should be aspirated.
- As the pressure on the myocardium decreases, and, its filling increases, the myocardium may move towards the cannula tip and an injury pattern may recur.
- The cannula is then taped in place and a three way tap attached.
- The pericardial sac can be re-aspirated should the signs of tamponade recur.

An alternative technique is to insert a Seldinger wire through the cannula once it is in the pericardial sac. The cannula is then withdrawn and a larger calibre silicone catheter is inserted over the wire. This also avoids the need for repeated needle decompression.

### Complications

- Obstruction of the cannula by:
  - Blood
  - Tissue
  - Kinking
- Drainage of blood from subcutaneous vessels.
- Drainage of blood from cardiac chamber.
- Inability to aspirate blood because it has clotted within the pericardium and assuming there is no tamponade.
- Inability to drain a large collection.
- Requirement for repeated needle decompression.
- Bleeding (most commonly from an injury of an intercostal artery).
- Damage to the:
  - Myocardium
  - Coronary artery laceration
  - Lung
  - Abdominal viscera
- Cardiac arrhythmias, arrest and tamponade.
- Infection

## Abdominal Injury

### 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

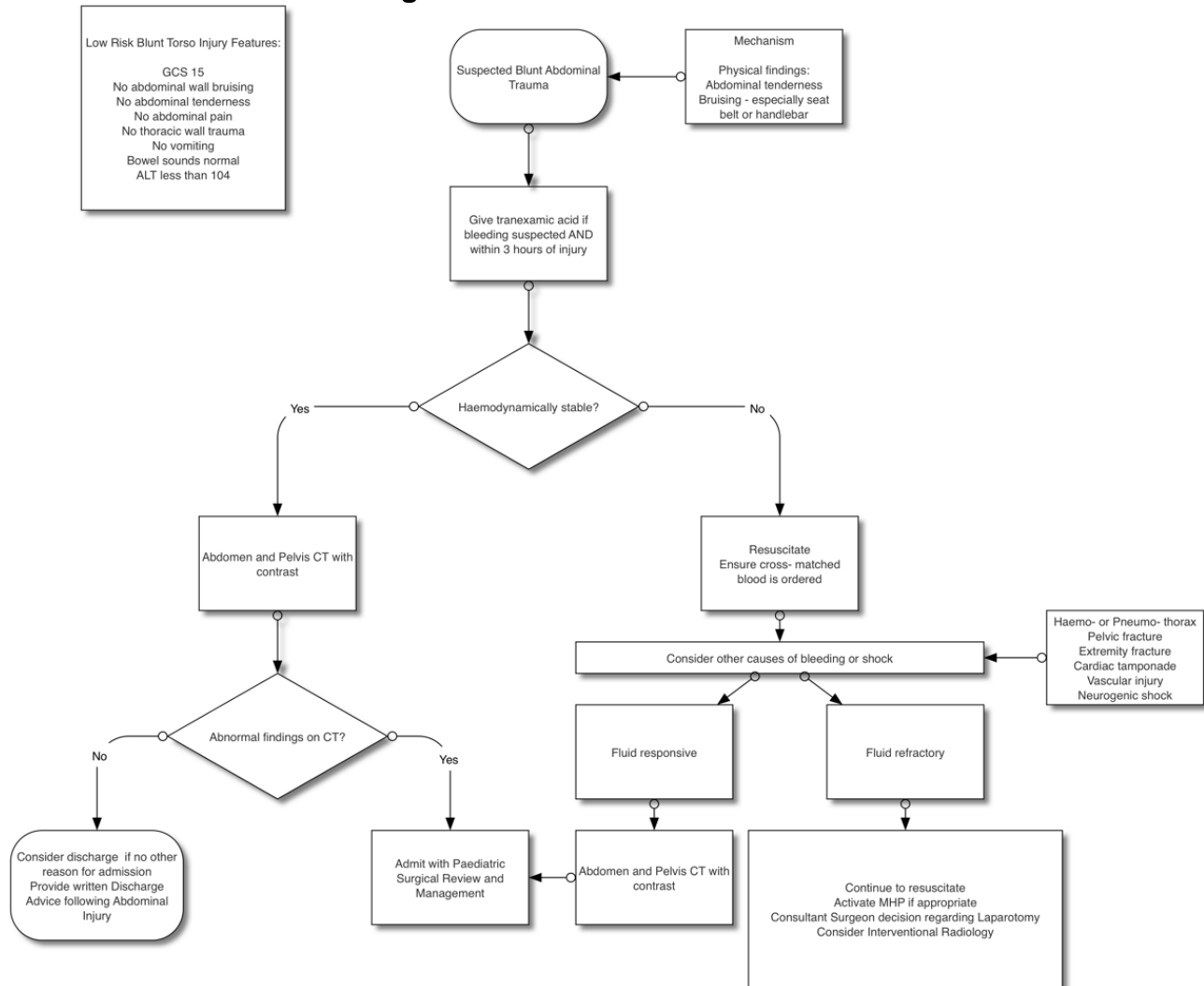
**The Paediatric Surgical Consultant should be present for all trauma laparotomies**

**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

## Abdominal Injury

### Blunt Abdominal Trauma Algorithm



### Penetrating Abdominal Trauma

**These cases should all be 'Trauma calls'. Please request a call if this has not already happened.**

#### Abdomen

1. Gunshot wounds (GSW) to the abdomen require a laparotomy although occasionally they can be tangential passing through soft tissue only; this is rare in the UK and a laparotomy is the most appropriate investigation. CT and occasionally plain x-rays have a role in stable patients to assess for associated fractures, foreign body retention and track of the round. Always check THOROUGHLY for an exit wound, which may be remote from the entry wound.
2. 'Stable' patients with stab wounds to the torso may undergo CT
  - o CT is a good investigation for stab wounds to the back
  - o With a completely normal CT the patient can be observed with regular clinical evaluation (2-3 hourly)
  - o Development of peritonitis requires a laparotomy
  - o Abnormal CT (free air, fluid etc) may require a laparotomy

## **Abdominal Injury**

- o CT is poor in patients with thoraco-abdominal wounds – these patients may require laparoscopy to exclude diaphragmatic injury
- o Evisceration or omental herniation requires a laparotomy

