

2018

**Clinical
Guidelines
for**

**Major
Incidents
and
Mass Casualty
Events**

Clinical guidelines for use in a trauma major incident or mass casualty event

Contents

Introduction

- Forewords
- Editorial note including key

Pre-event planning

- 1 v1 Major Incident awareness

Mechanism of injury (MOI)

- 1 v1 Ballistic injury
- 2 v1 Blast injury
- 3 v1 Crush injury
- 4 v1 Penetrating knife injury
- 5 v1 Chemical, biological, radiation and nuclear events (CBRN)

Major Incident STANDBY

- 1 v1 Major Incident STANDBY
- 2 v1 METHANE report

Major Incident DECLARED

- 1 v1 **Major Incident DECLARED**
- 2 v1 Clinical impact assessment call patient summary sheet

Emergency Department (ED)

- 1 v1 ED triage (adults)
- 2 v1 ED triage (paediatric <12 years)
- 3 v1 ED outcomes, discharges and follow up advice in Major Incident

ED Reception and Resuscitation

- 1 v1 Trauma team roles in a Major Incident
- 2 v1 Catastrophic haemorrhage and massive transfusion pathway in a Major Incident
- 3 v1 MI Senior clinical decision making
- 4 v1 MI Imaging (incl. CT whole body)

Injury management in ED

- 1 v1 MI anaesthesia for P1/Resus casualties
- 2 v1 MI neuro trauma (brain injuries)
- 3 v1 MI surgical/proximal haemorrhage control
- 4 v1 MI vascular trauma
- 5 v1 MI thoracic trauma
- 6 v1 MI abdominal trauma
- 7 v1 MI pelvic and long bone injuries
- 8 v1 MI immediate wound management
- 9 v1 MI universal fasciotomies

Specialty overviews

- 1 v1 Pain management in a Major Incident
- 2 v1 Antimicrobial prophylaxis in a Major Incident
- 3 v1 Blast ear and hearing loss in a Major Incident
- 4 v1 Blast lung in a Major Incident
- 5 v1 Burns in a Major Incident
- 6 Eye injuries in a Major Incident
- 7 v1 Forensic awareness in a Major Incident
- 8 v1 Head, face and neck injuries in a Major Incident
- 9 v1 Paediatric casualties in a Major Incident
- 10 v1 Management of a pregnant casualty in a Major Incident
- 11 v1 Psychosocial support for anyone affected by a Major Incident
- 12 v1 Psychosocial support for staff after a Major Incident
- 13 v1 Rehabilitation co-ordination and medical support in a Major Incident
- 14 Safe spinal injury care in a Major Incident
- 15 Bereavement care in a Major Incident

Appendices

- Glossary
- Links
- Acknowledgements

NHS England INFORMATION READER BOX

Directorate

Medical	Operations and Information	Specialised Commissioning
Nursing	Trans. & Corp. Ops.	Strategy & Innovation
Finance		

Publications Gateway Reference:

08649

Document Purpose	Guidance
Document Name	Clinical guidelines for major incidents and mass casualty events.
Author	NHS England
Publication Date	19 November 2018
Target Audience	Medical Directors, Directors of Nursing, Allied Health Professionals, Emergency Care Leads
Additional Circulation List	
Description	These guidelines have been created with the occasional trauma team in mind. They have been produced following the numerous major incidents which we've had to deal with over the last couple of years. They have been developed by experts in the subject areas from both civilian and military practice.
Cross Reference	N/A
Superseded Docs (if applicable)	Clinical guidelines for use in major incidents 2011
Action Required	N/A
Timing / Deadlines (if applicable)	N/A
Contact Details for further information	NHS England EPRR (National) 4W42 Quarry House Leeds LS2 7UE england.epr@nhs.net

Document Status

This is a controlled document. Whilst this document may be printed, the electronic version posted on the intranet is the controlled copy. Any printed copies of this document are not controlled. As a controlled document, this document should not be saved onto local or network drives but should always be accessed from the intranet.

Foreword

The clinical guidelines for use in major incidents and mass casualty events has been developed following a period of multiple incidents that have presented a range of challenging clinical scenarios such as blast injury, penetrating injury and the use of chemical agents, unlike those seen in day to day practice.

This guidance has been developed on behalf of the NHS to establish and share best practice in the clinical management of major incidents and mass casualty events, using experience from both military and civilian practice and lessons identified after the recent incidents, and to assist clinicians in managing these patients.

The intention is that this guidance will be regularly reviewed and re-issued as new developments based on an ever-increasing evidence base and experience emerge.

It is important to recognise and thank the wide range of experts from the military and the NHS who have contributed to the development of these guidelines.

The challenge now is to ensure that organisations ensure that these guidelines are available to staff and that staff are appropriately trained and confident in responding to major incidents.

Stephen Groves
National Head of Emergency
Preparedness, Resilience and Response

Keith Willett
Medical Director Acute Care
& Emergency Preparedness

As the Surgeon General for the Defence Medical Services, I am delighted to write the forward to this very important document that provides clinical guidelines for mass casualty incidents in the civilian setting. This work culminates considerable collaboration between NHS Emergency Planning experts and Defence Medical Services personnel in which we have shared knowledge from both the civilian and military sector. This knowledge has been consolidated into one place in order to provide an authoritative reference for anyone who might be involved in the health sector response to a mass casualty incident.

This document is the modern embodiment of the close co-operation between our professions. We have always shared knowledge from the unique environment of military medical practice into the civilian sector to inform our professions how to care for the types of casualties normally seen in conflict. We collaborated together to inform the development of the Emergency Medical Services to respond to Air Raid in the Second World War, this has continued as the NHS developed Major Trauma Centres, and has been evident as we responded to recent terrorist incidents in the U.K. It is very fitting that we publish this document in the year of the 70th anniversary of the creation of the National Health Service.

Martin Bricknell
Lieutenant General
Surgeon General United Kingdom



Public Health
England

NHS
England

NHS
University Hospitals
Birmingham
NHS Foundation Trust

Editor's introduction :

The Clinical Guidelines for use in a Major Incident have been created with the occasional trauma team in mind, for example, for surgeons in a trauma unit who need to treat a deteriorating P2 patient, or a P1 patient who has been conveyed to the trauma unit, during a major incident response.

Current protocols and guidance from pre-hospital care and advanced trauma practices have been blended with expert clinical knowledge, military experience gained over many years of managing blast and ballistic injury, NGO/global trauma doctrine and learning points from recent incidents, and made relevant to UK NHS clinical practice.

Major trauma centres may have their own protocols and guidance already in place for managing multiple severely injured casualties and these guidelines are not intended to replace these. For the occasional trauma team responder, in a trauma unit or local emergency centre, these guidelines should form the basis of clinical emergency preparedness and serve as an aide memoire during a major incident.

It is unusual for an Editor to wish that their work is never used and gathers dust on a shelf someplace, and with regard to a major casualty response, I will always covet this. However, acting as a custodian of knowledge and expertise gained by managing wounded servicemen and victims of terrorist events, I hope that these guidelines will be perpetually updated and constantly used to support ongoing learning and training, and to set global standards in good quality casualty care.

Justine Lee

Editor

Specialty Doctor in Major Trauma, Queen Elizabeth Hospital, Birmingham
Clinical Reference Group Emergency Preparedness, Resilience and Response

How to use this guide:

If a Major Incident has been declared, turn to MI DECLARED and follow the guidance from this point. If there is time, the mechanism of injury section should be reviewed as the METHANE report communicates the types of injury mechanism(s) involved.

It is important that these guidelines are practical, self explanatory, relevant to the users and updated regularly. Individual guidelines can be (and will be) updated independently. You can check that you are using the most up to date version of any guideline by checking the version number on the latest index page at the front or the guidelines or on the web www.epronline.gov.uk/ourwork

All feedback and suggestions, from current and future contributors will be gratefully received. Please email me directly: justine.lee@uhb.nhs.uk. I look forward to hearing from you.

Key:

The following symbols are used throughout these guidelines to emphasize the text, but have not been strictly applied. They may mean:

- | | | | |
|---|--|---|--------------------------|
| ➔ | must do's, mandatory, immediate action |  | Catastrophic haemorrhage |
| ✔ | check this has been done |  | Airway |
| ? | choices, look for, decision to be made |  | Breathing |
| ▶ | consider, points of note |  | Circulation |
| ⚠ | alerts, warning |  | Disability |
| ✘ | avoid, do not |  | Exposure/everything else |
| 🔗 | link to external reference/online resource | | |

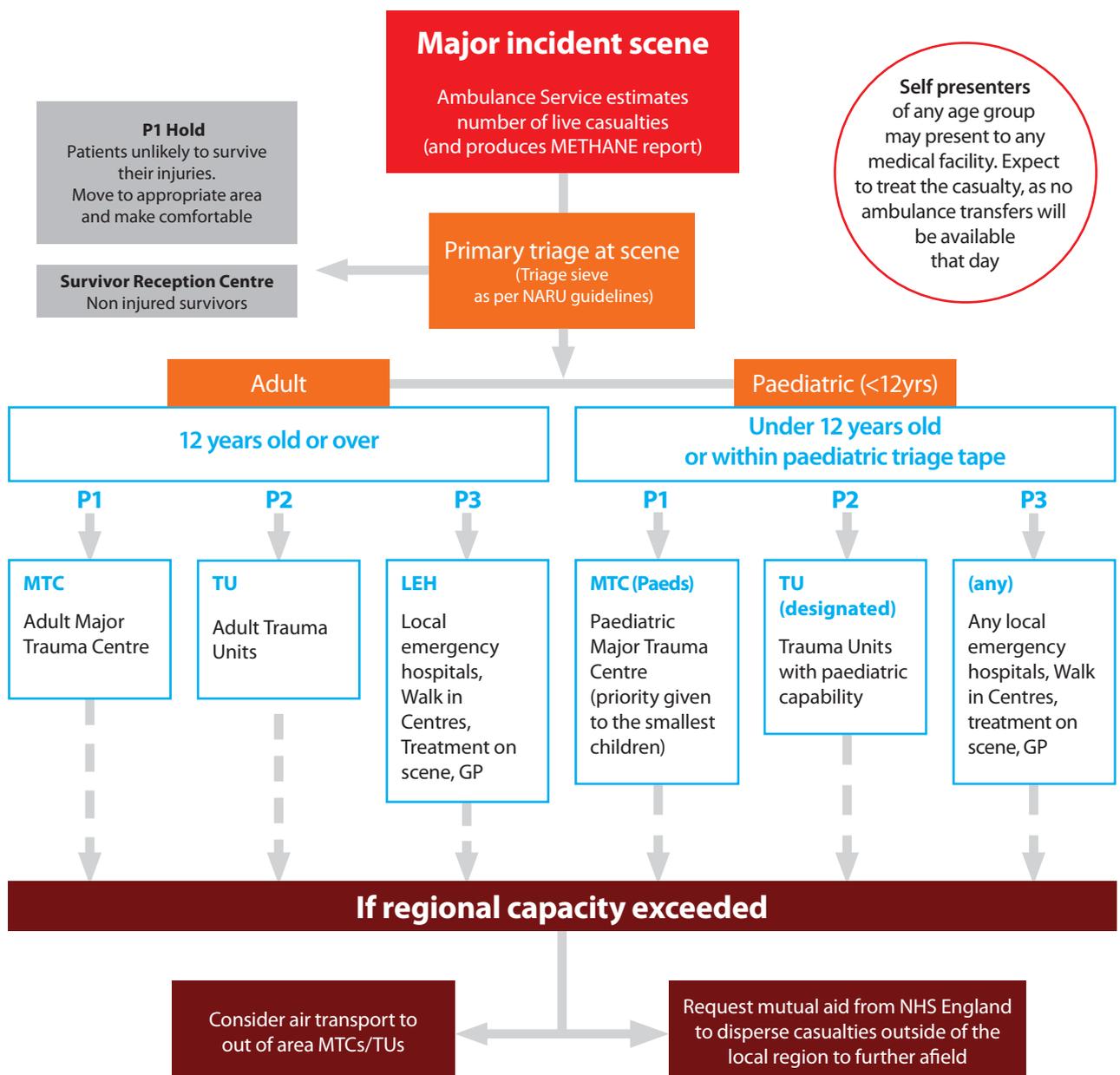
Major incident awareness

A mass casualty incident for UK health resources is an incident (or series of incidents) causing casualties on a scale that is beyond the normal resources of the emergency and healthcare services' ability to manage.

- ▶ may involve hundreds or thousands of casualties with a range of injuries, the response to which will be beyond the capacity of normal major incident procedures to cope and require further measures to appropriately deal with the casualty numbers.
- ▶ casualties are likely to be a mixture of categories with 25% requiring immediate life saving intervention (P1), 25% requiring intervention that can be delayed (P2) and 50% being walking wounded or minor injuries (P3).
- ▶ usually caused by sudden onset events (big bang), and exclude casualties as a result of infectious diseases such as pandemic influenza.

Several smaller incidents may combine, or be geographically located, so as to require a mass casualty response to be enacted due to the large number of simultaneous casualties.

For specialist services such as burns, the trigger for activation of their mass casualty arrangements will be lower due to the limited availability of resource for incident response.



Major incident awareness

A major incident is any occurrence that presents serious threat to the health of the community or causes such numbers or types of casualties, as to require special arrangements to be implemented. For the NHS this will include any event defined as an “emergency” as in section 6.4. of NHS England Emergency Preparedness, Resilience and Response Framework.

Under Section 1 of the CCA 2004 an “emergency” means

- (a) an event or situation which threatens serious damage to human welfare in a place in the United Kingdom;
- (b) an event or situation which threatens serious damage to the environment of a place in the United Kingdom;
- (c) war, or terrorism, which threatens serious damage to the security of the United Kingdom.

Your hospital's emergency planning, preparedness, response and resilience to a major incident

A major trauma centre (MTC) should expect to receive predominantly (P1) patients, a Trauma Unit (TU) should expect to receive (P2) patients and other medical facilities will be assigned (P3) patients. However, a mix of casualties should be planned for, as there will be little (if any) ability to transfer patients between sites for the first 24 hours.

To assist a regional response to a mass casualty event, a **pre-determined patient dispersal plan** (casualty regulation) should be used, showing where casualties will be dispersed to by the ambulance service and how many casualties each hospital has pre-agreed to accept in the first hour.

The local emergency services (ambulance/police/fire) are usually the first to notice unusual activity in their control rooms and will notify their incident management director on call. They will decide if escalation of the incident is required and if this is a potential or actual major incident.

If there is a **surge of casualties arriving in ED without warning**, or if there is news (via social media or word of mouth) of an emerging incident, then the ED consultant on call/senior nurse on duty will contact the medical director or clinical site manager (see local MI protocol) and decide whether to self declare and start escalation of the hospital major incident plan.

Ballistic injury

Introduction

Bullets cause injury by two main mechanisms:

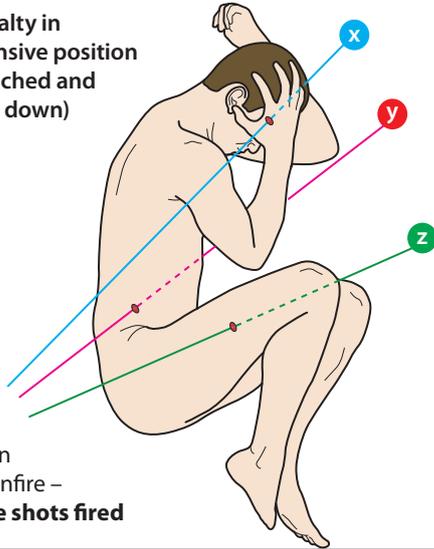
1. Tissue being crushed and lacerated along the bullet path.
2. Tissue being stretched and displaced by the temporary cavity.

The clinical effects will depend on the body area and underlying organs hit by the bullet.

Summary

- ▶ Immediate casualty management follows the standard CABC approach and is dictated by the casualty's clinical condition.
- ▶ Diagrams below demonstrate the average path of bullets. However it must be appreciated that bullets will tumble, fragment and produce fragments that are not in the average path.

Casualty in defensive position (crouched and lying down)



Origin of gunfire – **three shots fired**

Clinical presentation of casualty

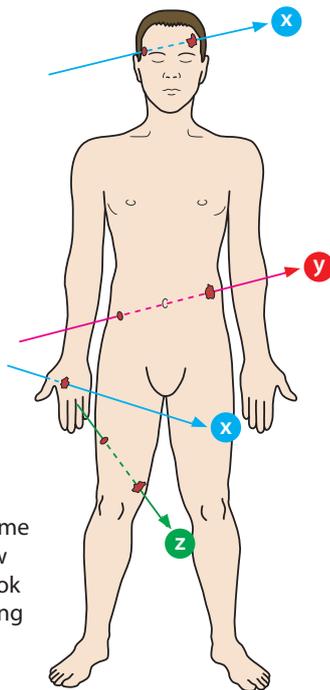


Figure shows same person, and how wound tracts look in a clinical setting
Note: **four wound tracts**

A

- Gunshot involving face/neck – see [Speciality Overview 8](#) ↗
- ▶ Gunshot not involving face/neck = standard airway management.