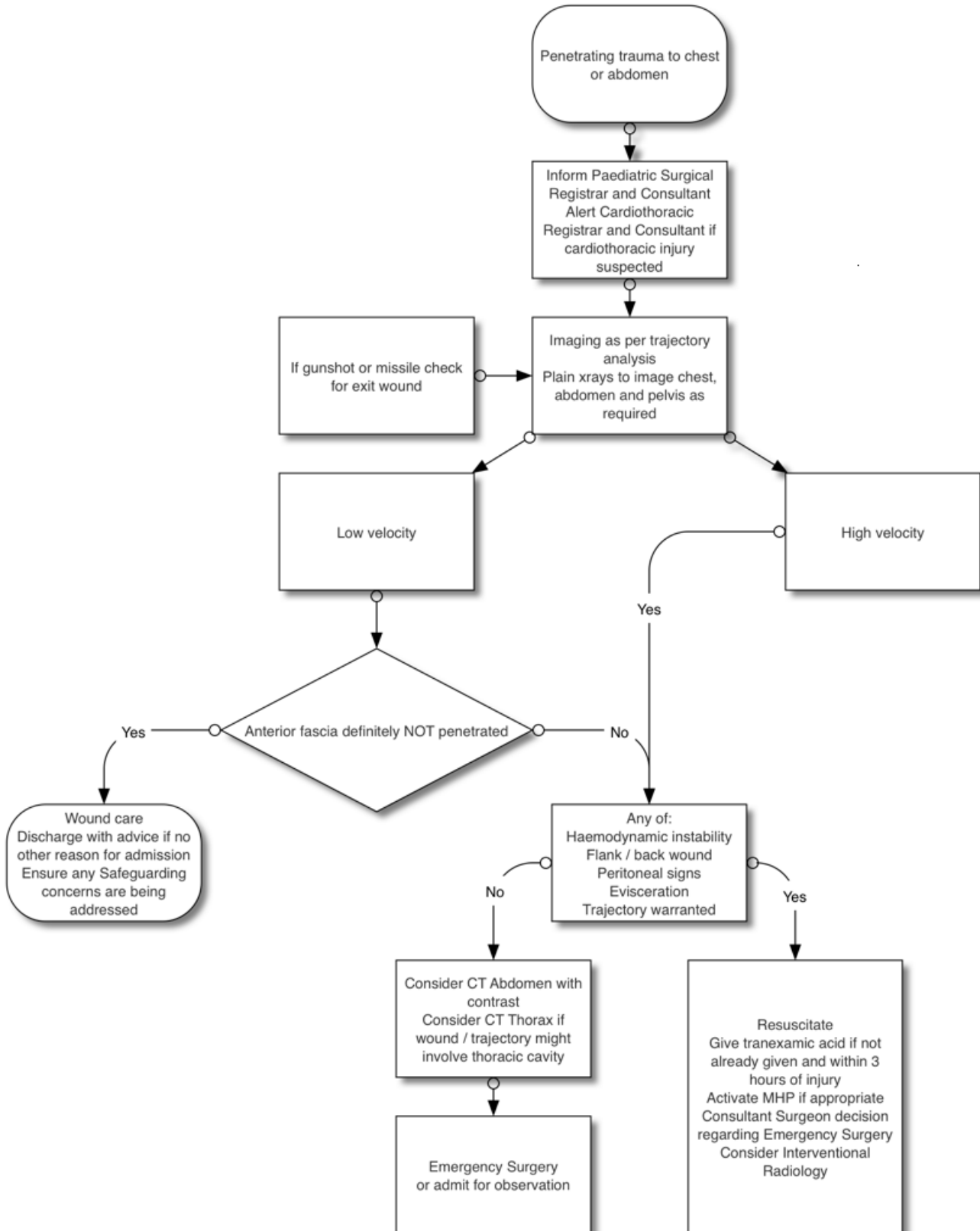
Do **NOT** remove retained weapons from the torso (or neck) in ED.

Do not forget pregnancy tests for all female patients aged over 10 however counselling for this investigation or obtaining a specimen should not delay appropriate emergency investigations and treatment.

### **PAEDIATRIC IMAGING OF ABDOMINAL TRAUMA-as per The Royal College of Radiologists-Paediatic Trauma Protocols**

## Abdominal Injury

### Penetrating Abdominal Trauma Algorithm



## Pelvic Injury Emergency Management of Severe Pelvic Fracture

### Guidelines

1. Call Trauma Team
2. Follow ATLS protocol – ABC's first
3. Protect the spine and pelvis at all times
4. If pelvic fracture suspected – splint pelvis with sheet or binder
5. Early pelvic CT is essential
6. Do not test pelvis for mechanical stability
7. Do not log-roll patient until pelvis is cleared or stabilised
8. Decision making is difficult
9. Call Secondary Trauma Team
10. Consider Interventional Radiology

### Associated Injuries

90% multiple injuries  
60% hypovolaemic shock  
>50% head injury

### Haemorrhagic shock

+

### Pelvic fracture

### Immediate pelvic splint

+/-

### Blood products/TXA

### Massive Transfusion Protocol

+/-

### Laparotomy/Embolisation

### ABC's First

'The first clot is the best clot'  
Reduce bleeding by:

- Careful patient handling
- Immobilising the pelvis
- Administer Tranexamic Acid
- Early blood transfusion
- Early clotting screen
- Early FFP/platelets
- Consider Factor VIIa

### AP Compression

- Open symphysis or vertical pubic rami fracture
- Pelvic brim open
- SI joint open
- No vertical migration



### Lateral Compression

- Horizontal pubic rami fracture
- Pelvic brim closed
- Posterior injury difficult to see
- Look at sacral foramina



### Vertical Shear

- Open symphysis or vertical pubic rami fracture
- SI joint open
- Vertical migration
- Associated with urethral injury-see urethrogram guidance-Appendix \*\*\*\*



## Pelvic Injury

### 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 mmHg: 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 quickly examine for open wounds in the perineum
6. If binder applied pre-hospital leave it, check position and obtain radiographs.
7. Hypotension: Activate massive transfusion protocol
8. Do NOT examine the pelvis for mechanical stability.
9. Do NOT logroll the patient until the pelvis is cleared or stabilised
10. Obtain an early pelvic radiograph (or immediate CT) to clear the pelvis.

**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

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

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

Retrograde urethrogram: use 50ml diluted (50% saline, 50% contrast) IV contrast medium in bladder syringe. Insert size 10 Foley catheter so that balloon is just past the meatus then gently inflate balloon with 5mls saline. Hold in place whilst assistant injects contrast into catheter and take AP pelvis xray.

- 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**



## Pelvic Injury



**BRITISH ORTHOPAEDIC ASSOCIATION**  
**STANDARDS for TRAUMA (BOAST)**  
 December 2008



### BOAST 3: PELVIC and ACETABULAR FRACTURE MANAGEMENT

#### Background and Justification

Major pelvic and acetabular fractures must be managed with an established trauma system with defined referral pathways. A mismanaged pelvic injury can lead to early death from haemorrhage or major disability while delayed or poor management of an acetabular fracture can lead to accelerated osteoarthritis and avoidable permanent hip dysfunction. 5-10% of pelvic fractures will have a major urological injury. The major fracture incidence has been estimated at 3 displaced acetabular fractures per 100,000 population per year.

**Inclusions:** Patients of all ages with displaced fractures of the pelvic ring or acetabular fractures.

**Exclusions:** Undisplaced fractures, isolated pubic rami fractures and pathological fractures.

#### Standards for Practice Audit:

##### Pelvic Ring Fractures and Dislocations:

1. Major pelvic (and acetabular) fractures and dislocations may be associated with major haemorrhage. The early application of a pelvic binder or crossed sheet will aid resuscitation and facilitate laparotomy if required. It may be necessary to replace this with an external fixator if there is an enforced delay in transfer.
2. In the presence of continuing haemorrhage, the urgent treatment must include early fresh frozen plasma, platelets and blood. If there remains ongoing haemodynamic instability, attributable to the pelvic injury, then the further treatment options are open pelvic packing and embolisation (where that expertise can be accessed).
3. After haemodynamic stabilisation, early CT scanning should be undertaken to define the pelvic injury. If CT scanning is available in the emergency department it should be carried out at a very early stage as long as it does not interfere with the primary resuscitation and treatment of haemorrhage.
- 4.\* A high index of suspicion of genito-urinary damage requires early contrast studies (cystography  $\pm$  CT and urethrography). Intra-peritoneal bladder tears, bladder neck involvement or penetrating bone fragments require open bladder repair; extraperitoneal injuries can be managed by urethral drainage. These all demand urgent urological input.
- 5.\* Open pelvic fractures, with wounds to the groin, buttock, perineum, vagina or rectum, require urgent bladder drainage by cystostomy tube and bowel diversion with an end-colostomy (with washout). These demand urgent senior general surgical and urologist input. Any colostomy should be sited in an upper abdominal quadrant remote from potential definitive pelvic surgical fixation approaches.
- 6.\* Posterior urethral injuries identified by urethrography should be managed initially by open or ultrasound-guided suprapubic catheterisation. Subsequently, when necessary, definitive repair by delayed urethroplasty will be part of specialist care.
7. Following haemodynamic and temporary skeletal stabilisation, a definitive plan for pelvic reconstruction needs to be formulated and carried out by a specialist pelvic surgeon as soon as possible and ideally within five days.
8. Image transfer to a hospital specialising in pelvic surgery should occur within 24 hours of presentation for initial treatment advice and to facilitate a coordinated prompt transfer if required. The specialist unit should have all the surgical disciplines to meet the treatment needs of these patients, who often have multi-system injuries.
9. Patient follow-up should occur in the specialist pelvic units to ensure full advice is available for the pain, physical, urological and sexual disabilities which are common outcomes.