B

- ✓ Standard care.

C

- ✓ Standard care.
- ▶ The bullet path will not respect anatomical boundaries so look for multicavity/multi organ injury.
- ▶ Small entry and exit wounds may be associated with significant internal injury.
- ⚠ **Be guided by the clinical condition – ‘what you see may not be what you get’**

D

- Immediate wound management as per [ED injury management 8](#) ↗
- ▶ Entry and exit wounds do have different characteristics but practically, can be very difficult to distinguish (and it is rarely important during initial care).

E

- ▶ The actual path taken by the bullet within the casualty will depend on how they were orientated when struck (standing, sitting, crouching, running) – which is often not the position the casualty is examined in by responding clinicians.
- ▶ Bullets that ricochet off an intermediate surface or pass through intermediate targets (bags, clothes) may become unstable, hit side face on (rather than with the tip) and produce greater immediate energy transfer.

i KEY POINTS

- ▶ Bullets that fragment may lead to multiple wound tracts across different body (or anatomical) regions.
- ▶ Some tissues tolerate deformity from temporary cavitation better than others *ie* skeletal muscle versus bone.

⚠ **Small entry and exit wounds may mask catastrophic internal damage**

Investigations

- ▶ The pattern of bone fragments and bullet debris may show the direction of travel of the bullet within the casualty.
- ▶ Some bullets break up ('fragment') within the casualty producing multiple wound tracts.
- ▶ CT is used to screen for bullet fragments prior to MRI (if needed). Retained bullets and fragments are likely to have steel components and be affected and moved by the MRI magnetic field.
- Imaging is covered in [ED Resus 4](#) ↗

Ballistic injury

Ammunition

A round of ammunition consists of **two main parts**:

- ▶ **Bullet** (the part that leaves the gun and strikes the target).
- ▶ **Cartridge case** that contains primer and propellant.

The cartridge is ejected from the gun (a 'spent case' or 'brass') and may be present at the incident scene.

Ammunition is often described by width and length:

- ▶ A '9×19mm' has a bullet head 9mm in width and a brass case 19mm long. This describes ammunition often fired from a handgun/pistol.
- ▶ A '7.62×39mm' has a bullet 7.62mm wide and a case 39mm long. The longer case, compared to the 9×19mm ammunition, allows for more propellant to be packed into the case. This gives the bullet more kinetic energy when fired.

Ammunition can also be described using imperial measurements for the bullet width – usually fractions of an inch (eg .223) or using both imperial and metric measurements (eg .223in/5.56mm).

Bullet effects

When a bullet impacts a target, energy is transferred to the target. The effects depend on:

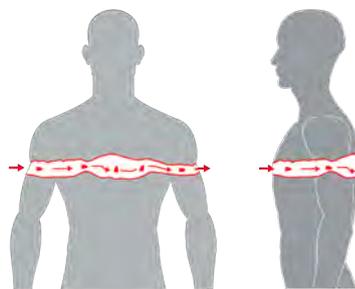
1. the material properties of the target
2. the bullet design

This is illustrated using the figures below depicting bullet impacts into 500×250×250mm 10% gelatine blocks (derived from high speed digital photography of actual impacts). When shot, 10% gelatine behaves in a similar way to muscle tissue.

The temporary cavity is also shown superimposed on the outline of a human torso to illustrate possible wounding effects.

The energy from the bullet impact creates a 'temporary cavity' within gelatine or muscle lasting for fractions of a second. This collapses down around a much smaller permanent tract created by the bullet.

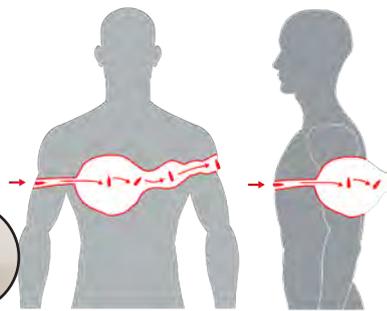
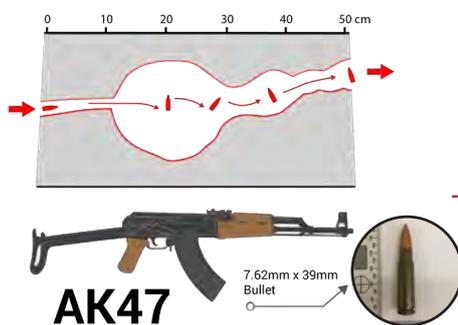
If the bullet becomes unstable within the gelatine or muscle and begins to tumble, it will present its side face to the material rather than its tip. In this way more energy is transferred, due to a greater contact surface area between the bullet and tissue, and the cavity will be larger.



Pistol

9×19mm ammunition

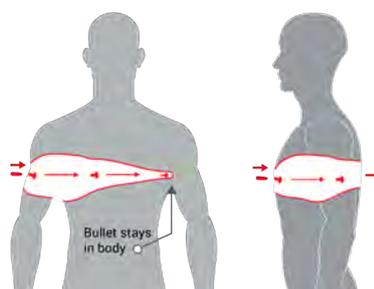
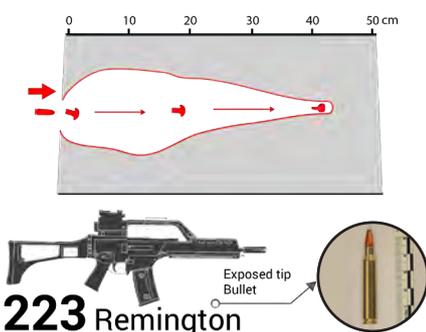
The temporary cavity is smaller than that associated with rifle ammunition.



AK47

7.62×39mm ammunition

The bullet flies straight initially then becomes unstable, creating a large temporary cavity associated with tissue stretching and tearing.



Police rifle

.223 Remington exposed tip

This is an example of a bullet designed to flatten out ('expand') soon after impacting on a target, so that energy is transferred rapidly and the temporary cavity is large early in the bullet's flight. The bullet is more likely to stay in the body of the first person shot and not go through and hit someone else.

Blast injury

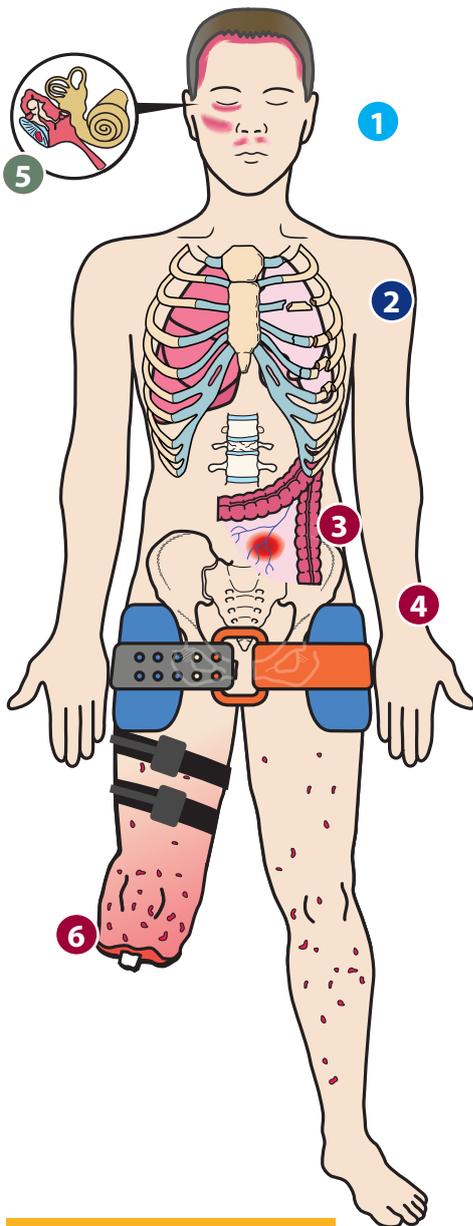
Introduction

- ▶ Aggressive resuscitation is required in close range survivors.
- ▶ Look for a occult injuries and monitor for evolving injuries.

Catastrophic haemorrhage

Does patient have a traumatic amputation or is this an isolated injury? Look for other associated injuries:

- ▶ **Blast Thorax** – High risk of catastrophic great vessel and aortic disruption – seek early cardiothoracic opinion.
- ▶ **Blast Lung** – early intubation, lung protective ventilation from outset and through to ICU care.
- ▶ **Blast Abdomen** – risk of significant intra-abdominal bleeding and late bowel perforation, even if abdominal wall is not breached.
- ▶ **Blast Pelvis** – High mortality rate from exsanguination, especially if SI joints are open (of relevance for landmines, IEDs and floor-based devices).
 - ➔ apply pelvic binder, gain rapid proximal control, resuscitation/surgery.



KEY POINTS

- ✓ Early CT whole body (head to ankles)
- ✓ Use rapid transfuser (Level I/Belmont)
- ✓ Give tranexamic acid (TXA) early
- ✓ Do a blood-borne virus screen (BBV) if fragment injury
- ⓧ Fasciotomy for blast limbs
- ⓧ Damage control surgery

A

- ▶ Have a high index of suspicion for **airway compromise** if blast and casualty were in a confined space (bus/underground/metro)
- ▶ Flash burns indicate a high risk of blast lung **1**

B

- Have a high index of suspicion for **blast lung** (incidence increases when casualty in an enclosed space) see [Speciality Overview 4](#)
- ▶ Blast Lung is the most common fatal injury among initial survivors
 - ▶ Low initial O₂ Sats may indicate primary blast lung injury
 - ▶ Rib fractures, pneumothorax and lung contusions are commonly associated with a blast **2**
 - ⓧ Have a low threshold for chest decompression/chest drain
 - ⓧ Consider early intubation and lung protective ventilation from outset and through to ICU care

C

Neck

Penetrating neck injuries are common and often fatal

Chest

- ⓧ Great vessel/aortic injury
- ⓧ Pericardial tamponade
- ⓧ Myocardial contusions - may lead to cardiac arrhythmias

Abdomen

Blunt abdominal injury caused by secondary and tertiary blast mechanisms can cause significant bleeding and late bowel perforation, even if the abdominal wall is not breached **3**

- ⓧ Liver/splenic rupture
- ⓧ Air embolism leading to mesenteric ischaemia

Pelvis

- ▶ Significant bleeding can occur with open SI joints
- ▶ The wider the pubic symphysis, the greater the transfusion requirement
- ➔ Manage initially with pelvic binder and rapid proximal control. Further resuscitation and surgery may be required **4**

Traumatic amputation

- ✓ Check tourniquet(s) have been applied **6**
- ➔ Prepare to exchange for pneumatic tourniquet(s)
- ⚠ Avoid crystalloids during resuscitation (worsens coagulopathy)

D

E

Blast injury



D

Head

- ▶ Diffuse axonal injury (DAI), skull fracture, cerebral contusions, stroke
- ▶ Penetrating injury with exposed brain
- ▶ Globe perforation, subconjunctival haemorrhage, foreign body
- ▶ TM rupture, inner ear disruption **S**

Spine

- ▶ Spinal cord injury

Chest

- ▶ Blast lung injury
- ▶ Haemothorax, pneumothorax, pulmonary contusions and haemorrhage



E

- ▶ Blood borne virus screen may be advised (*Overview: Management of bloodborne virus (BBVs) risk in bomb blast victims (hepatitis B, C and HIV)* – PHE publications gateway number: 2017077 Produced: May 2017)
- ▶ Air embolism is common and can present as stroke, MI, acute abdomen, spinal cord injury, limb claudication, loss of hearing or sight
- ▶ Observe for late fungal infection if there is major soft tissue damage

Classifications of blast injury

- ▶ **Primary** – injury resulting in direct tissue damage from the shock wave hitting the body.
- ▶ **Secondary** – injury from fragments ('shrapnel') from a device or the environment.
- ▶ **Tertiary** – injury from displacement of the body (thrown against a wall/up in the air).
- ▶ **Quaternary** – other types of injury (for example: burns, inhalation injuries etc).
- ▶ **Quinary** – sequelae and late complications, for example fungal infection if major tissue damage.

Blast injury environment

Explosive devices

Explosive device may be predominately blast weapon, or packed with fragments, for example, with screws, nuts, ball bearings etc.

- ▶ **Blast weapons** increase the risk of primary blast injuries such as blast lung and building collapse.
- ▶ **Fragmentation weapons** increase the risk of fatality especially over longer distance in the open field – explosion outside, victim outside.

Distance from blast

Primary blast injuries common in fatalities, but rare in survivors as overpressure effects reduce rapidly with increasing distance from the device.

- ▶ **Close range injuries** – mutilating injuries common, traumatic amputations, open head, chest, abdominal injuries with exposed contents.
- ➔ Aggressive resuscitation in survivors is required
- ▶ **Further away** – secondary and tertiary blast injuries predominate and survival much more likely, with increasing distance fragments are less numerous, and less serious unless vital structures damaged.

Blast location

- ▶ **Enclosed space: explosion inside, victim inside (bus bombs, pub bombings etc.)**
 - ▶ Complex blast environment with increased effects of overpressure due to reflection and amplification. Primary blast injuries especially blast lung common in both fatalities or survivors.
 - ▶ Effects may be localised if protection offered by walls or furniture.
- ▶ **Explosion outside – victim inside building or vehicle.**
 - ▶ Low risk of primary blast injury.
 - ▶ Victim also protected from fragments.
 - ▶ Tertiary blast injuries predominate, with civilian pattern fractures.
 - ▶ Safest environment, unless building collapse occurs.

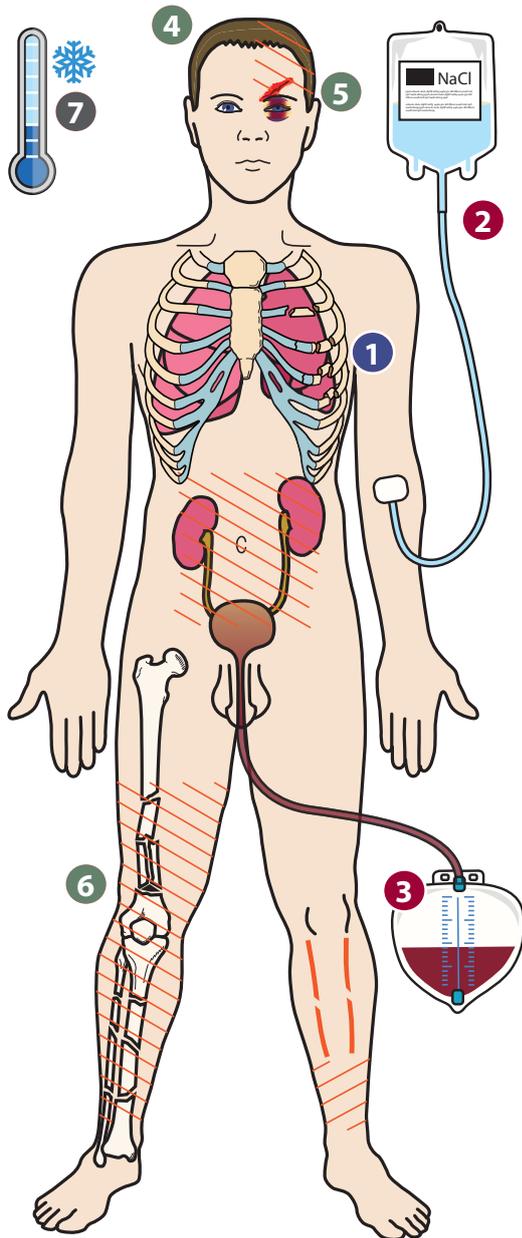
Suicide bombers

- ▶ Main effects as above and related to type of explosive device and environment.
- ▶ Secondary fragments from bomber or other victim can occur – especially bone fragments.
- ▶ Risk of infection (e.g. blood borne viruses) from biological implantation.

Crush injury

Summary

- ▶ Patients may have multiple injuries affecting different tissues and organs and are at risk of crush syndrome.
- ▶ In explosions, additional injury types such as blast and fragment injury should also be considered.
- ▶ Prolonged entrapment may occur.
- ▶ Extrication after a long period of entrapment is associated with a high risk of cardiovascular collapse; may lead to worsened renal failure or cardiac arrest.