##### Acetabular Fractures:

10. Hip dislocations must be reduced urgently and then an assessment of stability recorded. The neurovascular status before and after reduction must be documented. Skeletal traction should be applied. If the hip remains irreducible or unstable, then urgent advice should be sought from a specialist in acetabular reconstruction. Immediate transfer should be considered.
11. Following reduction of all hip dislocations, a CT scan must be done within 24 hours to exclude bony entrapment and to assess hip congruence and the extent of any fracture. These images should be referred to an expert in acetabular fracture reconstruction promptly to secure an urgent transfer for surgery if required.
12. Displaced fractures requiring reduction and internal fixation should undergo surgery by an acetabular reconstruction expert as early as possible, ideally within five days but no later than 10 days from injury.
13. Chemical thromboprophylaxis should start within 48 hours of injury providing there are no contraindications.

#### Evidence Base:

Predominantly retrospective case series but also prospective cohort studies. Guidance consistent with the evolved international consensus over 20 years.

\* European Urological Association, Guidelines on Urological Trauma 2003.

#### Limitations:

The potential of pharmacotherapy (e.g. rFactor VII) in major pelvic haemorrhage is yet to be validated.

## Pelvic Injury

BRITISH ORTHOPAEDIC ASSOCIATION  
AUDIT STANDARDS for TRAUMA

August 2016

THE BRITISH ASSOCIATION  
OF UROLOGICAL SURGEONS**BOAST 14: THE MANAGEMENT OF UROLOGICAL TRAUMA  
ASSOCIATED WITH PELVIC FRACTURES****Background and Justification:**

Urological trauma is rare and the incidence of severe urethral trauma is 1/million population/year. The majority of cases are due to blunt high-energy trauma with associated multi-system injuries and 80% of these cases are associated with pelvic fractures. Urological injuries are potentially fatal and can result in severe long-term disability.

**Inclusions:** Patients of all ages with potential bladder or urethral trauma.

**Standards for practice audit:**

1. All Major Trauma Centres and Trauma Units should have agreed written guidelines for the management of suspected urological trauma and these must be easily available within the Emergency Department.
2. All patients suffering high-energy trauma must have examination of the perineum and genitalia plus a rectal examination and the findings recorded in the medical records.
3. A single, gentle attempt at catheterization, by an experienced doctor, is permissible, even if the clinical or CT findings suggest urethral injury. In adults a 16F soft, silicone catheter should be used. The procedure and the presence of clear or blood stained urine must be recorded in the medical records.
4. The finding of blood stained urine mandates a retrograde cystogram via the catheter.
5. If the catheter will not pass or passes and drains only blood, do NOT inflate balloon. Withdraw catheter and perform a retrograde urethrogram.
6. If there is a urethral or bladder injury, the on-call urologist should be informed immediately so that a treatment plan can be formulated and recorded in the notes.
7. If a urethral catheter cannot be passed, a suprapubic catheter is required. This can be inserted during emergency laparotomy but otherwise a percutaneous suprapubic catheter should be placed.
8. A percutaneous, suprapubic catheter should be placed using a Seldinger technique under ultrasound control by a doctor experienced in this technique. The skin insertion point MUST be in the midline and should be 3 to 4 fingers-breadths above the symphysis. A 16F silicone catheter should be used.
9. The placement of a suprapubic catheter may alter the timing of pelvic fracture surgery and so the pelvic fracture service should be involved at an early stage.
10. If there is a urine leak from either the bladder or urethra, the pelvic fracture should be treated like an open long-bone fracture with appropriate antibiotics for 72 hours and early fracture fixation if the patient's physiology allows.
11. Intra-peritoneal bladder rupture requires emergency laparotomy and direct repair.
12. Extraperitoneal rupture of the bladder may be treated by catheter drainage alone. However, in the presence of an unstable pelvic fracture, it is recommended that fracture reduction and fixation is performed along with primary repair of the bladder.
13. Extraperitoneal rupture of the bladder neck continues to leak even in the presence of a catheter and requires primary repair.
14. Bladder injuries identified during pelvic fracture surgery should be repaired at the same time and bladder drainage (via urethral or suprapubic catheter, as appropriate) ensured.
15. Bladder injury in children is rare but often more complex than adults. A paediatric urologist should always be involved early in the care of these injuries.
16. All urethral injuries in females and children must be discussed at a very early stage with the appropriate supra-regional specialist in urology.
17. The indications for primary (within 48 hours) urethral repair are: associated ano-rectal injury, perineal degloving, bladder neck injury, massive bladder displacement and penetrating trauma to the anterior urethra.
18. The recommended definitive treatment for urethral rupture in adult males is delayed repair at 3 months post injury. Each MTC should have a clear referral pathway to a recognised centre for reconstructive urethral surgery with a named urological lead consultant.
19. Primary re-alignment of the urethra during fracture surgery is not recommended as, in the hands of an inexperienced (urethral) surgeon, the risk of additional damage probably out-weighs the benefits. Accurate reduction of the bony pelvic ring indirectly re-aligns the urethra and facilitates delayed repair.
20. Male and female patients suffering displaced anterior pelvic fractures or urethral injury have a high incidence of urinary and sexual dysfunction. All patients should be provided with a written information sheet on this issue.
21. All Major Trauma Centres must have a linked Andrological service and all patients with displaced anterior pelvic fractures should be offered access to this service.
22. Hospitals receiving patients with these severe injuries must be part of the Trauma Audit and Research Network (TARN) and all centres performing delayed urethral reconstruction should participate in the national audit of this procedure.

## Pelvic Injury

### 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

#### Treatment Algorithm

1. Initial primary survey assessment
2. Control external haemorrhage<sup>1</sup>
3. Administer analgesia
4. Assess and document neuromuscular status<sup>2</sup>
5. Remove GROSS contamination from wound\*
6. Photograph and cover wound<sup>3</sup>
7. Straighten and align limb\*<sup>4</sup>
8. Splint fracture<sup>4</sup>
9. Administer IV antibiotics<sup>5</sup> +/- tetanus
10. Obtain radiographs
11. Notify:
  - Orthopaedic Registrar
  - Plastics<sup>6</sup>
  - +/- Vascular surgery<sup>1</sup>

\* If appropriate and indicated

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.
2. Palpate and mark dorsalis pedis +/- posterior tibial pulses. 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. Cefuroxime 50mg/kg (max 1.5g) initial dose then 30mg/kg (max 750mg) 8 hourly. In presence of penicillin allergy use clindamycin 6.25mg/kg (max 600mg) 6 hourly. Add gentamicin for Gram negative cover and metronidazole for anaerobic cover.

### **Limb Injury**

6. 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.

## Limb Injury



BRITISH ORTHOPAEDIC ASSOCIATION and  
BRITISH ASSOCIATION OF PLASTIC, RECONSTRUCTIVE  
AND AESTHETIC SURGEONS  
STANDARD for TRAUMA – 2009



BAPRAS  
British Association of Plastic  
Reconstructive and Aesthetic Surgeons

## BOAST 4: THE MANAGEMENT OF SEVERE OPEN LOWER LIMB FRACTURES

### Background and Justification:

The British Orthopaedic Association and the British Association of Plastic, Reconstructive and Aesthetic Surgeons have reviewed their 1997 guidance and now publish a review of all aspects of the acute management of these injuries using an evidence-based approach, leading to the "Standards for the Management of Open Lower Limb Fractures," which are free to download from [www.boa.ac.uk](http://www.boa.ac.uk) and [www.bapras.org.uk](http://www.bapras.org.uk). This BOAST is derived from these standards. Contrary to traditional teaching, best outcomes are achieved by timely, specialist surgery rather than emergency surgery by less experienced teams.