A

→ Standard care

⚠ Do not use Suxamethonium for RSI – risk of hyperkalaemia/death

B

✓ Lung Protective Ventilation for all ventilated patients from ED onwards

Rib fractures ①

- ② Early multimodal analgesia
- ② Surgical stabilisation of flail segment if more than four ribs involved

C

Risk of:

- ▶ CV collapse on release from entrapment
- ▶ Risk of internal bleeding from organ contusions
- ▶ High risk of pelvic fracture with associated haemorrhage
- ② Consider need for pelvic binder

If prolonged extrication, patient may have had IV fluids at scene

- Continue adequate fluid resuscitation
- ② Patient is at risk of rhabdomyolysis ③
- ② Use blood if haemorrhagic shock is present, then give crystalloid solutions to ensure adequate urine output ②

⚠ Do not apply tourniquet to a crushed extremity unless there is catastrophic haemorrhage

D

Cranial trauma ④

- ▶ Associated with poor outcome → seek early neurosurgical advice

Penetrating eye injuries

- ▶ Are easily missed → inspect the globes (if unable to do so, refer to ophthalmology) ⑤

Multiple fractures are common ⑥

- ② Look for occult nerve/tendon damage
- ▶ small child/frail older person with co-morbidities are at increased risk of death due to crush syndrome

E

- ② Treat hypothermia if present ⑦

i KEY POINTS

Consider multiple other injuries:

- ▶ burns
- ▶ fragmentation injuries
- ▶ blast lung
- ▶ multi-fragmentary fractures
- ▶ subdural haematoma
- ▶ eye injuries
- ▶ tympanic membrane rupture – steroids may salvage sensorineural hearing loss

⚠ Have a high index of suspicion for crush syndrome

② Rhabdomyolysis:

- Check creatine kinase
- Check urine myoglobin
- ▶ Give crystalloid to establish good urinary output if rhabdomyolysis suspected or confirmed

Crush injury and crush syndrome

Pre-hospital, the patient may have had the following management:

- ▶ Intravenous fluids may have been given prior to releasing the crushed body. This is especially important in cases of prolonged crush (> 4 hours).
- ▶ A tourniquet may have been used on the affected limb
 - slow release of tourniquet required.

▲ Observe all crush casualties, even those who look well

Patients are at risk of:

Reperfusion Injury

- ▶ Acute hypovolaemia with metabolic abnormalities
- ▶ May occur when a trapped limb or casualty is suddenly released

Observe for:

- ❓ cardiac arrhythmias (may be lethal)
- ❓ myoglobinuria (release of toxins from necrotic tissues into the circulation which may cause renal failure)

Hypotension

- ▶ Casualties may require considerable fluid replacement in the first 24 hours (third space losses)

Observe for:

- ❓ Compartment syndrome (consider prophylactic fasciotomies)
- ❓ Signs of renal failure

ED Resus

- ➔ Initiate (or continue) IV hydration—up to 1.5 L/hour

Renal Failure

Rhabdomyolysis releases myoglobin, potassium, phosphorous, and creatine kinase into the circulation

- ▶ Myoglobinuria may result in renal tubular necrosis if untreated
- ▶ Release of electrolytes from ischaemic muscles causes metabolic abnormalities

ED Resus

- ❓ Patient may require IV fluids and mannitol to maintain diuresis of at least 30mls/hr, to prevent renal failure

ITU

- ❓ Patient may require haemodialysis

Patients with acute renal failure may require up to one to two months of dialysis treatment; however, in the absence of any infection, patients are likely to regain normal kidney function.

Metabolic abnormalities

- ▶ Hypocalcaemia: Calcium flows into muscle cells through leaky membranes
- ▶ Hyperkalemia: Potassium from ischaemic muscle
- ▶ Metabolic acidosis: Lactic acid from ischaemic muscle may cause life-threatening cardiac arrhythmias, including cardiac arrest; metabolic acidosis may exacerbate this situation

ED Resus

- ❓ Consider correcting Hyperkalemia/Hypocalcemia
 - ➔ If required, give **calcium gluconate 10% 10mls** or **calcium chloride 10% 5mls IV** over two minutes; **sodium bicarbonate 1mg/kg IV** slow push; regular **insulin 5–10 U** and **D50 1–2 ampoules IV** bolus; **kayexalate 25–50g** with **sorbitol 20% 100mL PO** or PR

ITU

- ▶ Alkaline diuresis is not required. Use Hartmann's (lactated Ringer's) or N. Saline

Complications

Compartment syndrome

- ➔ Apply ice to injured areas and monitor for pain, paresis, pain on passive movement, and reduced temperature of affected limb
- ➔ Fasciotomies [ED injury management 9](#) ➔

Open wounds

- ✔ Manage open wounds with antibiotics, tetanus toxoid, and debridement [ED injury management 8](#) ➔

Penetrating knife injury

Terror related stab wounds differ from interpersonal and non-terror related penetrating blade injuries. There are usually a greater number of wounds, particularly of the upper body and neck, and more body regions injured.

Terror related stab injuries (TRS)

- ▶ Usually inflicted by a powerful overhand grip, with the intention to kill.

Interpersonal stab injuries

- ▶ Most likely to be caused by an underhand grip, with the intention to threaten the victim.

The management of penetrating trauma is likely to involve:

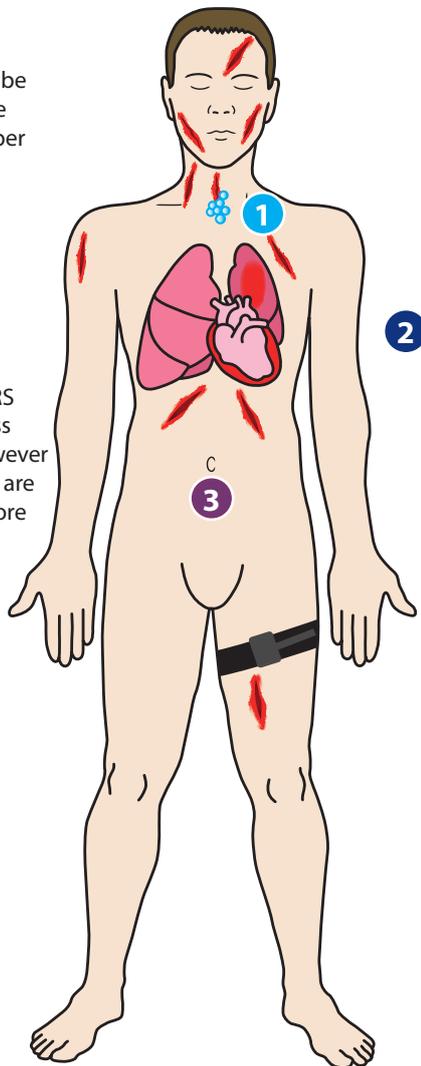
- ▶ endotracheal intubation
- ▶ chest drain insertion
- ▶ IR (if available) and/or surgery

Catastrophic haemorrhage

- ❓ Non-compressible? → Does patient need to go direct to theatre?
- ❓ Compressible? → Apply direct pressure/junctional techniques

TRS injuries more likely to be inflicted to the head and upper body

Abdominal TRS injuries are less common, however when present are likely to be more severe



A

- ❓ Airway Injury - bubbling wound, stridor, change of voice. 1
 - ▶ Consider early intubation or access to airway via wound
 - ▶ Oesophageal/nerve injuries can usually wait

B

- ❓ Tension pneumothorax → needle decompression
- ❓ Cardiac tamponade → resuscitative thoracotomy 2
 - ▶ Most (75%) penetrating injuries to the chest can be managed with CABC and a chest drain

C

- If patient is stable:**
 - a whole body CT
- If patient is unstable:**
 - ❓ potential cardiac and abdominal injury
 - manage/exclude the cardiac injury first

Be mindful of **transient responders**. 3
 ❓ an occult ongoing bleed in the abdomen may suddenly decompensate. Only 40% of patients with peritoneal penetration have an injury requiring laparotomy. Even if stable, keep the patients NBM for - 12-24hrs and observe.

D

⚠ Don't forget to examine the back

i KEY POINTS

- Tertiary survey (don't forget the back)
- Whole body CT imaging with contrast, as soon as patient is stable enough
- Timely clinical reviews and re-review of imaging, to look for occult injuries. GI/GU injuries are challenging to diagnose
- ❓ Blood Borne Virus PEP Speciality Overview 2 ↗
- ❓ Counselling signposting Speciality Overview 11 ↗

Penetrating knife injury

In general, casualties injured in TRS events:

- ▶ More likely to arrive in ED in worse condition (hypotensive with lower GCS and lower revised trauma scores)
- ▶ More likely to require blood transfusion
- ▶ Will require more hospital resources to manage these patients
- ▶ Half are likely to require emergency surgery
- ▶ One third will require critical care (ICU)
- ▶ Have a significantly longer hospital stay compared with other mechanisms of injury
- ▶ Six times more likely to die in hospital after TRS

Anatomy of TRS wounds

Head and face

- ▶ Associated with an increased number of head, face and neck wounds, of greater severity

Spine

- ▶ More injuries to the spine and upper extremities

Chest

- ▶ More likely to have thorax and MSK injuries
- ▶ Chest injuries are more severe

Abdomen

Abdominal injuries are less likely, however in TRS the wounds tend to be more severe.

In non-TRS stabbings, casualties are more likely to have abdominal and lower limb injuries.

Hazardous Materials (HAZMAT) and Chemical, Biological, Radiological and Nuclear events (CBRN)

The management of CBRN casualties including HAZMAT follows general principles as well as specific treatment priorities including trauma care. Priorities depend on the type of exposure and presence of any contamination or contagious casualty hazards.

Assistance on managing such incidents should be obtained quickly through the national ECOSA (Emergency Co-Ordinated Scientific Advice system) and the clinical management of individual patients supported by NPIS (National Poisons Information Service).

Emergency CBRN assistance:

📞 Incident management ECOSA:

0300 3033 493

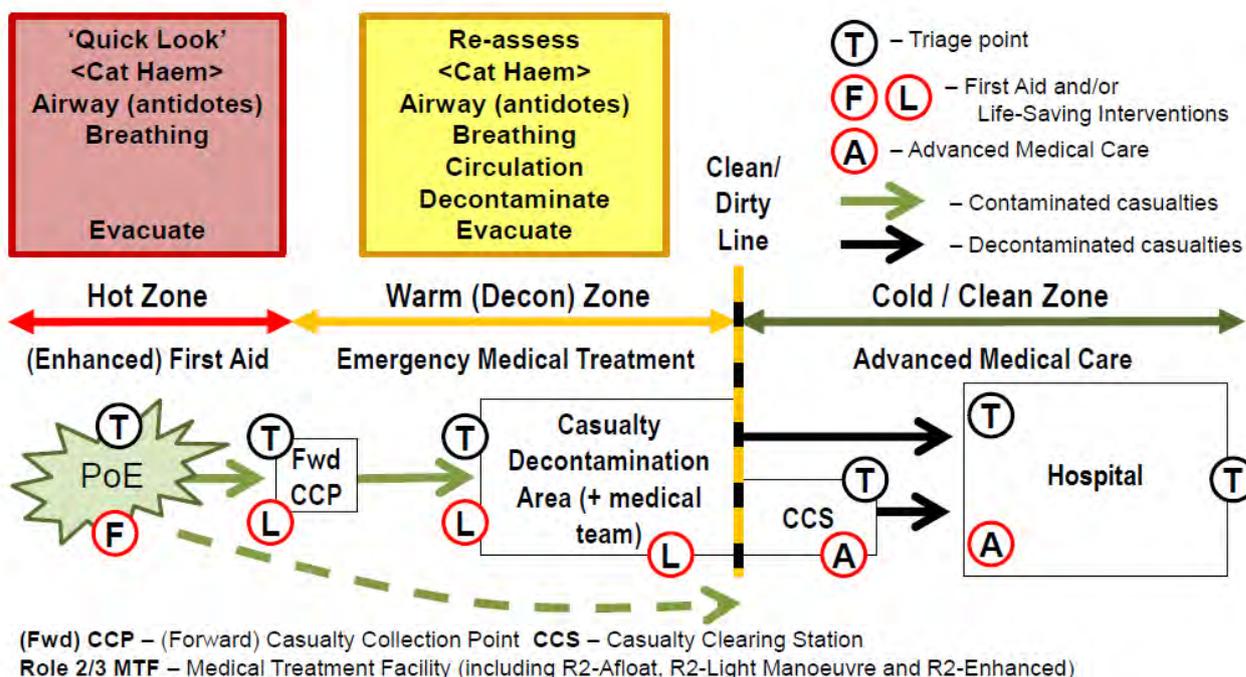
📞 Clinical management NPIS:

0344 892 0111

PRINCIPLES OF CBRN CASUALTY CARE

- ▼ RECOGNITION
- ▼ SAFETY
- ▼ SELF AID/FIRST AID
- ▼ TRIAGE Emergency Medical Treatment
- ▼ QUICK LOOK
- ▼ LIFE SAVING INTERVENTIONS (T1 casualties)
- ▼ CASUALTY HAZARD MANAGEMENT
- ▼ SUPPORTIVE MANAGEMENT Advanced Medical Care
- ▼ DEFINITIVE MANAGEMENT (including critical care)
- ▼ REHABILITATION

PRIORITIES FOR CASUALTY CARE



Hazardous Materials (HAZMAT) and Chemical, Biological, Radiological and Nuclear events (CBRN)

CBRN Guidelines: Recognition

Any symptoms involving emergency services and hospital staff

Multiple casualties with similar non-traumatic symptoms and signs (STEP 1-2-3 PLUS)

Unusual taste, smell or mist

Unexplained dead animals

Unexplained symptoms including:

Altered vision

Eye pain

Headache

Excessive secretions

Chest tightness

Difficulty in breathing

Non-thermal burns (erythema, blistering and necrosis)

Any unusual or unexplained symptoms, signs, illness or deaths

Unusual investigation result(s) including laboratory and diagnostic imaging

Chemical exposures are more likely to be associated with immediate or acute (minutes to hours) onset symptoms although not in all cases. Biological and radiological exposures may not be obvious and have a longer onset time.

STEP 1-2-3 PLUS - SAFETY TRIGGERS FOR EMERGENCY PERSONNEL

(adapted from Joint Emergency Services Interoperability Programme for hospital use)

If any ambulance or hospital staff have symptoms - Go straight to Step 3

Step 1: One person incapacitated with no obvious reason

- Manage using standard protocols (consider standard precautions).

Step 2: Two people incapacitated with no obvious reason

- Manage with caution using standard protocols (consider personal protective equipment).

Step 3: Three or more people in close proximity, incapacitated with no obvious reason

- Manage in a safe area well ventilated area(s) (consider disrobing before handover).

PLUS: these safety interventions may include:

- **Evacuate** - consider removing the patient, other patients and/or non-essential staff;
- **Communicate** - inform staff, management and/or emergency services;
- **Disrobe** - as a minimum remove clothing from P1 patients; and
- **Decontamination** - consider the requirement and type of formal decontamination, however where practicable life-saving interventions should be performed first.

REFERENCE AND SPECIALIST ADVICE

References: NATO Medical Management of CBRN Casualties (AMedP-7.1 Chapters 4 and 5),
NHS Initial Operational Response (IOR) to a HAZMAT/CBRN Incident

Further advice: TOXBASE <https://www.toxbase.org>

NHS England EPRR IOR <https://www.england.nhs.uk/ourwork/epr/hm/#ior>

Hazardous Materials (HAZMAT) and Chemical, Biological, Radiological and Nuclear events (CBRN)

CBRN Guidelines: Nerve Agents

Nerve agents are highly **lethal** organophosphorous compounds with varying physical properties ranging from volatile liquid and vapour hazard through to non-volatile liquid. Antidotes and supportive therapy are the main treatment options.

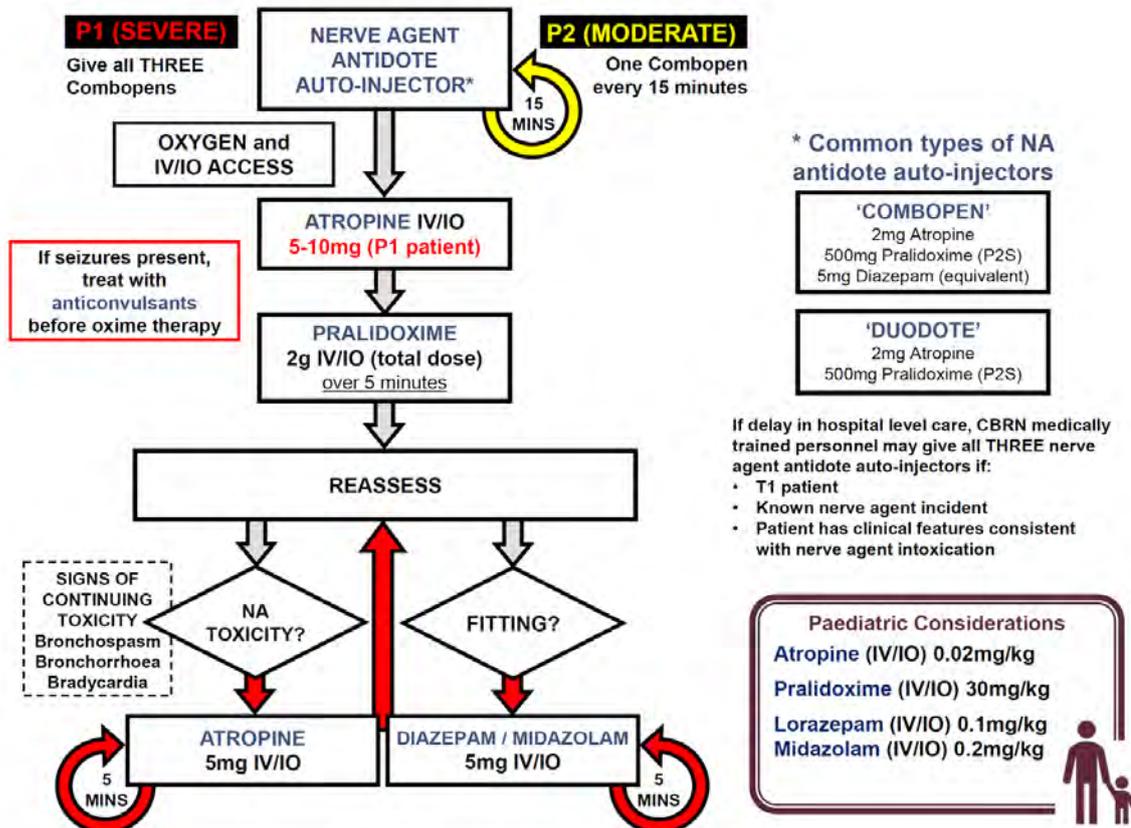
TRIAGE

P1 (Severe)	P2 (Moderate)	P3 (Mild)
Unconscious, convulsions, respiratory distress, respiratory paralysis / arrest, profound bradycardia (< 40), cyanosis.	Not walking. Excessive secretions, confusion, not obeying commands, wheezing, incontinence.	Walking. Pinpoint pupils, dimmed vision, eye pain.

CASUALTY (CRESS) ASSESSMENT

Conscious	Respiration	Eyes	Secretions	Skin	Other
Convulsions Unconscious	Increased, then reduced or apnoea	Pinpoint pupils (delayed following skin exposure)	Increased Vomiting	Sweating	Bradycardia

EMERGENCY MEDICAL TREATMENT



Hazardous Materials (HAZMAT) and Chemical, Biological, Radiological and Nuclear events (CBRN)

CBRN Guidelines: Nerve Agents



MECHANISM OF ACTION AND EFFECTS

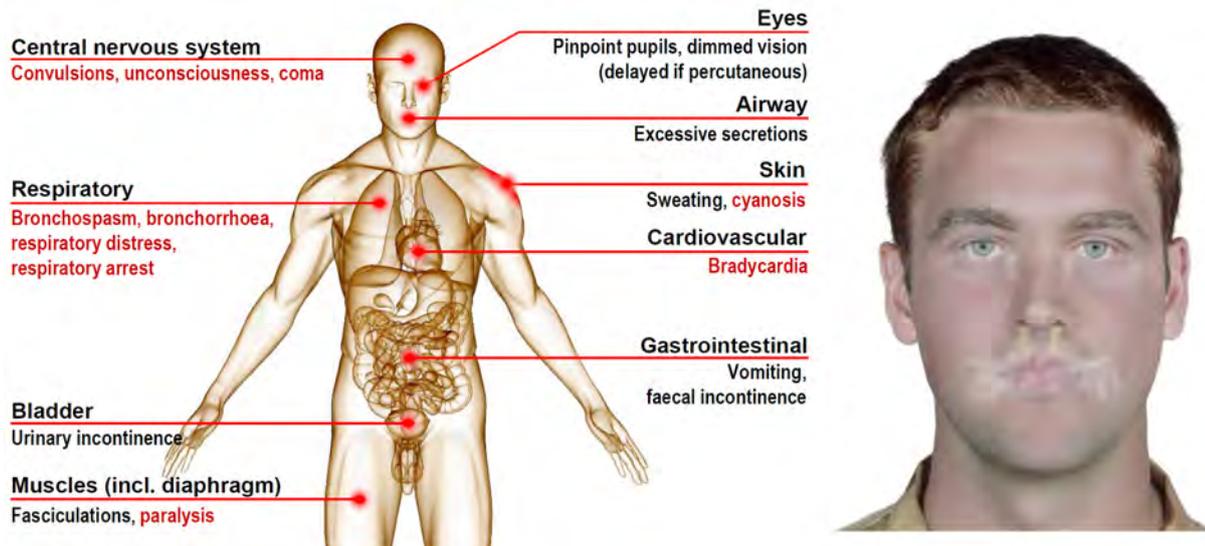
Nerve agents cause the inhibition of the enzyme acetylcholinesterase that breaks down the neurotransmitter acetylcholine. This results in over-stimulation of the following parts of the nervous system:

Parasympathetic: Miosis, secretions (tears, bronchorrhoea, salivation), vomiting, incontinence, bradycardia.

Central nervous system: Confusion, coma, seizures and central respiratory failure.

Sympathetic ganglia: Tachycardia, hypertension. *Sweat glands:* Sweating.

Neuromuscular junction: Fasciculation (systemic and local), depolarising paralysis, respiratory failure.



MEDICAL THERAPIES

Atropine: Atropine is an antimuscarinic and reverses nerve agent parasympathetic effects. The dose is titrated to effect based on the reversal of bradycardia (endpoint > 90), bronchospasm and secretions. High doses (up to 1000mg) have been used in the past especially in the absence of effective oxime therapy. Alternatives to atropine include hyoscine.

Oxime therapy: Oximes are *enzyme reactivators* and should be given as soon as possible to P1 patients. The first choice of oxime in the UK is pralidoxime and has good efficacy for sarin and VX. An alternative oxime is obidoxime and may be used if tabun or delayed enzyme reactivation is suspected especially with a requirement for high atropine doses or failure to reverse nicotinic effects.

Benzodiazepines: Benzodiazepines are used as anti-convulsants and are also neuroprotective.

Ventilation strategy: This is similar to the asthma ventilation strategy due to high airway pressures, and atropinisation can be monitored by reversal of bronchospasm and capnography normalisation.

REFERENCE AND SPECIALIST ADVICE

Reference: NATO Medical Management of CBRN Casualties (AMedP-7.1 Chapter 19: Nerve Agents)

Further advice: TOXBASE <https://www.toxbase.org>

NHS England EPRR IOR <https://www.england.nhs.uk/ourwork/epr/hm/#ior>

Major incident STANDBY

Major incident STANDBY message has been announced

- ▶ **External source of order**
Message has been received from any of the emergency services or NHS England authorities, direct into ED, requesting your hospital to STANDBY for a major incident.
- ▶ **Internal source of order**
Unusual activity reporting within ED, news via social media or other sources etc, may lead to a self declaration of major incident standby by an ED consultant in discussion with the hospital on call team.

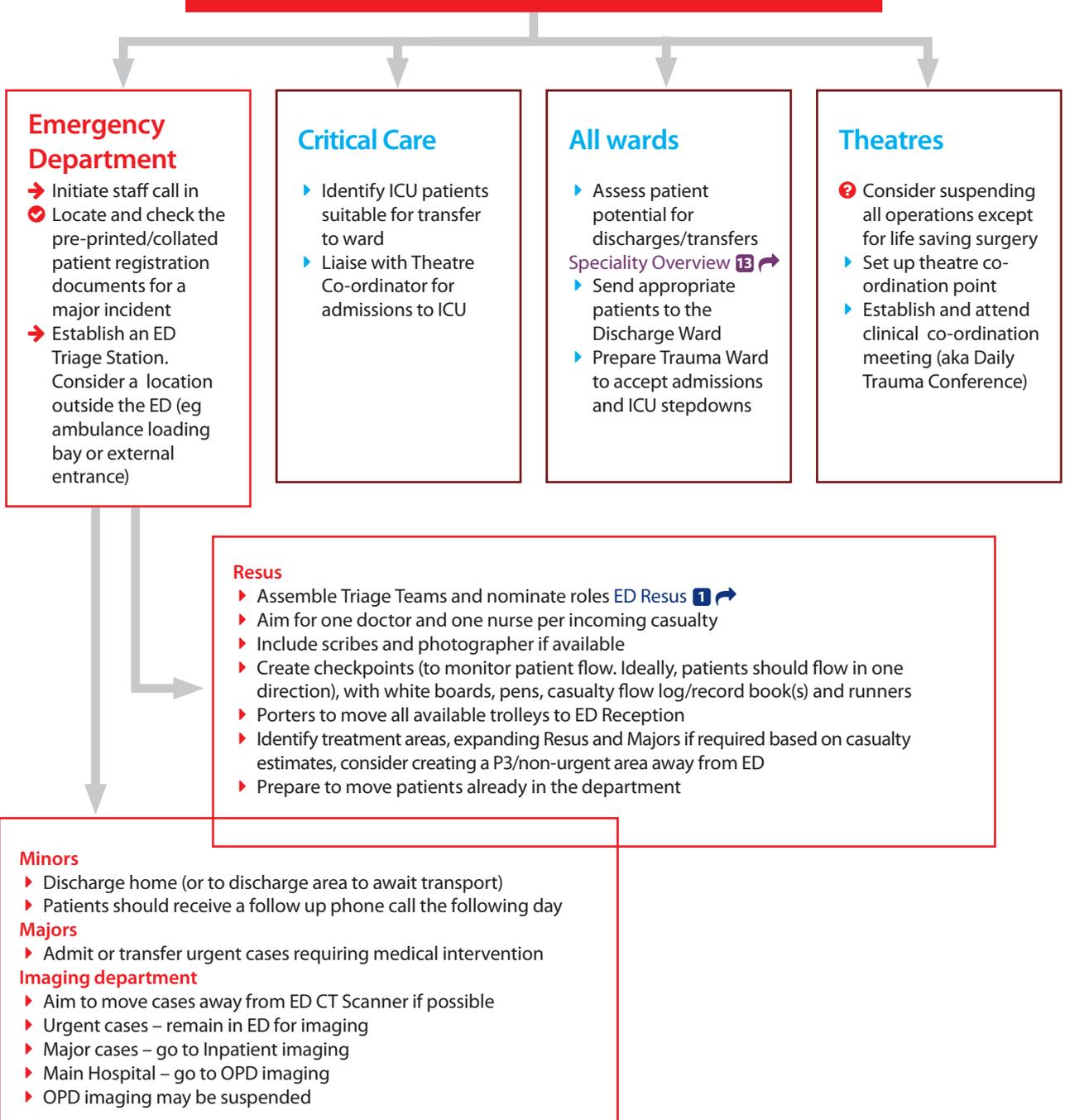
Use the METHANE chart to record details of any alert messages. If you are self-declaring, other agencies may call you to ask for your METHANE information, so make it visible to all.

Exact numbers are difficult, therefore estimates of total numbers of P1+P2 casualties may be given to help receiving hospitals understand severity of incident and numbers to prepare for.

▲ Self presenting casualties may start to arrive without warning, pre-alert or declaration, particularly if non-ambulance service transport is used.

- M** Major incident standby
- E** Exact location of incident
- T** Type of Incident
- H** Hazards/potential hazards
- A** Access (best routes for access to and exit from the hospital)
- N** Number of casualties
- E** Which emergency services are involved/needed?

Hospital Major Incident STANDBY



METHANE report

METHANE is the recognised common model for passing incident information between services and their control rooms. All services have use a common model which will mean information can be shared in a consistent way, quickly and easily, whoever the information is passing between.

M	Major incident	Has a major incident been declared? (Yes/No)
E	Exact location	What is the exact location or geographical area of the incident?
T	Type of incident	Blast/Explosion/Gunshots/Fire/Building Collapse/Flood/Chemical/Nuclear/Biological/Radiation
H	Hazards	What hazards or potential hazards can be identified?
A	Access	What are the best routes for access and exit?
N	Number of casualties	How many casualties are there, and what condition are they in?
E	Emergency services	Which, and how many, emergency assets and personnel are required or are already on-scene?

MAJOR INCIDENT STANDBY

Standby message received:
Date:
Time:

MAJOR INCIDENT DECLARED

Declared message received:
Date:
Time:

Please use the following spaces to write details and any changes/updates:

Major incident DECLARED

Be prepared to update the METHANE report or give out METHANE information to others

M Major Incident has been DECLARED

E The EXACT location is

T The TYPE of incident is

H HAZARDS identified are

A Casualties should ARRIVE by and ambulances should EXIT by

N Estimated NUMBER of Casualties are P1 P2 P3

E The EMERGENCY services involved are: Paramedics/HART/MERIT/HEMS/MCV/Others?

Fire and Rescue/Police/Others?

Major Incident – Cancelled

If the message, 'Major Incident – Cancelled' is received, the plan is not activated and the standby call is cancelled.

Major Incident – Stand Down

If the message, 'Major Incident – Stand Down' is received, no new casualties are expected. The call may be full or a partial stand down, and this will be further described by the Incident Director.

(H)MIMMS general checklist

- ▶ Prepare areas for clinical and administrative uses
- ▶ Call in appropriate number of staff (use cascade contact system)
- ▶ Maintain internal and external communications
- ▶ Provide a command and control structure for the medical, nursing and administrative staff
- ▶ Staff already on duty should report to their clinical areas
- ▶ Called in staff should report to the Staff Reporting Area and await further instructions
- ▶ Review MOI section of these guidelines if mechanism(s) of incident known [Mechanism of injury](#)  

ED checklist

- ▶ Hospital Ambulance Liaison Officers (HALO), if available will improve communications into the receiving hospital. They can also give real-time ED Resus capacity updates to the ambulance control centre and divert ambulances if required
- ▶ Know how many patients your hospital is expected to manage within the first hour (Patient dispersal framework and casualty capability chart) and plan to exceed this number
- ▶ Minimal relatives should attend ED, however keep parents and children together if possible.
- ▶ Security may need to assist with management of relatives to the relatives area
- ▶ Documentation should be kept to a minimum
- ▶ Involve clinical photography early, to guide clinical care and for forensics
- ▶ Security screening (sanitization) of patients and relatives may be required and must be planned for

ED Triage

- ▶ Should be established outside of ED, eg in the Ambulance reception area
- ▶ Should be staffed by a Senior ED consultant and a Senior ED Nurse
- ▶ Patients must be re-triaged at this point, in case of any change/deterioration since their on-scene triage category was given
- ▶ Patients should be triaged to ED Resus (P1 Resuscitation), Majors (P1&P2 likely to need surgery/critical care) and Minors (P2)
- ▶ Ideally, P3 walking wounded patients should not enter the ED but be directed to and managed in a separate area, given a clinic appointment, or advised to see a GP/ other treatment facility
- ▶ Patients should be given a pre-assigned (random) hospital ID number and this should remain their hospital number until the patient is on the wards, even if their real identity is known

Major incident DECLARED

ED Resus

- ▶ There should be one treatment team per patient **ED Resus** [📄](#) [↗](#)
- ▶ A senior clinician should oversee all casualties in Resus and co-ordinate their transfer to theatre/imaging/critical care/ward as appropriate
- ▶ Identify, classify and record, patient's identifiers and their injuries using the **MI DECLARED** [📄](#) [↗](#)
- ▶ Check for tourniquets. They may be hidden under clothing or blankets. Not all patients will have a T (and the time) marked on their foreheads.
- ▶ There should be a dedicated ED Porter assigned to keeping the blood fridge full with 10+ units blood ONeg (for females) OPos (for males) at all times

ED Majors

- ▶ All patients must have a careful primary and secondary survey
- ▶ Patients must be regularly observed to identify changes in their clinical condition
- ▶ Deteriorating patients may need a trauma team response, even though they have been in the department for some time
- ▶ Some patients may be well enough to discharge directly from ED, but should always have a follow up appointment with a hospital clinic or GP

ED Minors

- ▶ Most patients will be well enough to discharge directly from ED, but should always have some form of follow up arrangement made (eg. phone call the next day, or a letter to take to their GP)

ED Discharge Area

A common discharge area is useful in order to:

- ▶ Organise follow up arrangements
- ▶ Give patients time to talk to others and share their experiences
- ▶ Re-unite with relatives and friends prior to discharge, to allow this to be done away from any unwanted media attention
- ▶ Advise patients and their families how to cope with media attention
- ▶ Receive counsel from the hospital chaplaincy (multi-faith if available)

Psychosocial first aid is important:

- ▶ listening to stories, acknowledging a traumatic event, helping families
- ▶ talk to children about bad news
- ▶ patients may have worries about going home and getting back to normal

⚠ Immediate formal counselling is not often required and may make PTSD more likely to occur.