### Included Patients:

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

- Fracture Pattern:
- Multifragmentary (comminuted) tibial fracture with fibular fracture at same level
  - Segmental fractures
  - Fractures with bone loss, either from extrusion or after debridement
- Soft tissue injury:
- Swelling or skin loss, such that direct, tension-free wound closure is not possible
  - Degloving
  - Muscle injury that requires excision of devitalised muscle via wound extensions
  - Injury to one or more major arteries of the leg
  - Wound contamination with marine, agricultural or sewage material

### Standards for Practice Audit:

1. Intravenous antibiotics are administered as soon as possible, ideally within 3 hours of injury: Co-amoxiclav (1.2g) or Cefuroxime (1.5g) 8 hourly and are continued until wound debridement. Clindamycin 600mg, 6 hourly if penicillin allergy
2. The vascular and neurological status of the limb is assessed systematically and repeated at intervals, particularly after reduction of fractures or the application of splints
3. Vascular impairment requires immediate surgery and restoration of the circulation using shunts, ideally within 3-4 hours, with a maximum acceptable delay of 6 hours of warm ischaemia
4. Compartment syndrome also requires immediate surgery, with 4 compartment decompression via 2 incisions (see overleaf)
5. Urgent surgery is also needed in some multiply injured patients with open fractures or if the wound is heavily contaminated by marine, agricultural or sewage matter.
6. A combined plan for the management of both the soft tissues and bone is formulated by the plastic and orthopaedic surgical teams and clearly documented
7. The wound is handled only to remove gross contamination and to allow photography, then covered in saline-soaked gauze and an impermeable film to prevent desiccation
8. The limb, including the knee and ankle, is splinted
9. Centres that cannot provide combined plastic and orthopaedic surgical care for severe open tibial fractures have protocols in place for the early transfer of the patient to an appropriate specialist centre
10. The primary surgical treatment (wound excision and fracture stabilisation) of severe open tibial fractures only takes place in a non-specialist centre if the patient cannot be transferred safely
11. The wound, soft tissue and bone excision (debridement) is performed by senior plastic and orthopaedic surgeons working together on scheduled trauma operating lists within normal working hours and within 24 hours of the injury unless there is marine, agricultural or sewage contamination. The 6 hour rule does not apply for solitary open fractures. Co-amoxiclav (1.2g) and Gentamicin (1.5mg/kg) are administered at wound excision and continued for 72 hours or definitive wound closure, whichever ever is sooner
12. If definitive skeletal and soft tissue reconstruction is not to be undertaken in a single stage, then vacuum foam dressing or an antibiotic bead pouch is applied until definitive surgery.
13. Definitive skeletal stabilisation and wound cover are achieved within 72hours and should not exceed 7 days.
14. Vacuum foam dressings are not used for definitive wound management in open fractures.
15. The wound in open tibial fractures in children is treated in the same way as adults

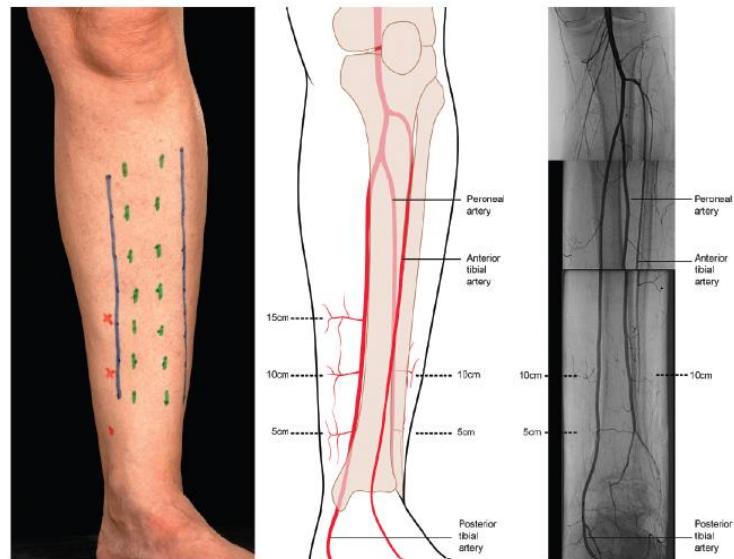
## Limb Injury

### Evidence Base:

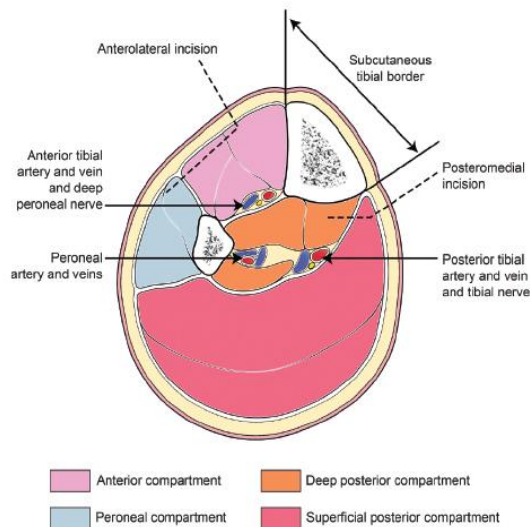
Derived from the 2009 BOA/BAPRAS Standards for the Management of Open Lower Limb Fractures. This is based upon case series, case-controlled studies and reviews together with an evolved, multi-national, professional consensus over 15 years.

### Limitations:

There is inconclusive evidence to the best method of skeletal stabilisation.



**Recommended incisions for fasciotomy and wound extensions.** (a) Margins of subcutaneous border of tibia marked in green, fasciotomy incisions in blue and the perforators on the medial side arising from the posterior tibial vessels in red. (b) line drawing depicting the location of the perforators. (c) montage of an arteriogram. The 10cm perforator on the medial side is usually the largest and most reliable for distally-based fasciocutaneous flaps. In this patient, the anterior tibial artery had been disrupted following an open dislocation of the ankle; hence the poor flow evident in this vessel in the distal 1/3 of the leg. The distances of the perforators from the tip of the medial malleolus are approximate and vary between patients. It is essential to preserve the perforators and avoid incisions crossing the line between them.



Cross-section through the leg showing incisions to decompress all four compartments

## Limb Injury



BRITISH ORTHOPAEDIC ASSOCIATION

STANDARDS for TRAUMA (BOAST)

Sept 2012



BAPRAS British Association of Plastic  
Reconstructive and Aesthetic Surgeons

BSSH

The British Society for Surgery of the Hand

### BOAST 5: PERIPHERAL NERVE INJURY

All surgeons undertaking Musculoskeletal Trauma Surgery will be involved in the management of peripheral nerve injury, either as a result of injury or a postoperative complication. Nerve repair and complex nerve injuries (e.g. brachial plexus) is now a specialist field but all surgeons involved in trauma surgery must be able to diagnose nerve injuries and identify those that need referral to a specialist. These audit standards have been distilled from the recent BOA blue book on peripheral nerve injury which provides evidence-based guidelines for management.

- A careful examination of the peripheral nervous and vascular systems must be performed and clearly recorded for all injuries. This examination must be repeated and recorded after any manipulation or surgery.
- If a laceration is near a nerve or associated with a neurological deficit, the urgent advice of a surgeon who treats nerve injuries should be obtained.
- If a nerve injury is present with an unstable fracture or dislocation, the urgent priority (after life-saving interventions) is reduction and stabilisation of the skeleton.
- When internal fixation of a fracture associated with a nerve injury is performed, in general, the nerve must be explored. Possible exceptions are an axillary nerve palsy associated with low-energy shoulder trauma and sacro-iliac screw fixation with a lumbosacral plexus injury.
- If a nerve is explored during fracture surgery, this must be clearly recorded in the operation record including an indication of the nerve's relationship to any internal fixation device.
- Nerves will occasionally be damaged during surgery and recognition and urgent treatment is essential. Basic science evidence strongly supports very urgent repair as this will give the best possible outcome.
- If a divided nerve is found at surgery, and the surgeon does not have the skills to perform a definitive repair, the nerve ends should be gently opposed with fine, coloured sutures. The patient should then be discussed with a surgeon experienced in nerve repair.
- When a nerve or vascular deficit is identified following surgery, immediate measures include loosening bandages, splitting Plaster of Paris splints (to the skin) and gentle repositioning of the limb. If these measures are ineffective, a senior surgeon should be alerted to decide whether urgent re-exploration is required.
- Painful, postoperative paralysis must be explored urgently. It may be due to compartment syndrome or nerve compression from bone fragments, suture, haematoma or hardware.
- Pain and progressing loss of sensation is the hallmark of critical ischaemia. Immediate surgical exploration is required. By the time paralysis occurs it is too late.
- Neurophysiological investigations are rarely needed in the acute injury and requesting neurophysiology must not delay referral or treatment. MRI is not essential before surgery but can assist in preoperative planning. Referral or surgery should not be delayed to wait for a scan.
- Brachial plexus injuries should be discussed with a plexus/complex nerve injury specialist within 3 days of injury, or sooner if possible.

#### Evidence Base:

Predominantly retrospective case series but with good expert reviews and an evolved, multi-national, professional consensus over 15 years.



## Limb Injury



BRITISH ORTHOPAEDIC ASSOCIATION

STANDARDS for TRAUMA (BOAST)

February 2014

BAPRAS  
British Association of Plastic  
Reconstructive and Aesthetic Surgeons

OF GREAT BRITAIN AND IRELAND

## BOAST 6: MANAGEMENT OF ARTERIAL INJURIES ASSOCIATED WITH FRACTURES AND DISLOCATIONS

### Background and Justification

Arterial injuries to the extremities are rare and present a diagnostic and management challenge if limb salvage is to be successful. In civilian practice, fast and accurate diagnosis is of paramount importance. There should be immediate referral to a surgeon with the skills to perform vascular repair. A low threshold for early surgical intervention is important for successful salvage. The responsibility for managing these cases lies jointly with the orthopaedic surgeon and the team managing the vascular injury.

**Inclusions:** Patients of all ages with vascular injuries to the extremity.

#### Standards for Practice Audit

1. Resuscitation and management of all life threatening injuries must take priority over any extremity problems.
2. Active extremity haemorrhage must be controlled immediately by direct pressure or tourniquet. Blind clamping in wounds is discouraged and potentially detrimental.
3. Neurovascular injury should be assumed in all injured extremities until definitively excluded; this is a diagnostic priority. The findings of neurovascular examination must be documented as a timed entry in the medical records.
4. The pulseless, deformed limb should be re-aligned and any dislocations reduced under appropriate sedation or anaesthesia. The limb should be splinted, the neurovascular examination repeated and documented and appropriate radiological imaging obtained. In many cases, the circulation will be restored.
5. The clinical signs of vascular injury may be difficult to identify. Key signs include altered sensation, expanding haematoma and absent pulse(s). The pink, pulseless limb must be assumed to have an arterial injury until proven otherwise. Capillary return can be misleading due to pooling of blood in the extremity.
6. A devascularised limb requires urgent surgical exploration; this should only be delayed to treat life-threatening injuries.
7. Some injuries will not be salvageable: patients must be made aware that there is a high risk of amputation. A decision to perform early amputation should be made by two consultants.
8. All Trauma Units and Major Trauma Centres must have a clear emergency referral protocol to the appropriate vascular surgical team (plastic, vascular, general, or hand surgery). Consultants in orthopaedics and from the appropriate vascular team must be involved from the time of diagnosis.
9. The limb must be revascularised as a surgical emergency. Beyond 3-4 hours, warm ischaemia results in irreversible tissue damage and an increasing risk of amputation. Risks of delayed revascularisation include myoglobinuria and may be associated with increased mortality. Access incisions should be planned to facilitate subsequent soft tissue coverage of open fractures.
10. Imaging modalities include duplex, angiography, CT angiogram and on-table angiogram. Access to these must not significantly delay reperfusion surgery and the injury pattern usually predicts the level.
11. The sequence of surgical interventions can be crucial. In general, vascular perfusion should be restored using temporary shunts followed by assessment of viability. Skeletal stabilisation should then be performed, followed by definitive reconstruction with autologous vein grafts.
12. Any peripheral nerve injury identified at the time of surgery should be carefully documented and the patient referred early to the appropriate specialist. If the expertise is available, ideally peripheral nerves should be repaired.
13. The risk of compartment syndrome is high following reperfusion and there should be a low threshold for performing fasciotomies. The incisions should aim to preserve perforating vessels.
14. Post-operative care should be provided 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 and reviews.

## Limb Injury



**BRITISH ORTHOPAEDIC ASSOCIATION  
STANDARDS FOR TRAUMA (BOAST) ©**



**BAPRAS**  
British Association of Plastic  
Reconstructive and Aesthetic Surgeons



## 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

#### PAEDIATRIC BURN REFERRAL CRITERIA AND GUIDELINES – June 2012 v1.0

##### NON-COMPLEX BURN

\* Complete and Fax NBCN Non-Complex Burn Referral Form \*

**Size:** 2-10% TBSA >1 and <16 years old

**Wound healing:** Any wound unhealed at 7 days

**Rehabilitation:** Any healed wound where scarring suggests that there may be a significant aesthetic/functional impact, loss of function or psychological disturbance

##### MUST GIVE

**IV Resuscitation Fluids:** All children with burns  $\geq 10\%$  TBSA will receive fluid according to the Parkland Formula:-  
3 ml/kg/% burn over 24 hrs from time of injury given  $\frac{1}{2}$  in the 1<sup>st</sup> 8 hrs &  $\frac{1}{2}$  in the 2<sup>nd</sup> 16 hours given as Hartmann's solution.

##### AND

**IV Maintenance Fluids:** 100ml/kg over 24hrs from time of injury for 1<sup>st</sup> 10kg, plus 50ml/kg over 24hrs for 2<sup>nd</sup> 10kg, plus 20ml/kg over 24hrs for each additional kg. Give as 0.45% Sodium Chloride and 5% Glucose solution or a suitable local alternative

**Analgesia:** Ensure adequate analgesia is given prior to intervention/transfer. Discuss with burn service

**Catheterisation:** All children with burns  $\geq 10-15\%$  TBSA and/or burns to genitalia should have an appropriate size catheter.

**Infection: Toxic Shock Syndrome / Burn Sepsis Syndrome**  
Observe for 2 of the following:

- Temperature  $>38^{\circ}\text{C}$
- General malaise
- Rash
- Hypotension
- Diarrhoea and vomiting
- Not eating or drinking
- Tachycardia / tachypnoea

**Suspected Inhalation Injury:** If there is a suspected inhalation injury, give oxygen (15 litres via non-re-breathe mask and bag) and seek anaesthetic review

##### COMPLEX BURN

\* Complete and Fax NBCN Complex Burn Referral Form \*

**Total Body Surface Area (TBSA)/Depth:**

$\geq 10\%$  (<16 years)

$>1\%$  TBSA Deep Dermal burn (all children <1 year)

All Full Thickness burns  $>$ size of a patients finger tip

**Any depth and size of the following:**

**Mechanism:** All burns associated with chemical or electrical injuries, exposure to ionising radiation or high pressure steam, or suspicion of non-accidental injury

**Site:** Buttocks, nappy area, perineum, facial, neck, hands, feet, joints or flexural creases  
All circumferential burns

**Existing Conditions:** Burn wound infection, congenital conditions or significant medical conditions

**Associated Injuries:** All burns associated with inhalation or trauma

**Progressive Non-Burn Skin Loss:** Blistering skin disorders e.g. Toxic Epidermal Necrolysis, Staphylococcal Scalded Skin Syndrome, and Stevens-Johnson syndrome

##### FLUID GUIDELINES

$<10\%$  encouraged to have oral fluids unless NBM

$\geq 10\%$  cannula, resus fluids and maintenance

**Contact Burn Unit for advice re: NBM, sedation, analgesia and future fluids**

**For cases that do not meet the criteria for referral:**

**Continue** local care and give advice to observe for signs of infection. Refer on if unhealed at 7 days

**Discharge** when wound healed, with written advice to moisturise and protect from sun until healed skin loses pink colour