⚠ Some people will have pre-existing mental health concerns and should be referred early [Speciality Overview](#) [📄](#) [↗](#)

Other considerations

- ❓ Can refreshments be ordered for the clinical staff?
- ❓ Are crèche arrangements required to support the staff response?
- ❓ Consider placing non-MI major trauma on divert to other MTCs, whilst there is still a significant surgical workload
- ❓ Consider diverting elective/other work load to other hospitals for several days/weeks
- ❓ Consider an immediate ED team debrief once ED is cleared. (Hot debrief)
 - ▶ Take a roll call and ensure that all staff members (not just clinical) are invited to future debriefs
 - ▶ Multiple debrief sessions may be required to allow all staff who work shift systems to attend
 - ▶ Other debriefs will follow in the next few weeks and months

Clinical impact assessment call - patient summary sheet (Patients 1 to 10)

- ▶ Precise details of injuries should not be recorded on this summary sheet
- ▶ Please only include admitted patients
- ▶ Easiest method: use one grid for patients with single injury and one for multiple system trauma

Injury	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6	Patient 7	Patient 8	Patient 9	Patient 10
Hospital number										
Patient identifiers										
On scene triage SIEVE (P1/P2/P3)										
Hospital/ED triage (P1/P2/P3)										
Age										
Mechanism										
Arrival time										
Destination										
Outcome (critical care/ward/RIP)										
Traumatic brain injury										
Spinal injury – cord or fracture										
Chest trauma										
Abdominal trauma										
Vascular trauma										
Pelvic trauma										
Single open fracture										
Multiple open fracture										
Single closed fracture										
Multiple closed fractures										
Soft tissue injuries										
Burns										
Maxillofacial trauma										
Ocular trauma										
Others										

Clinical impact assessment call - patient summary sheet (Patients 11 to 20)

- Precise details of injuries should not be recorded on this summary sheet
- Please only include admitted patients
- Easiest method: use one grid for patients with single injury and one for multiple system trauma

Injury	Patient 11	Patient 12	Patient 13	Patient 14	Patient 15	Patient 16	Patient 17	Patient 18	Patient 19	Patient 20
Hospital number										
Patient identifiers										
On scene triage SIEVE (P1/P2/P3)										
ED triage (P1/P2/P3)										
Age										
Mechanism										
Arrival time										
Destination										
Outcome (critical care/ward/RIP)										
Traumatic brain injury										
Spinal injury – cord or fracture										
Chest trauma										
Abdominal trauma										
Vascular trauma										
Pelvic trauma										
Single open fracture										
Multiple open fracture										
Single closed fracture										
Multiple closed fractures										
Soft tissue injuries										
Burns										
Maxillofacial trauma										
Ocular trauma										
Others										

Emergency department triage (adults)

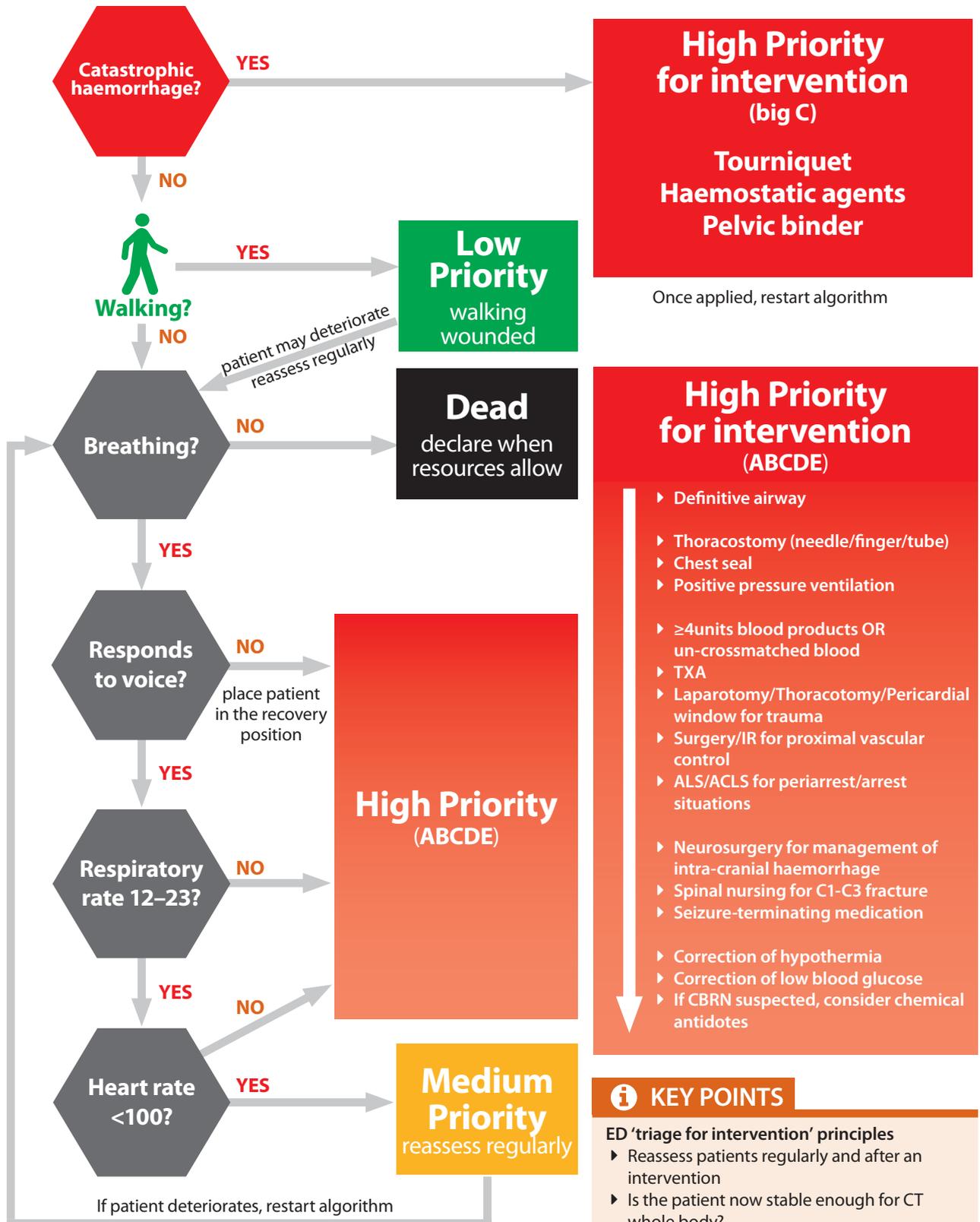
Priority for intervention

Introduction

This is an in-hospital clinical guideline for use in a major incident. It is designed to be used in times of SURGE in order to identify patients in need of a life-saving intervention and suggests the intervention(s) required.

- ▶ Early secondary assessment from senior clinicians is recommended to mitigate for initial over-prioritization.

⚠ Note This guideline is not designed for pre-hospital triage.



Rationale for the MPTT-24

- ▶ Can be completed by inexperienced personnel in 30 seconds
- ▶ The MPTT-24 is designed to **minimise under-triage**

Adapted from Modified Physiological Triage Tool 24 (MPTT-24). Vassallo 2017 CC BY 4.0

KEY POINTS

ED 'triage for intervention' principles

- ▶ Reassess patients regularly and after an intervention
- ▶ Is the patient now stable enough for CT whole body?
- ▶ Is the patient still a high priority for 'direct to theatre'?

Emergency department triage (adults)

List of life-saving interventions to be considered in a major incident or mass casualty event.

These were defined through an international Delphi consensus of experts involved in major incident management.¹

- 1 Intubation for actual or impending airway obstruction
- 2 Surgical airway for actual or impending airway obstruction
- 3 Thoracostomy (needle/finger/tube)
- 4 Application of a chest seal (commercial/improvised)
- 5 Positive pressure ventilation for ventilatory inadequacy
- 6 Application of a tourniquet for haemorrhage control
- 7 Use of haemostatic agents for haemorrhage control
- 8 Insertion of an intra-osseous device for resuscitation purposes
- 9 Receiving un-crossmatched blood
- 10 Receiving ≥ 4 units of blood/blood products
- 11 Administration of tranexamic acid
- 12 Laparotomy for trauma
- 13 Thoracotomy or pericardial window
- 14 Surgery to gain proximal vascular control
- 15 Interventional radiology for haemorrhage control
- 16 Application of a pelvic binder
- 17 ALS/ACLS for a patient in a peri-arrest/cardiac arrest situation
- 18 Neurosurgery for the evacuation of an intra-cranial haematoma
- 19 Craniotomy/Burr hole insertion
- 20 Spinal nursing for a C1–3 fracture
- 21 Administration of a seizure-terminating medication
- 22 Active/passive rewarming for initial core temp $< 32^{\circ}\text{C}$
- 23 Correction of low blood glucose
- 24 Administration of chemical antidotes

This process is designed to be used in circumstances when the receiving hospital is over-whelmed with casualties from a major incident i.e. in times of SURGE and when individual patients cannot be met by individual treatment teams. Casualties arriving at the hospital may not have undergone a pre-hospital triage process.

Under normal circumstances, casualties from a major incident will have undergone a pre-hospital triage process to determine their priority for treatment. On arrival at hospital, they will be met by individual and designated treatment teams.

The aim of this process is to rapidly identify those casualties in need of life-saving interventions. It can be completed by providers with all levels of experience in under 30 seconds.

The physiological assessments within the process are evidence-based (adapted from the MPTT-24)² and have the greatest sensitivity for identifying those in need of life-saving interventions within both the civilian and military environments.

As a consequence of this, a greater proportion of casualties will be categorised as “High Priority” including a number of those who do not require life-saving interventions. At the earliest opportunity, and within a permissive setting, early secondary assessment by a senior decision-maker is required to review those categorised as “High Priority”.

References:

- 1 Vassallo J, Smith JE, Bruijns SR, Wallis LA. Major incident triage: A consensus based definition of the essential life-saving interventions during the definitive care phase of a major incident. *Injury*. 2016 Sep;47(9):1898–902.
- 2 Vassallo J, Smith J, Bouamra O, Lecky F, Wallis LA. The civilian validation of the Modified Physiological Triage Tool (MPTT): an evidence-based approach to primary major incident triage. *Emergency Medicine Journal*. 2017 Dec;34(12):810–5.

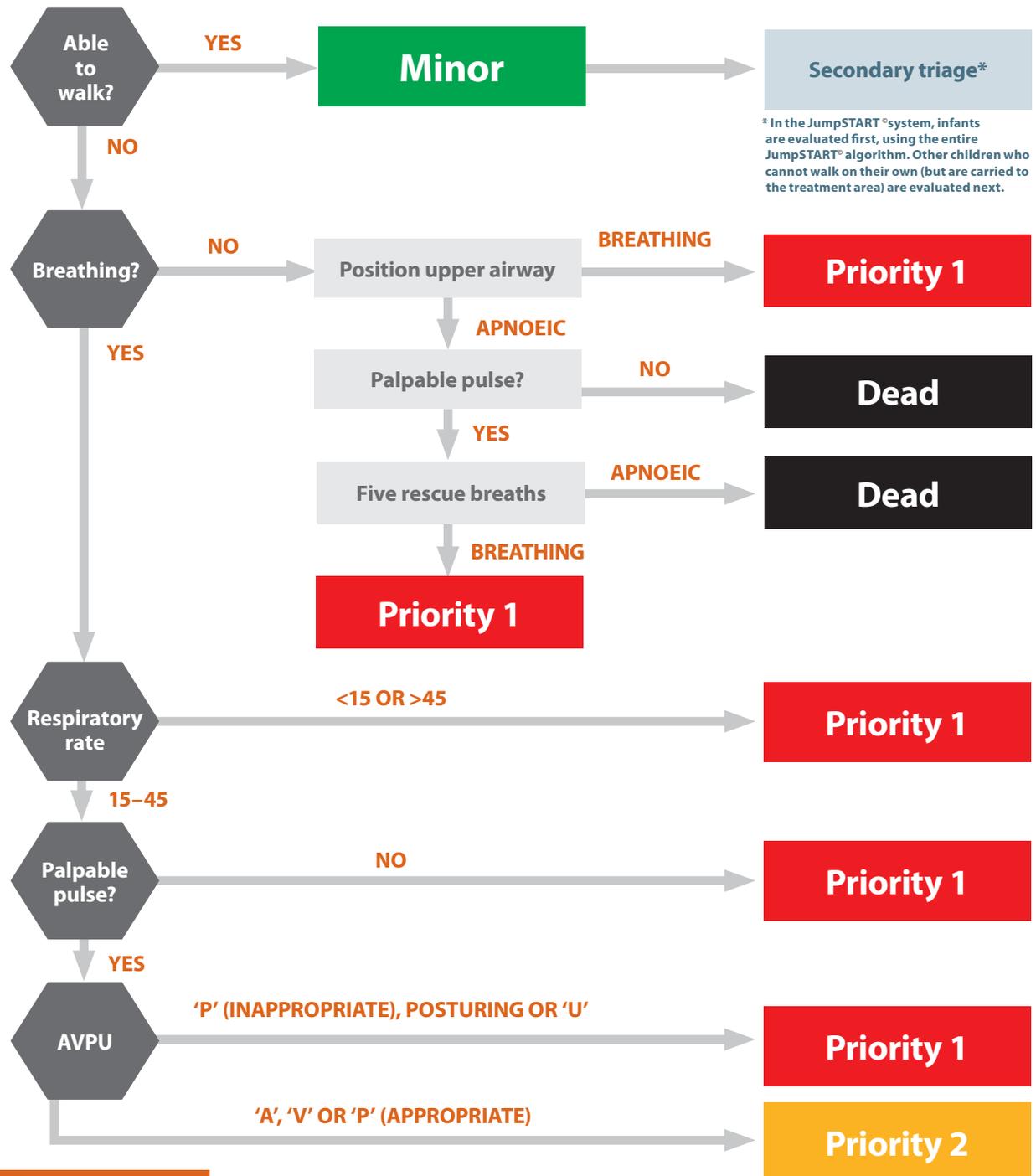
Emergency department triage (paediatric <12 years)

Introduction

In conventional triage, the objective is to sort and prioritise patients; to do the best for each individual. However the objective of triage in a mass casualty situation is to do the greatest good for the greatest number.

JumpSTART[®] is a system designed specifically for triaging children in disaster settings. Infants are seen first, followed by anyone who is or appears to be a child aged 12 or less.

- ▶ Allows paediatric casualties to be assessed based on physiology and should not prioritise paediatric casualties above sicker adult casualties
- ▶ Provides an objective framework for stressful and emotional decision making



KEY POINTS

- ▶ If a casualty appears to be a child, use this algorithm
- ▶ If a casualty appears to be an adult, use the Adult Triage tool [ED Triage](#)

Speciality information

- ▶ Reflects unique aspects of paediatric physiology
- ▶ Can be completed within 30 seconds

Emergency department triage (paediatric <12 years)

Primary triage

- ▶ Typically performed at the scene of the incident
- ▶ Helps to prioritise patients for evacuation/transport
- ▶ Can occur at a hospital

Secondary triage

- ▶ Performed to re-evaluate a patient after primary triage has been completed
- ▶ Typically done once the patient arrives in hospital
- ▶ Can also be done at an alternative care site, casualty clearing station or if time on scene is prolonged

Priority 1 Immediate Severely ill/injured but treatable and able to be saved with relatively quick treatment and transport *eg* severe bleeding, sepsis, open chest or abdominal wounds, severe respiratory distress, emotionally uncontrollable.

Priority 2 Delayed Injured/ill and unable to walk on their own; potentially serious injuries/illnesses but stable enough to wait a short while for medical treatment *eg* burns with no respiratory distress, spinal injuries, moderate blood loss, conscious with a head injury.

Priority 3 Minor Minor injuries/illnesses that can wait for a longer period of time for treatment *eg* minor fractures, minor bleeding or minor lacerations.

Priority 4 Expectant Dead or obviously dying. May have signs of life but injuries are incompatible with survival *eg* cardiac arrest, respiratory arrest with a pulse*, massive head injury. It can be psychologically difficult to tag a child as expectant/deceased. Resist the tendency to assign a higher triage category to paediatric patients just because they are children. Using an objective triage tool during a major incident can provide emotional support for staff forced to make these decisions for children.

** In children, typically respiratory failure precedes circulatory failure. If a child is apnoeic but has a pulse, a brief trial of ventilations, may 'jumpstart' their respirations (trial: five rescue breaths)*

Main differences between adult and paediatric triage

1. In children, if positioning the airway does not restart ventilation, then give a trial of ventilation, as this may restart spontaneous ventilation. In adults, there is no trial of ventilation and the casualty is tagged expectant or dead.
2. In children, only peripheral pulses should be used to assess circulation.
3. In children, AVPU is used to assess mental status, not ability to follow commands.

Non-ambulatory children include:

- ▶ infants (who can't walk yet)
- ▶ children with developmental delays
- ▶ children with acute injuries or chronic conditions prior to the incident that prevented them from walking

The JumpSTART® paediatric triage MCI triage tool (usually shortened to JumpSTART®) is a variation of the simple triage and rapid treatment (START) triage system. Both systems are used to sort patients into categories at mass casualty incidents (MCIs).