##### MEETS CRITERIA FOR REFERRAL – CALL LOCAL BURN SERVICE

Newcastle: 0191 2826011 / 0191 2829009  
Liverpool: 0151 252 5400

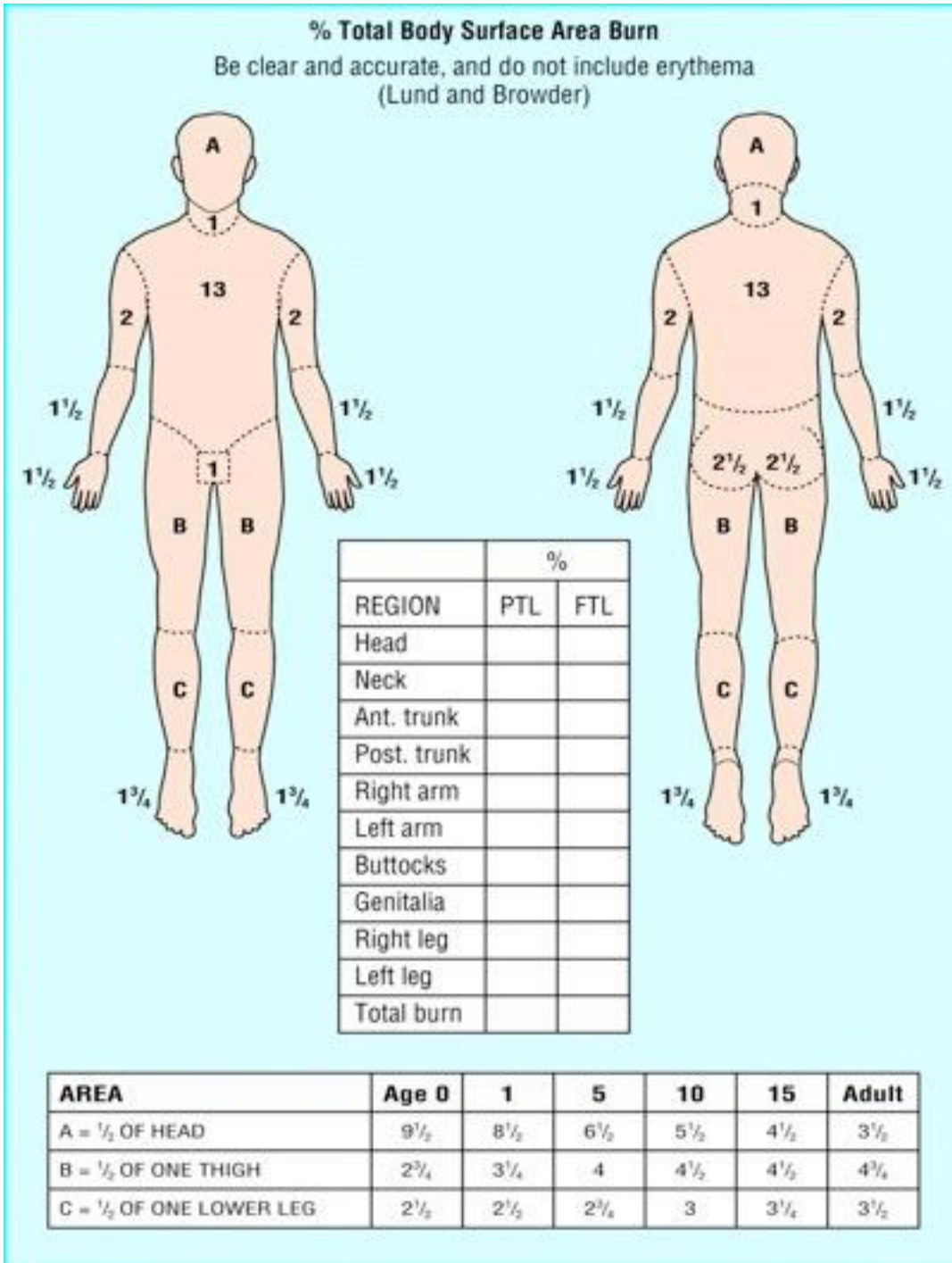
Manchester: 0161 701 8100  
Wakefield: 01924 541931

Sheffield: 0114 2260694

## Burn Injury

### Burns Assessment Chart

For children a Lund and Browder chart is used:



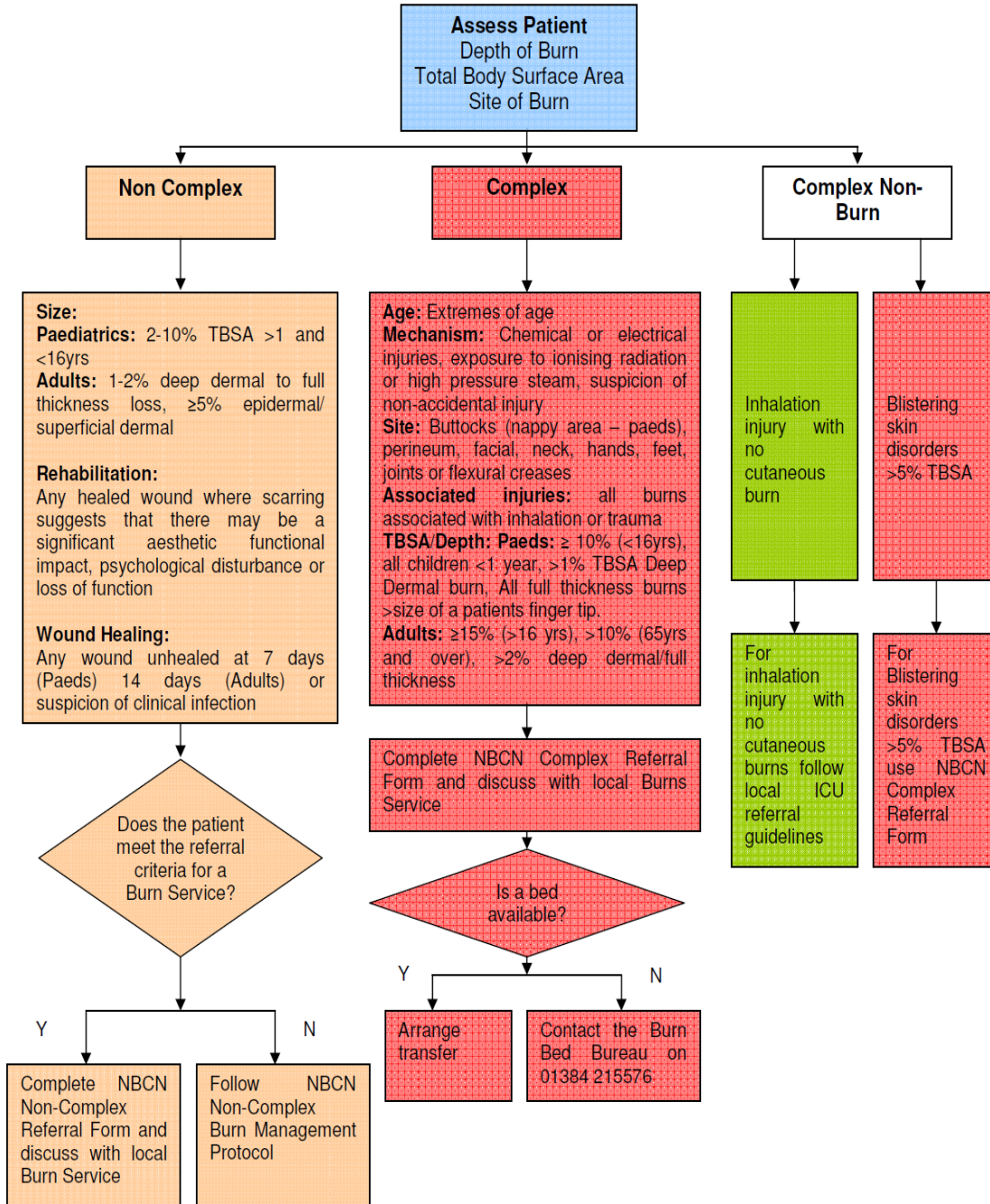
## Burn Injury

### Referral to Specialist Burns Service

Northern Burn Care Network  
North of England, North Wales & Isle of Man



NBCN Burn Referral Flowchart – V1.0 June 2012



## Burn Injury

### Electrical burns

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 as 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 rhabdomyolysis
- 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 drowning's 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<sub>2</sub>O 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°C, use active warming measures. Above 32°C, warm passively.