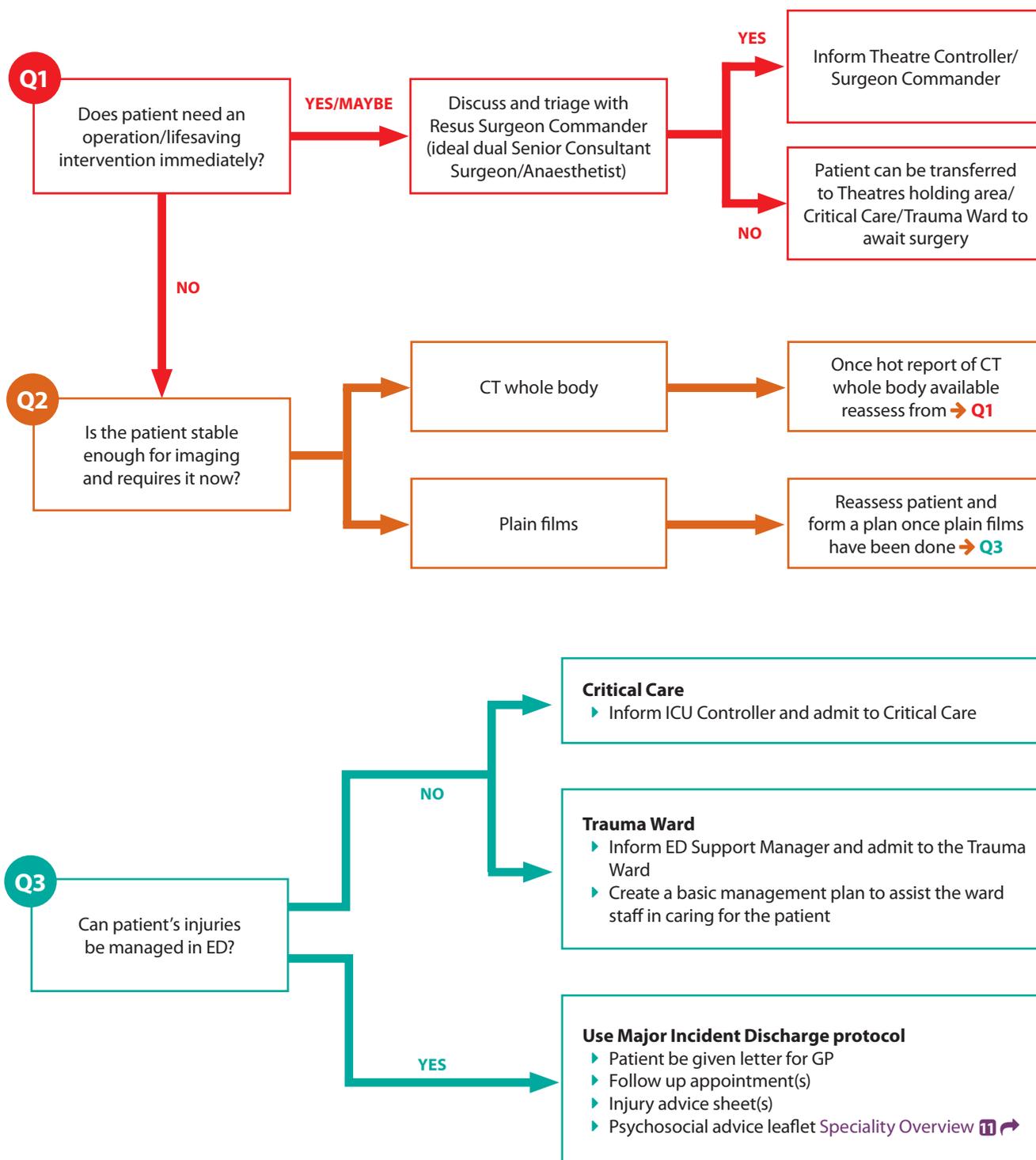
However, JumpSTART® was designed specifically for triaging children in disaster settings. Though JumpSTART® was developed for use in children from infancy to age 8, where age is not immediately obvious, it is used in any patient who appears to be a child (patients who appear to be young adults are triaged using START or other adult triage systems).

Emergency department outcomes, discharges and follow up advice in a major incident

In a major incident, decisions regarding the sickest patients need to be made quickly and decisively, so that these patients reach their treatment destination first time and without delay.

Less severely injured patients may be managed and discharged from ED with further management or follow up plans in place, if their wounds and physiological status allows this, to protect theatre and bed capacity for other more urgent cases.

▶ This algorithm suggests rapid ED outcomes that are acceptable in a major incident, or mass casualty event



Trauma team roles in a major incident

The usual ED trauma team response may not be possible. This guide suggests the essential roles and jobs to resuscitate and receive a trauma patient. Some roles can be quickly assigned to clinical staff who are not usually part of the trauma team and contains job lists for those roles.

- Essential trauma team to receive the casualty
- Minimum medical team to remain with casualty until delivered to theatre/critical care or trauma ward
- Additional medical staff if available

Anaesthetist Support ODP

Pre-Arrival:

- ⊖ Equipment check
- ⊖ Collect emergency drugs

On Arrival:

- ✔ Monitoring On
- ✔ Checks C-Spine collar correctly applied
- ✔ Assists Trauma Anaesthetist – AIRWAY
- ✔ Assists A-Line insertion
- ✔ Checks equipment ready for move to CT/Theatre/ Other destination

Trauma Anaesthetist

Pre-Arrival:

- ⊖ Equipment check with ODP

On Arrival:

- ✔ Assess Airway and report to TTL&Scribe
- ✔ Rx and gives O2, fluids and drugs
- ✔ RSI if required
- ✔ Analgesia
- ✔ Maintains C-Spine immobilisation for log roll
- ✔ Takes control of the log roll
- ✔ AMPLE (if patient conscious)
- ✔ TXA
- ✔ A-line insertion once airway secure
- ✔ Remains with patient until final destination (Theatre/ICU/Ward)

Trauma Doctor 1

Pre-Arrival:

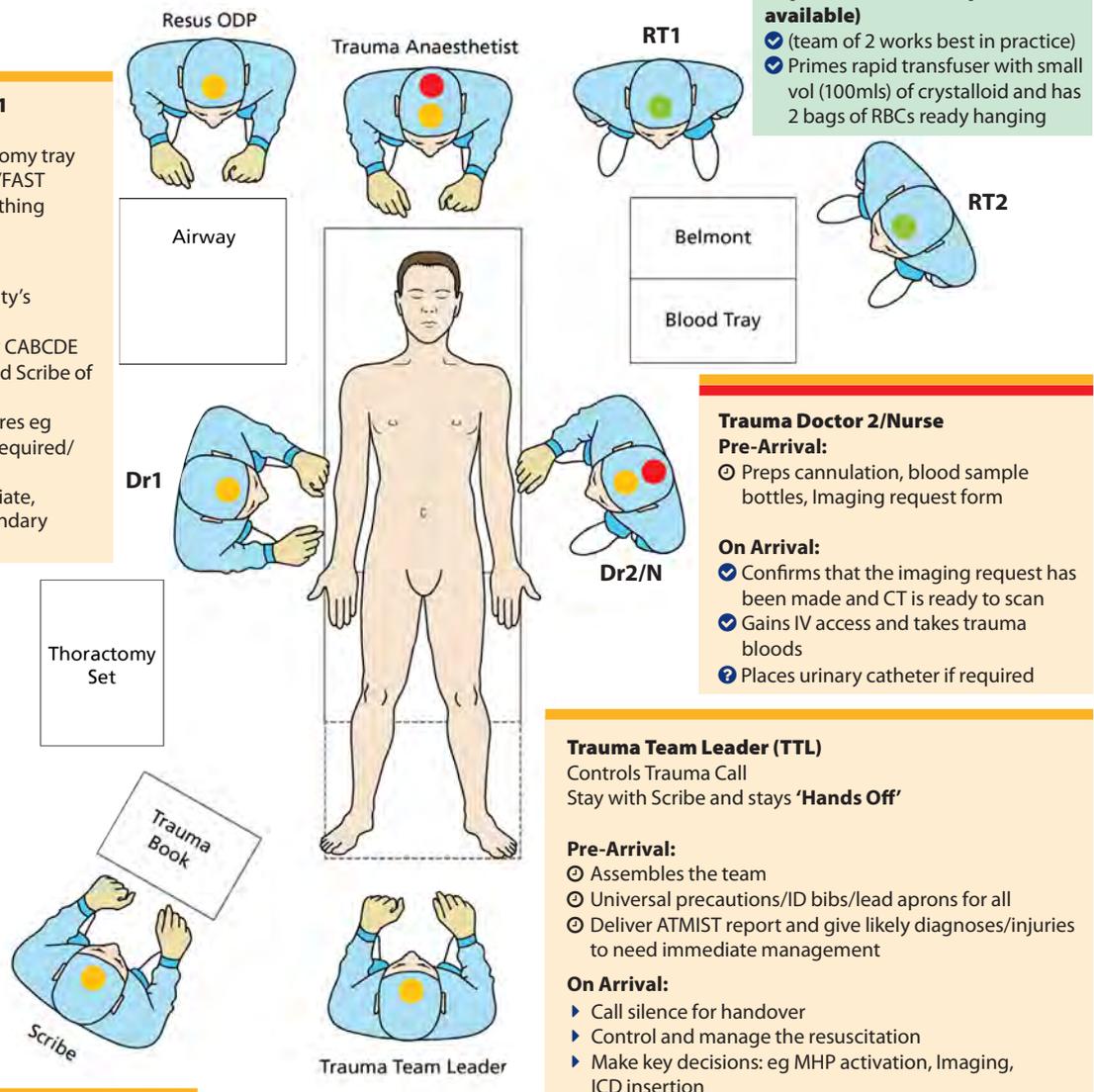
- ⊖ Preps thoracotomy tray
- ⊖ Switch on USS/FAST
- ⊖ Scissors for clothing removal

On Arrival:

- ✔ Remove casualty's clothing
- ✔ Primary survey CABCDE
- ✔ Informs TTL and Scribe of findings
- ❓ Other procedures eg FAST, ICDs, as required/able
- ✔ When appropriate, conducts secondary survey

Rapid Transfusion 1 (plus 2nd if available)

- ✔ (team of 2 works best in practice)
- ✔ Primes rapid transfuser with small vol (100mls) of crystalloid and has 2 bags of RBCs ready hanging



Trauma Doctor 2/Nurse

Pre-Arrival:

- ⊖ Preps cannulation, blood sample bottles, Imaging request form

On Arrival:

- ✔ Confirms that the imaging request has been made and CT is ready to scan
- ✔ Gains IV access and takes trauma bloods
- ❓ Places urinary catheter if required

Trauma Team Leader (TTL)

Controls Trauma Call
Stay with Scribe and stays 'Hands Off'

Pre-Arrival:

- ⊖ Assembles the team
- ⊖ Universal precautions/ID bibs/lead aprons for all
- ⊖ Deliver ATMIST report and give likely diagnoses/injuries to need immediate management

On Arrival:

- ▶ Call silence for handover
- ▶ Control and manage the resuscitation
- ▶ Make key decisions: eg MHP activation, Imaging, ICD insertion

Scribe

- ▶ Keep writing/recording everything you see and hear in the bay
- ▶ Stay in one place

Senior Resus Nurse/Co-ordinator

- ✔ Receives METHANE updates
- ✔ Co-ordinates and supports nursing staff response

Trauma team roles in a major incident

Major Incident Trauma Team

As part of the Major Incident Standby and Declared action, theatres, critical care, blood bank, surgical specialities and imaging will have also been informed and making ready to receive casualties.

- ▶ The MI Trauma Teams can focus on making their resus bay ready to receive a casualty
- ▶ Relatives should be managed by other hospital teams and should not come direct to ED Resus
- ▶ If required, the Senior Resus Nurse should manage any overcrowding in Resus

Key Roles explained

Co-ordinators

- ▶ Senior clinical staff who provide oversight of the department and pre-hospital situation and forward communications with imaging, theatres, critical care and the wards

ED Resus Controller

- ▶ Oversees all Resus activity and prioritises patients for resus bays or move out to majors
- ▶ Maintains hospital and pre-hospital situational awareness via regular hospital updates and METHANE reporting

Resus Senior Nurse Co-ordinator

- ▶ Co-ordinates the nursing response in ED
- ▶ Ensures that a scribe and a suitable nurse are available for each trauma team/resus bay
- ▶ Informs hospital control of staffing needs and patient numbers
- ▶ Liaises with Site manager/Bed manager when destination identified for patient
- ▶ Responsible for crowd control (staff and relatives) in Resus

Resus Surgeon Commander

- ▶ Usually senior/experienced trauma surgeon or trauma intensivist/anaesthetist
- ▶ Supports TTLs and prioritises patients for theatres and imaging
- ▶ Liaises with Imaging, Theatres and Critical Care for casualty demands
- ▶ Also known as surgical triage commander, co-ordinating trauma consultant

Imaging Controller/Anaesthesia Controller/Critical care Controller/Bed manager (for Wards)

- ▶ Interface with Resus Surgeon Commander to understand ED situation and need for imaging, theatres, critical care, ward beds, and to inform them (and Hospital Control) of capacity in their respective areas

Pre-Arrival	On Arrival
Trauma Team Leader (TTL)	
<p>Assemble team and ensure universal precautions are worn Relay ATMIST to team and identify possible injuries to prep for Checks that the Resus Surgeon Commander/Speciality teams are aware of patient's details Confirms with Trauma Team that equipment is ready and have they identified any issues?</p> <p>Checklist:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Airways and emergency drugs <input type="checkbox"/> Rapid Transfuser primed <input type="checkbox"/> ONeg blood ready (OPos if male) <input type="checkbox"/> Thoracotomy set ready <input type="checkbox"/> Cannulation for IV access (plus alternative e.g. EZIO), blood bottles, A/VBG <input type="checkbox"/> Trauma Documentation incl CT imaging request form <input type="checkbox"/> Identifies bags for clothing and forensic specimens <input type="checkbox"/> ALL casualties from an MI/MCE should remain under their hospital trauma number until in ICU/Ward and no further blood transfusion is required 	<p>SILENCE for pre-hospital handover to team (ATMIST) Controls and manages the trauma resuscitation Remains HANDS OFF during the resuscitation Makes critical decisions and prioritises investigations, interventions and treatment</p> <p>Checklist:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Massive Transfusion activation and sitreps <input type="checkbox"/> Hypothermia mitigation <input type="checkbox"/> Checks patient details on blood samples <input type="checkbox"/> Any catastrophic haemorrhage controlled? <input type="checkbox"/> Is Airway secure/Breathing optimised/IV access gained? <input type="checkbox"/> Is patient ready for CT Wholebody imaging? <input type="checkbox"/> Is patient unstable/transient responder? – inform Resus Surgeon Commander, patient may need to go direct to theatre <input type="checkbox"/> Obtain CT HOT REPORT <input type="checkbox"/> Make a management plan with Trauma Anaesthetist <input type="checkbox"/> Inform Resus Surgeon Commander of your findings and plan for destination after Resus <input type="checkbox"/> Ensure Tetanus prophylaxis, IV antibiotics, TXA are considered and prescribed <input type="checkbox"/> Ensure all documentation including decision making, blood products and drugs are documented/prescribed clearly

photocopy & cut

Pre-Arrival	On Arrival
Scribe	
<p>Familiarise yourself with MI documentation Assist by obtaining blood imaging request forms Locate yourself next to the TTL</p>	<p>Keep writing! Record times and details of decision making and any issues, as well as what happens to the patient Don't be afraid to speak to confirm findings/information</p>

photocopy & cut

Pre-Arrival	On Arrival
Resus Anaesthetist- remains with patient	
<p>Check all essential equipment with your assistant Conduct RSI WHO checklist Ensure RSI drugs, analgesia and TXA are available Prep for any potential needs (as suggested by TTL) You are expected to stay with the patient until an appropriate handover after Resus (Theatres/ICU/Ward)</p>	<p>Co-ordinate the safe transfer of patient from pre-hospital trolley Secure the airway (after discussion of airway findings with TTL) Give O₂, airway interventions and RSI if required Maintain C-Spine immobilisation and control the log roll Take an AMPLE history if patient is awake Prescribe all fluids and drugs given to the patient Discusses and finalises the management plan with TTL</p>

photocopy & cut

Pre-Arrival	On Arrival
Resus Anaesthetist Assistant	
<p>Set up and check airway equipment Collect drugs from cupboard and fridge Ear thermometer Trauma ID tag Prep monitoring equipment</p>	<p>Assists Trauma Anaesthetist with advanced airway interventions Checks C-Collar is correctly fitted Take temperature on arrival Attach Trauma ID on arrival Attach monitoring, BP cuff and pulse oximeter Prepares and administers drugs as required Ensures equipment and drugs are gathered for a safe transfer from Resus to destination (e.g. CT)</p>

Pre-Arrival	On Arrival
Trauma 1 (Senior Doctor ATLS trained)	
Preps thoracotomy tray FAST Scissors for clothing removal Confirms with Trauma 2 which skills they have, procedures they are comfortable with and if any support may be required.	(C) Identify any catastrophic bleeding and manage accordingly (A) Confirm with Trauma Anaesthetist that airway is clear and secure BCDE (Primary Survey) as usual Relays finding clearly to TTL and Scribe Performs other procedures/investigations as required (e.g. FAST, IV cannulation/access depending on skills and training) When appropriate, proceed to secondary survey

photocopy & cut

Pre-Arrival	On Arrival
Trauma 2 (Doctor/Nurse/PA)-remains with patient	
Prepares to secure IV access and obtain blood samples including venous/arterial blood gas Prepare the blood request forms Scissors- prepare to unclothe patient, but be mindful of dignity, hypothermia and exposure	Secures IV Access: minimum 2x large IV access, IO/Venous cutdown access, according to skill set Obtains blood for: A/VBG, FBC, U&Es, LFTs, Amylase, Clotting screen (INR, aPTT, Fibrinogen), Crossmatch, Group&Save, CK, pregnancy test if female Place urinary catheter post CT (if no pelvic trauma and required) Assist Trauma 1 (Procedures such as ICD insertion etc)

Catastrophic haemorrhage and massive transfusion pathway in a major incident

The definition of **major haemorrhage** is bleeding that leads to HR >110 beats/min and/or systolic BP <90mmHg. Pre-hospital management focuses primarily on the **prevention of further blood loss** and the **active management of hypothermia and hypoperfusion** to prevent Trauma Induced Coagulopathy (TIC).