Rate of warming should be 1°-2° per hour until core temperature is 33-36°C.

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

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

## Trauma in Pregnancy

### Trauma in Pregnancy

The priority is to resuscitate the mother. Uterine compression of the inferior vena cava can occur from 20 weeks gestation. It is essential to either manually displace the uterus to the left or to raise the patient by 10-12cms on the right side whilst on the spinal board. 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 mothers 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 periarrest or perimortem caesarean section within four minutes of the arrest with delivery by five minutes refer to local standard operational policy.

Fetal 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 fetal 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.



## Safeguarding

### Safeguarding Children Following Major Trauma

#### Management of Child Protection concerns in the Emergency Department

1. If any member of staff has child protection concerns about any child attending the ED the ED senior doctor and nursing shift leader on duty must be informed.
2. If a child seen in the ED requires a medical paediatric opinion for child protection concerns the child must be referred to the general paediatric registrar or consultant on call as per local Standard Operational Policy.
3. If there is any difficulty of difference of opinion regarding a child protection referral this should be escalated to the ED consultant on call and the paediatric consultant on call as per local Standard Operational Policy
4. All children under the age of 12 months presenting to the ED with injury must be discussed with the senior ED doctor (middle grade or consultant). If there are concerns that the injury may have be non-accidental or secondary to neglect then a safeguarding assessment must be sought from the general paediatric registrar (or consultant on call). All non-mobile infants presenting with oral injuries must be referred for child protection medical assessment. All non – mobile infants presenting with unexplained bruising must be referred for child protection medical assessment refer to local Standard Operational Policy
5. 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 general paediatrics for the child protection assessment refer to local Standard Operational Policy.
6. Adequate assessment for a young child presenting with an injury to the ED requires sufficient detail to be able to formulate an opinion as to the relative likelihood of the injury being accidental, inflicted or neglectful. Core information required in respect of the event is:
  - When, where and how it occurred;
  - Who was present;
  - The developmental ability of the child;
  - In relation to falls – the height of the fall and the type of surface onto which the child landed.
7. This information should be documented in the notes.  
 For ALL children under 12 months presenting with injury, the medical documentation MUST specifically note the presence or absence of safeguarding concerns and any actions taken.
8. All pre-mobile children presenting with femoral fractures MUST be referred for Child Protection Medical Assessment-refer to local Standard Operational Policy.

## Safeguarding

### Non – Accidental Injuries

It is important when dealing with any child to have an awareness of non-accidental injury. There are clues in the history; an unexplained delay in presentation, injury incompatible with history or a change in the story over time. In the resuscitation there are sometimes indicators of possible concern watching the interaction of the parents with the child and the parents' behaviour. Occasionally the appearance of the child can be cause for concern or the child may disclose physical abuse if given the opportunity.

During the examination, certain injuries should raise suspicion; rib fractures in an infant, long bone fractures in a non-mobile child, or metaphyseal or epiphyseal injuries, which are often multiple. It is important when examining burns or scalds to ensure that the injury distribution is compatible with the mechanism. Sometimes suspicion is only raised following imaging, when old fractures are identified or there is evidence of healing.

Non-accidental injuries must be considered but it is important to put all the factors together carefully to avoid any unnecessary distress for the family with an inappropriate accusation. However, if there are concerns, it is vital that they are explored, to ensure the well-being and safety of the child that is being treated, and any siblings still at home.

### Alcohol/Substance Abuse/Risk Taking Behaviours

Young people may engage in risk-taking behaviour for all sorts of reasons. Their actions may put themselves, or others, at risk of harm. Consideration must be given to the reasons why this behaviour is occurring and what context it is happening in. Decisions can then be made as to the appropriate level of intervention required.

Many adolescents move through a phase where they experiment with life and push organisational and parental boundaries and it can be argued that this is in some way necessary for a successful transition into adulthood. However there can be harmful consequences for children and young people drinking alcohol i.e:

- Alcohol fuelled violence or assault
- Injury as a result of intoxication
- Sexually transmitted infection / pregnancy due to unprotected sexual relations
- Criminality

As a front line practitioner the key objective is to recognise and act when the boundaries are pushed to such an extent that the young person's behaviour becomes detrimental or dangerous. A thorough history taking should include detail of what was drunk, in what volume, with whom, where and at what time of day. It is also relevant to document who brought the individual to hospital.

Any young person under the age of 18 years who attends Accident & Emergency Departments or other hospital services and there are concerns that they have been using alcohol or drugs should be notified to the relevant drug/alcohol service in the area that they live using the appropriate drug/alcohol referral form. This should be discussed with the young person and their parent/carer at the time of attendance –once the information has been passed to the relevant service it is then the young person and their family's choice if they wish to engage.