- ▶ Tranexamic Acid (TXA), an antifibrinolytic, should be given within three hours of injury
- ▶ Minimal non-haematological fluids should be used in order to maintain a central pulse
- ▶ Once a patient has reached hospital, care should be as close to the gold standard as possible
- ▶ NHS Blood Transfusion Service (NHSBT) is also responsible for holding CBRN (*ie* Nerve Agent) antidote pods [MOI 5](#) →

ED Resus

Once a major incident has been declared:

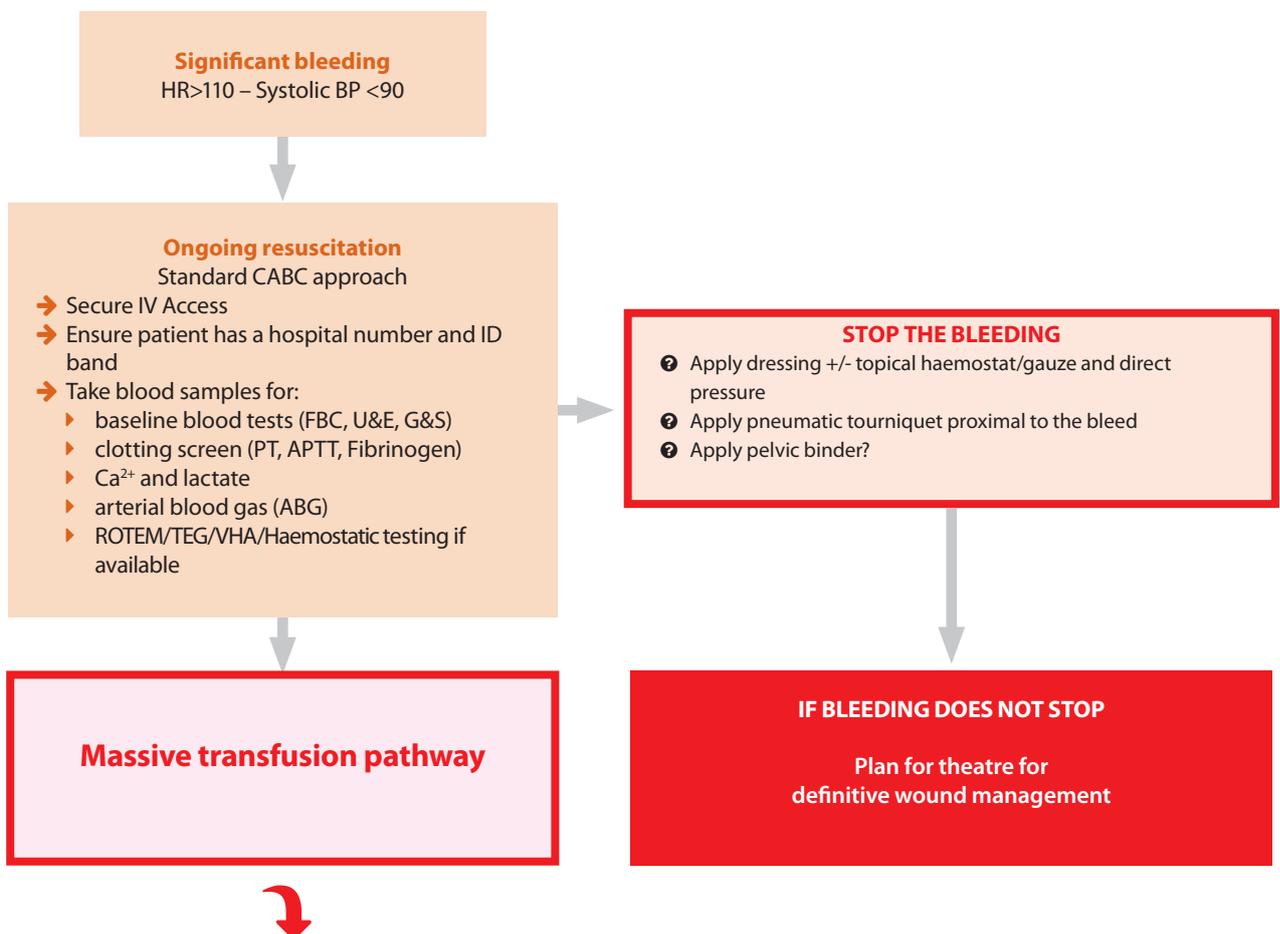
- ▶ Request one MHP1/MTP1/Shock pack for each P1 casualty expected
- ▶ Consider basing transfusion staff in ED (transfusion practitioners/medical staff) to support multiple ED transfusions
- ▶ A porter should be assigned to the ED blood fridge

Catastrophic haemorrhage

Prevent hypothermia

Manage shock

Minimise unnecessary use of crystalloids



Catastrophic haemorrhage and massive transfusion pathway in a major incident

Massive transfusion pathway

- Open **MHP1 pack**
 - ▶ Use rapid transfuser/blood warmer if available
 - ▶ Give FBC:FFP in 1:1 ratio (until coag monitoring available)
 - ▶ Anticipate the need for platelets and cryoprecipitate (fibrinogen)

- MHP1 pack** may contain;
- ▶ Four units RBCs (may be obtained from an emergency stock of Group O blood)
 - ▶ Four units plasma (Group A or AB)

Reassess patient

- ❓ Is there suspected continuing ongoing haemorrhage?
- ✓ Repeat trauma bloods
 - ▶ baseline blood tests (FBC, U&E, G&S)
 - ▶ clotting screen (PT, APTT, Fibrinogen)
 - ▶ Ca²⁺ and lactate
 - ▶ arterial blood gas (ABG)
 - ▶ ROTEM/TEG/VHA/Haemostatic testing if available

Other considerations

- ❓ Is group specific blood now available?
 - ▶ Aim for goal directed therapy using group specific blood
- ❓ Has TXA bolus been given?
 - if <3hrs after injury, give TXA 1g IV bolus over 10 mins
- ❓ Is the TXA infusion now required?
 - Then, TXA 1g IV infusion over 8 hours
- ❓ Anticipate low Calcium
 - ▶ Consider 10mls of 10% Calcium Chloride IV bolus over 10 mins (after MHP1)

- If bleeding continues**
- Open **MHP2 pack**

- MHP2 pack** may contain;
- ▶ Four units RBCs
 - ▶ Four units Plasma
 - ▶ One dose (ATD) Platelets
 - ▶ One pool of cryoprecipitate

If lab results are now available

(And use group specific blood if available)

Goal directed therapy

- ❓ Falling Hb → FBCs
- ❓ APPT and/or ratio >1.5 → FFP 15–20ml/kg
- ❓ Fibrinogen <1.5 g/l → Cryoprecipitate (2 pools)
- ❓ Platelet count <75×10⁹/l → Platelets 1 adult dose

OR

Lab bloods not yet available

- ▶ Continue to transfuse RBC:FFP:Platelets ratio 1:1:1
- ▶ Consider cryoprecipitate (Fibrinogen concentrate may be available)
- ▶ Chase lab results to enable goal directed therapy

After 2x MHP packs given, aim for
GOAL DIRECTED THERAPY

Post resuscitation aims

Hb	80–100 g/dl	Ca ²⁺	>1 mmol/l
Platelets	>75 x10 ⁹ /l	K ⁺	<5.8mmol/l
PT ratio	<1.5	Temp	>36°C
APTT ratio	<1.5	pH	>7.35 (on ABG)
Fibrinogen	>1.5 g/l		

Catastrophic haemorrhage and massive transfusion pathway in a major incident

- ▶ Trauma Induced Coagulopathy (TIC) is the acute intrinsic coagulopathy arising in severely injured trauma patients and is considered to be an emergent property of tissue injury combined with hypoperfusion.
- ▶ Massive Haemorrhage Packs (MHP)=Massive Transfusion Packs (MTP) = Shock Packs
- ▶ Universal components (ABO compatible blood products) may be used in the initial shock packs, but group specific component should be used when safe to do so. Shock packs vary between hospitals – be familiar with local practice.
- ▶ RBCs and Platelets should be RhD and K compatible to prevent the future development of antibodies, however Group O RhD and K Negative red cells may be in short supply and should be prioritised for children and women under the age of 50. Best practice requires two separate blood samples to confirm the ABO and RhD groups.

Blood Planning

There are a few suggested methods and all good enough for planning. The UK NHSBT advise to plan for 3 RBC units per casualty admitted to the hospital. EPRR Blood planning should include a pre-determined first hour capability (total of P1 and P2s), which can be used to support transfusion planning for the hospital and the blood service.

Transfusion requirements based on patient triage in the first 24hrs – estimated for planning purposes

Injury severity	Red Cells (SAGM)	Plasma (FFP or Octaplas)	Platelets (ATD = pool of 4)	Cryoprecipitate
P1	8	8	2	2
P2	2-4	0	0	0
P3	0	0	0	0

Use of blood products, coagulation studies and VTE prophylaxis

- ▶ **Serial coagulation studies** (Platelet count, PT, APTT and fibrinogen) or ROTEM/TEGs should be done, before and after resuscitation and every 30–60 minutes depending on severity of haemorrhage, to guide use of blood products.
- ▶ Cryoprecipitate is the standard source of **fibrinogen** in the UK. Consider if Fibrinogen falls below 1.5g/l. 2 pools (from five donors each), will increase fibrinogen in an adult by 1g/dl approx.
- ▶ **If FFP or Cryoprecipitate is required** urgently for a patient, before the blood group is known, then Group A should be issued (adults). In massive haemorrhage, the risk of clinically significant haemolysis is likely to be very low.
- ▶ **Thromboprophylaxis should be given after major haemorrhage** and should be started as soon as possible after bleeding ceases. There is some evidence from obstetrics that those who bleed excessively have a higher rate of VTE.

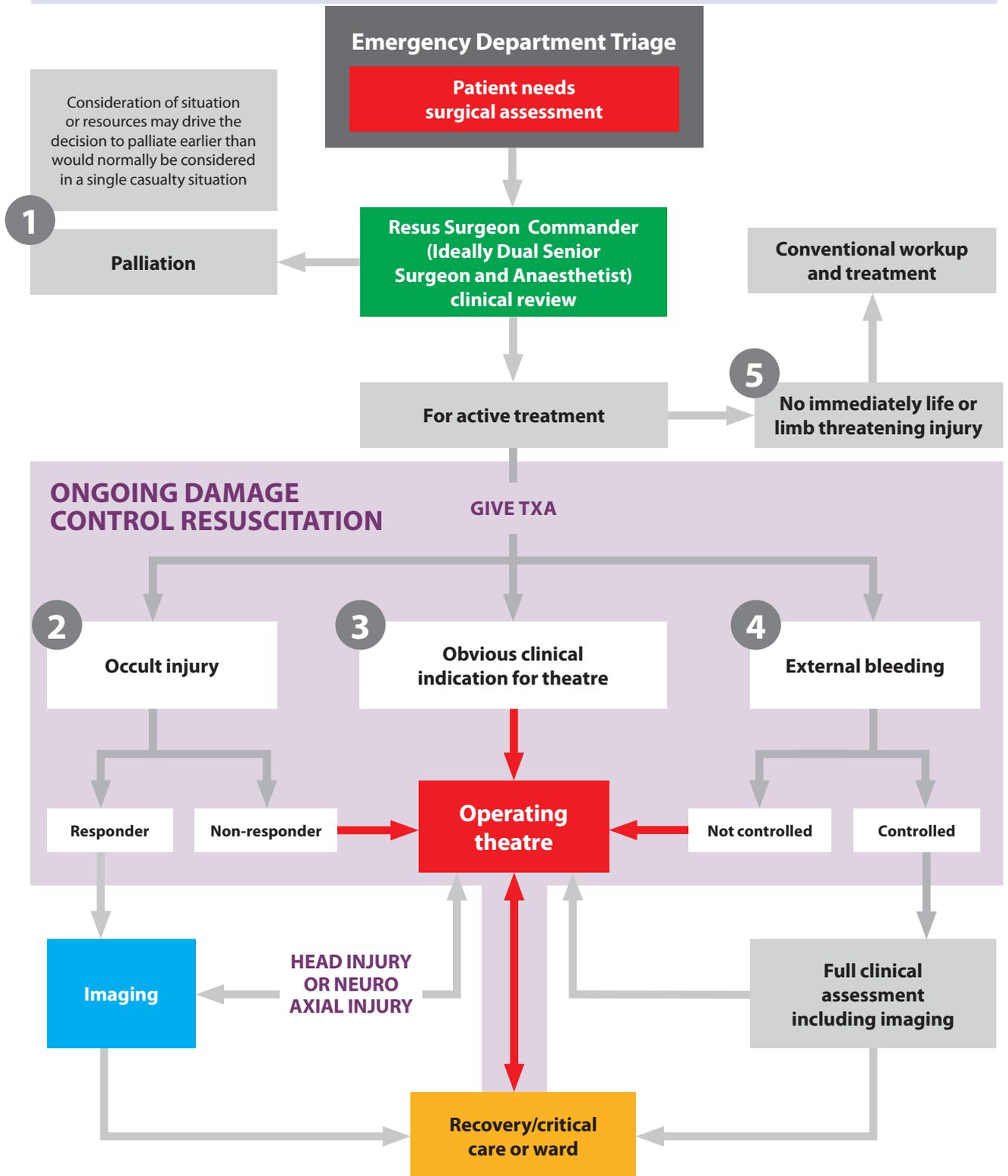
Blood donations during/after a major incident

One of the immediate responses of the public is to offer to donate blood. The challenge for blood services is how to harness that spirit of public altruism that manifests after a disaster, without wasting any blood. In 2001 after the World Trade Centre and Pentagon attacks, 475000 units of blood were collected, but only 258 used. Please advise any prospective donors that their blood is likely to be needed in the future and that they should register as a blood donor and respond to the blood donation service's requests for blood.

MI senior clinical decision making

- ▶ Dual senior decision making is preferred
- ▶ Reassess casualties often. Consider palliation or upgrading care if the casualties condition changes or if the situation changes (for example delays to transfer)

- ▶ Using POC thromboelastography (TEG/ROTEM) to guide resuscitation is the gold standard
- ▶ Consider Interventional Radiology if capability is available locally (without need to transfer) and if theatre space is limited
- ▶ FAST not yet proven to be reliable in trauma however may assist prioritisation of patient to imaging or theatre



MI imaging (including CT whole body)

Imaging is vital for triaging patients, helping to plan surgery, how critical is the need to have surgery and to help guide ongoing surgery. Unusual mechanisms and unfamiliar pathology are the hallmark of MI patients.

- ▶ Plan for interval imaging over the next few weeks as injuries evolve, blast injuries in particular.
- ▶ Use FAST USS imaging to stratify multiple patients; to decide who needs a CT, who needs it urgently and who needs to go directly to theatre.

CT is no longer the 'doughnut of death'. Patients can be resuscitated during a CT scan unless critically unwell, in which case the patient probably should have gone direct to theatre.

CT whole body takes two minutes, the rest of the time is spent on patient transfer and preparation. Regular team training will reduce this. Radiation exposure is approx 12mS.