## Safeguarding

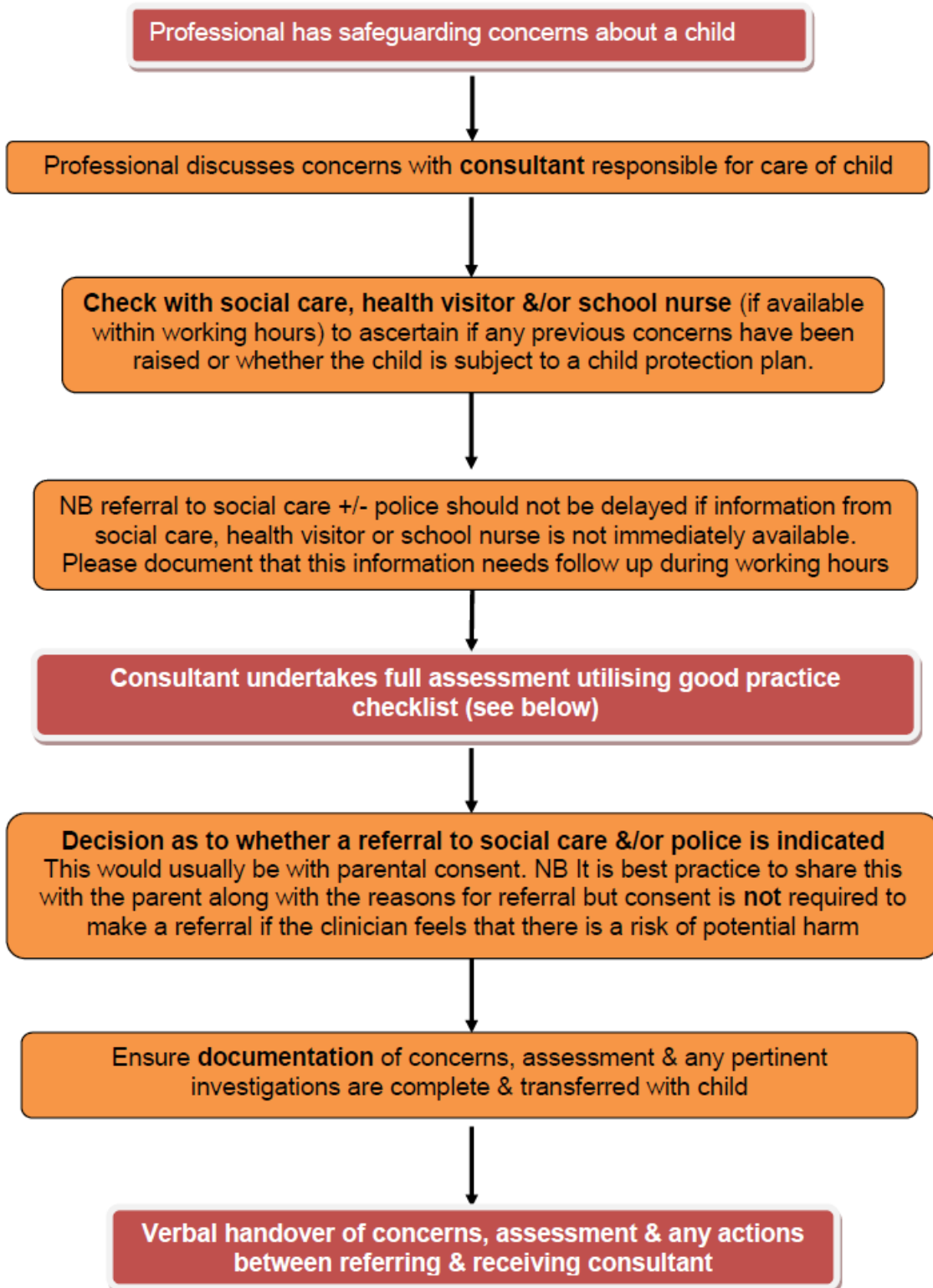
### Sharing Information

All safeguarding concerns must be passed on to the Trauma Team leader at the MTC at the time of referral. A copy of the Child's notes from the referring hospital should be sent with the child which should include details of the safeguarding concerns and actions to date with the names and contact numbers of professionals who have been contacted.

Safeguarding

**PROBABLE SAFEGUARDING CONCERNS**

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



## Safeguarding

### GOOD PRACTICE CHECKLIST - SAFEGUARDING

Information from Serious Case Reviews continues to highlight that when faced with the complex circumstances of a child's life, professionals find it difficult to keep the focus on the child 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:

Have you been able to speak to the child alone? Can you still do so?	
Is the child at immediate risk of harm (Physical, Sexual, Neglect, Emotional)	
Is there further information you do have about the child and their family? (However lack of information should not stop you making a referral, if you consider a child to be at risk.)	
Are there other children (siblings, peers) who could be at risk from harm?	
Is there a parent or carer at risk of harm? Does the parent or carer and the children have a safety plan?	
Is it safe to discuss your concerns with the child's parents or will doing so put the child at greater risk of harm?	
Is there a reason that makes it likely that the child will resist efforts to safeguard him/her (need for drugs)?	
Have you recorded everything that has been said to you by the child	
Have you recorded everything that has been said by the parent/family and other professionals?	
Have you recorded everything that you have said to others?	
Have you discussed your concerns with your agency nominated Safeguarding Children Lead? If not, have you been able to reflect on your concerns with a colleague (in your agency or another agency e.g. NWTs)	
If consent for a referral is not provided, the Children Act gives practitioners the authority to make a referral to Children's Social Care if they deem it necessary in the child's best interests. Parental consent is <b>not</b> a requirement. It is best practice for referral to be discussed and explained to parents or carers.	
Have you complied with your agency's child protection procedures?	
Is there a need to inform the police because a crime may have been committed?	
Have you considered a CAF assessment in this case?	
Has a CAF assessment been undertaken?	

## 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.

### Tertiary Survey

#### CHILDREN'S MAJOR TRAUMA MISSED INJURY FORM

Name: \_\_\_\_\_ Hospital No: \_\_\_\_\_ DOB: \_\_\_\_\_ Date: \_\_\_\_\_ Time \_\_\_\_\_

<b>Mechanism of injury:</b>					<b>Past medical history:</b>					
<b>Injuries:</b>					<b>Social history:</b>					
<b>Interventions:</b>										
<b>Vital signs</b>	<b>GCS</b>			<b>HR</b>	<b>RR</b>	<b>BP</b>	<b>Cap Refill</b>	<b>O2 Sats</b>	<b>O2</b>	<b>Temp</b>
	E:	V:	M:							

	Unable to Assess	Findings (Abnormal/Normal)	If Abnormal document the actions required
<b>Head/scalp - Inspect &amp; palpate</b>			
Lacerations/abrasions			
Swelling/haematoma			
<b>Face - Inspect &amp; palpate</b>			
Lacerations/abrasions			
Swelling/haematoma			
<b>Eyes - Examine</b>			
Eye Movement			
Pupil size/reaction			
Visual acuity			
<b>Mouth/nose/ears - Inspect</b>			
Teeth - abnormalities			
Teeth - Malocclusion			
CSF leak			
<b>C-Spine - Inspect &amp; Palpate</b>			
Pain/tenderness			
Swelling/haematoma			
Lacerations/abrasions			
Subcutaneous emphysema			
ROM: flex/ extn/lateral flex/rotation			
Radiologically cleared			
Clinically cleared			
<b>Chest - Inspect &amp; Palpate</b>			
Lacerations/abrasions			
Swelling/haematoma			
Paradoxical movement/flail			
Ribs			
Sternum			
Clavicle			
<b>Abdomen - Inspect &amp; Palpate</b>			
Pain/tenderness/guarding			
Swelling/masses			
Lacerations/Abrasions			
<b>Pelvis – Inspect</b>			
Radiologically cleared			
Bruising & Bleeding			
Lacerations/abrasions			
Swelling/haematoma			
Meatus			

## Tertiary Survey

Thoracic/Lumbar Spine - Inspect & Palpate			
Pain/tenderness			
Swelling/haematoma			
Lacerations/abrasions			
Subcutaneous emphysema			
ROM			

**Extremities - Mark on body map**  
Inspect and palpate for:  
Deformities  
ROM at joint  
Pain/tenderness  
Swelling/haematoma/lacerations/abrasions  
Pulses present? radial/femoral/pedal/dorsal

**MOTOR KEY MUSCLES**  
(scoring on reverse side)

(VAC) Voluntary anal contraction (Yes/No)

Comments:

Are there any safeguarding concerns in relation to:	Yes	No		Yes	No
Mechanism of injury			Risk taking behaviours		
Lack of supervision			Delay in presentation		
Neglect			Substance/alcohol abuse		
Other (please state):			Other (please state):		
<b>If safeguarding concerns raised referrals to be made to:</b>					
	Background Check		Referral		Completed by
	Yes	No	Yes	No	
Paediatrician					
Safeguarding Team					
Social Services					
Police					
Health Visitor / School Nurse					
GP					
School					
Other:					

COMPLETED BY:-

Sign & print name:- \_\_\_\_\_

GMC:

Date/time:



## 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 initiated 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, thromboprophylaxis, 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](http://www.nice.org.uk/guidance/ng40)

## References and Bibliography

### Death of a Child in the Emergency Department

In the unfortunate case of an unexpected death each emergency department must have their own local standards which will include:

- A local checklist based on national recommendations
- All children who die unexpectedly will be taken to the emergency department unless there is a need to preserve a crime scene
- A standard for supporting parents who witness resuscitation with a with an experienced member of staff
- The consultant paediatrician on call is advised as soon as possible about an unexpected child death
- Parents are offered an appointment to see the bereavement counselor swiftly and a relevant consultant at a suitable time interval
- There is co-operation with the Rapid Response Team and Child Death Overview panels

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.

## References and Bibliography

### 3. Equality Impact Assessment.

#### 4.1 Consultation

This guideline was originally developed with input from the North West Children's Major Trauma Network. The guidelines were circulated amongst the Royal Manchester Children's Hospital Major Trauma Steering Group prior to ratification. Consultation on this current version has been via Major Trauma Steering Group and with relevant professional groups.. All comments received have been reviewed and appropriate amendments incorporated.

#### 4.2 Approval

Royal Manchester Children's Hospital Major Trauma Steering Group

#### 4.3, 11 September 2018. Ratification Process

RMCH Quality and Safety Committee.

### 5. References and Bibliography

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

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Mehta B (2013). Alder Hey Children's Major Trauma System Standard Operating Procedures and Clinical Guidelines. Alder Hey Children's Hospital

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Water Incident Database – WAID (2014)  
<http://www.nationalwatersafety.org.uk/waid/index.asp>