2 – Neck

- ? Oedema
- ? Larynx and oesophageal
 - ▶ penetration
 - ▶ rupture
- ? Laryngeal fracture

4 – Abdomen and pelvis

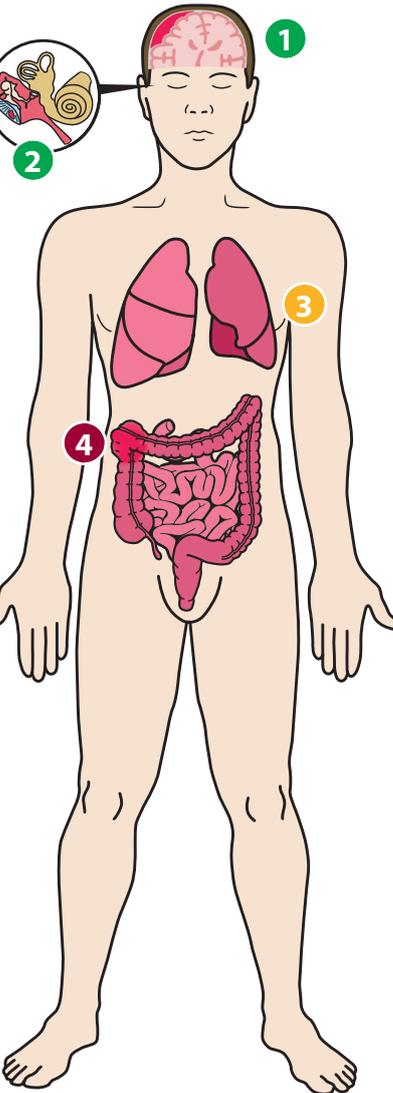
- ? Hollow viscus rupture **4**
- ? Repeat scans for solid organs
 - ▶ AVM/pseudo-aneurysm
 - ▶ cavitation effect

Vascular injury

- ? Haemorrhage or embolus
- ? Aneurysm or pseudo-aneurysm
- ? Vessel splaying
- ? Fragment within 5mm of artery
 - ▶ AVM/pseudo-aneurysm
 - ▶ cavitation effect

i KEY POINTS

- ⚠ Avoid MRI in acute phase**
 - ▶ Assume all frag/metallic foreign bodies are ferromagnetic until proven otherwise
 - ▶ Pistol rounds tend to be non-ferrous but there are exceptions
 - ▶ MRI likely to be safe after six weeks with caveats
 - ➔ PHE and Welsh guidance is available online 



1 – Head

- ? Haemorrhage **1**
 - ▶ intra- or extra-axial
 - ▶ small petechial foci
 - ▶ at bone ridges
- ? Middle ear effusion
 - ▶ +/- ossicular disruption **2**
- ? Fractures

3 – Thorax

- ? Pericardial and great vessel integrity
- ? Tracheobronchial integrity
- ? Pneumothorax/haemothorax
- ? Lung parenchyma **3**
 - ▶ contusions
 - ▶ infiltrates
 - ▶ emboli (may be transient)
 - ▶ ARDS may develop over next 24-72 hrs

Bones

- ? Spinal fractures and mal-alignment
- ? Long bone fractures
 - ▶ fat embolus
- ? Pelvic ring injury
 - ▶ SIJ integrity
 - ▶ sacral fractures

CT whole body

- ▶ Low threshold to image in mass events and in blast (blast radius can be large)
- ▶ CT whole body means head to ankles
- ▶ CT traumagram means head to lesser trochanters (Bastion protocol)
- ▶ Intraoperative CT can be done after haemorrhage control is gained
- ▶ Repeat, delayed imaging at 5–7 days should be considered if solid organ injury

Department planning

- ? Consider senior consultant in ED to coordinate imaging flow
- ▶ Use USS in ED to triage to CT
- ▶ Two consultants per CT scanner
 - ▶ The first issues an acute report, the second completes a full report

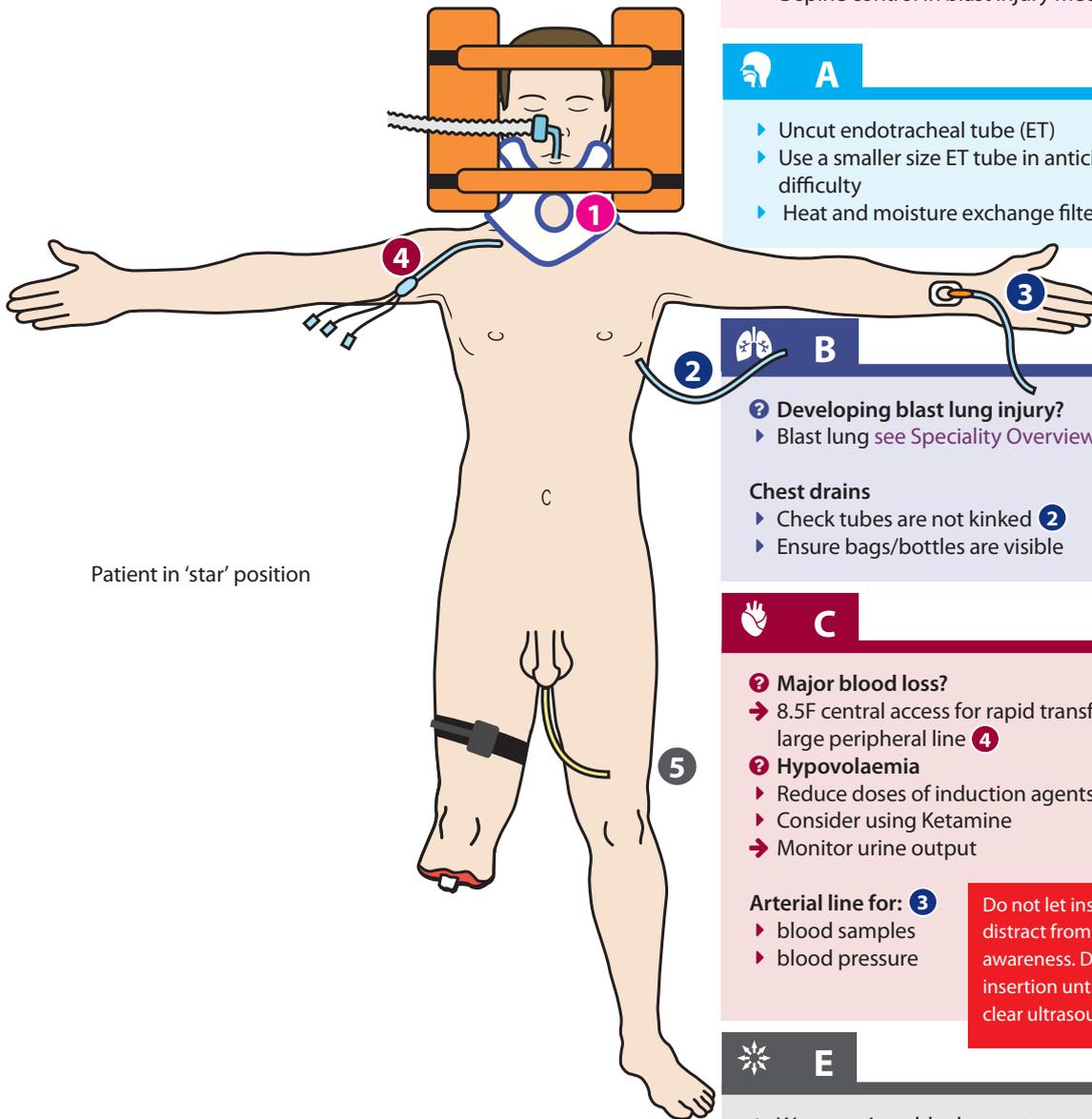
MI anaesthesia (for P1/Resus casualties)

Anaesthesia Induction

- ▶ RSI checklist – decide and designate responsibilities/tasks
- ▶ Patient in 'star' position

Communication

- ▶ **WHO briefing:**
WHO is doing WHAT and in WHAT SEQUENCE?



Patient in 'star' position



- ▶ C-spine control in blast injury mechanism **1**



- ▶ Uncut endotracheal tube (ET)
- ▶ Use a smaller size ET tube in anticipated airway difficulty
- ▶ Heat and moisture exchange filter (HME)



- ⚠ **Developing blast lung injury?**
- ▶ Blast lung see [Speciality Overview](#) **4** ↪

Chest drains

- ▶ Check tubes are not kinked **2**
- ▶ Ensure bags/bottles are visible



- ⚠ **Major blood loss?**
- 8.5F central access for rapid transfusion and/or large peripheral line **4**
- ⚠ **Hypovolaemia**
- ▶ Reduce doses of induction agents
- ▶ Consider using Ketamine
- Monitor urine output

Arterial line for: **3**

- ▶ blood samples
- ▶ blood pressure

Do not let insertion attempt(s) distract from situational awareness. Delay arterial insertion until palpable pulse or clear ultrasound image.



- ▶ Warm patient: blanket mattress, warm fluids, theatre temperature

i KEY POINTS

⚠ Falling oxygen saturation

- ⚠ Has IPPV caused an unrecognised pneumothorax to develop into a tension pneumothorax?
- ⚠ Is there developing lung contusion or 'blast lung'?
- ⚠ Could there be emboli?

⚠ Circulation

In 'non-star' patient positions (eg lateral), is the patient position impeding:

- ▶ diaphragm movement?
- ▶ chest movement?

⚠ Circulation

Unexplained drop in blood pressure NOT due to hypovolaemia. Consider:

- ▶ tension pneumothorax?
- ▶ cardiac tamponade?

MI neurotrauma (brain injuries)

The principal aim is to prevent or reduce secondary brain injury. Ideally a patient with a brain injury would be transferred to a neurosurgical centre, however in a major incident this may not be possible, or other injuries may dictate that a patient should be cared for at another specialist centre.

These guidelines are to assist in recognising which patients need to be transferred for surgery (once transfers are possible) and how to optimise their care prior to that transfer.

Most common blast brain injuries are diffuse axonal injury (DAI), cerebral contusions and subdural haemorrhage.

Assessing for brain injury

Conscious level	AVPU	Good for basic assessment,
	GCS	Preferred for monitoring patient and detecting subtle signs of deterioration Mild GCS 14-15, Moderate GCS 9-13, Severe GCS <8 Please use the E4, V5, M6 breakdown when discussing with neurosurgeons
Pupil response		▶ Pupillary response is a lateralising sign and can indicate the side of the injury
Limb weakness	✔	Simple documentation of a patient's movements at each assessment, starting on scene is very important <i>ie</i> patient able to move all four limbs
Signs of injury	✔	Document any lacerations, bruising, open/closed/depressed skull fractures, extruding brain. ▶ However, mild traumatic brain injury (mTBI) and simple contusions often occur without any external signs of injury



A

- ❓ Does the patient require intubation to secure the airway?
 - ▶ Intubate early if patient is aggressive or combative or has a low GCS
 - ▶ Intubate to protect the airway and allow safe transfer to the CT Scanner



B

- ▶ Manage chest injuries to optimise ventilation and reduce risk of hypoxic brain injury



C

- ▶ Control haemorrhage and correct hypovolaemia
 - ▶ Maintain systolic blood pressure >100mmHg
 - ▶ Volume replacement should be with blood until bleeding as a cause of hypovolaemia is ruled out.
 - ▶ Hypertonic saline may improve outcome, especially in TBI patients with GCS<8
 - ▶ Anticoagulants should be reversed (unless there is an overriding medical reason not to)



D

If ICP raised, there are some simple techniques to reduce ICP, including:

- ▶ Remove cervical collar (it may be strangling the patient)
- ▶ Avoid moving the patient (except for pressure relief)
- ▶ Nurse head-up (at 30°)
- ▶ Sedate and give analgesia. Most forms of sedation will reduce BP.
- ▶ Control ventilation. Aim for normocapnia and keep PEEP <12 H₂O
- ▶ Mannitol (Diuretic action): (0.5–1g/kg IV dose is given, which can be repeated if required)
- ▶ Hypertonic saline (6mL/kg of 5%, up to 350mls max dose)

Other medical management

- ❓ **Keppra (Levetiracetam)**
 - ▶ Loading dose 1g then 500mgs OD for 7/7 should be used to prevent fitting in any patients with intracranial haemorrhage
- ❓ **Pneumococcal vaccine**
 - ▶ Should be given in open cranial fractures and if there is any evidence of intra cranial gas
- ⚠ **AVOID:**
- ✖ **Steroids**
 - ▶ Increased mortality at two weeks associated with steroid use in head injury (GCS<14) and should be avoided
- ✖ **Nimodipine**
 - ▶ No evidence to support its use in cranial trauma
- ✖ **Magnesium**
 - ▶ No evidence to support its use in cranial trauma
- ✖ **Antibiotics**
 - ▶ No evidence that antibiotics prevent infection in skull based fractures, with or without CSF leak

MI neurotrauma (brain injuries)

Types of brain injury

Primary brain injury		▶ If patient requires surgery, it is unlikely that any medical intervention will replace surgical management. However, prevention of secondary injury is essential.
Secondary brain injury	Hypoxia	▶ A single episode of hypotension between injury and resuscitation doubles mortality and morbidity ▶ Protect airway, high flow oxygen with re-breathe mask during resuscitation
	Ischaemia	▶ Poor cerebral perfusion secondary to hypovolaemia causes raised intracranial pressure: treat hypovolaemia early
	Raised intracranial pressure	▶ Intracranial haematoma or oedema can raise intracranial pressure (ICP). This also reduces perfusion and causes ischaemia ▶ Normal ICP is 5–15mmHg. When ICP>20mmHg, contact the neurosurgical centre for advice on escalation of treatment
	Acidosis Coagulopathy	▶ Injury at cellular level causes lactic acid production and coagulopathy: reduced cerebral blood flow results in accumulation and further cellular damage
	Abnormal blood glucose	▶ Lack of glucose in the presence of oxygen results in neuronal necrosis; this is even more significant in hypoxia
Others		▶ Including cytotoxic cascade, vasospasm

Classification and significance of brain injuries

Extradural (epidural) haematomas (EDH)	▶ Small EDHs can be managed conservatively, however most will require neurosurgical evacuation
Subdural haematomas (SDH)	▶ Usually associated with significant primary brain injury, and therefore outcome is usually worse than EDHs ▶ May be due to an acute or chronic bleed ▶ Acute bleeds must be recognised, as they may cause mass effect/midline shift and are likely to need neurosurgical intervention
Subarachnoid haemorrhage	▶ Unlikely to require surgical treatment and can be managed with good supportive care. ▶ Will need to have a non-urgent CT Angio to exclude aneurysmal cause
Contusions and intracerebral haematomas	▶ Discrete contusions and haematomas may coalesce and evolve. Tends to peak 48–72 hours post injury. Intracranial pressure may need to be monitored ▶ Oedema and associated rise in ICP may make these minor cerebral injuries life threatening and difficult to treat
Diffuse injuries	▶ Full spectrum of injuries from mild concussion through to severe diffuse axonal injury. Little scope for surgical intervention and these patients are usually managed in regional severe brain injury centres

Signs of basal skull fractures

CSF rhinorrhea	▶ Use BM stix/urine dipsticks to test for Glucose (present in CSF but not in mucus)
Bilateral Peri-orbital haematomas (Raccoon/Panda eyes)	
Subconjunctival haemorrhage	▶ May indicate blood tracking from the orbital cavity
CSF otorrhea	▶ May be due to ruptured tympanic membrane (?CSF leak) or blood from an external ear laceration
Bruising over the mastoid(s) (Battle's Sign)	▶ May take 24–48 hours to develop

MI surgical/proximal haemorrhage control

If catastrophic haemorrhage cannot be stemmed by direct pressure or a tourniquet, so called “uncompressible haemorrhage”, it is essential to obtain control by surgical access. This is normally most rapidly achieved by exposing vessels proximal to the immediate zone of injury. To control retrograde filling, vessels distal to the injury should also be exposed.

- ▶ Interventional radiology is not recommended for genuine catastrophic haemorrhage in an unstable patient.
- ▶ REBOA may have a role but currently should be viewed as experimental and used as part of a trial.
- ▶ In the profoundly hypovolaemic patient a palpable pulse may not always be present so finding the vessels relies on knowledge of anatomical landmarks.

Primary (Rapid Access) Incisions:

1. Longitudinal incision along anterior border of the sternocleidomastoid muscle (ABSCM)
5. Clam shell thoracotomy
6. Supraclavicular for proximal control of arm vessels
17. Lower midline laparotomy for pelvic packing (can be extended to 15)
19. Longitudinal groin incisions for proximal control of leg vessels

Neck

- ❓ Oblique longitudinal incision **1** along the ABSCM
 - ▶ for access to the carotid tree and internal jugular vein in Zones 2 and 3
- ❓ Median sternotomy may be required for proximal control of Zone 1 injuries **5**

Thorax

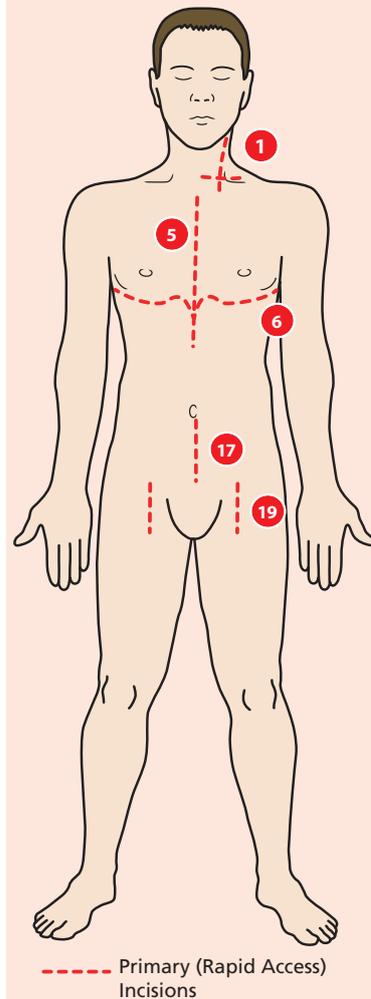
- ❓ 4th intercostal space clamshell incision **6**
 - ▶ for all large thoracic vessels
- ❓ 4th intercostal space anterolateral thoracotomy
 - ▶ cardiac tamponade
 - ▶ internal cardiac massage
 - ▶ control of the descending thoracic aorta

Abdomen

- ❓ 4th space anterolateral thoracotomy
 - ▶ Rapid proximal control in high abdominal injuries and peri-arrest situations
- ▶ All other approaches to the aorta and common iliacs should be via a midline laparotomy.
- ❓ If solid organ injury, rapid control is achieved by packing

i KEY POINTS

- ▶ Use extensile incisions
- ▶ Incision can incorporate wound line as required
- ▶ Aim to achieve proximal/ distal control outside of any haematoma or zone of injury



Upper limb

- ❓ Medial supraclavicular incision running parallel to the clavicle
 - ▶ control of the subclavian vessels as they cross the first rib
 - ▶ most proximal part of the axillary artery
- ❓ Lateral horizontal infraclavicular incision
 - ▶ access to the majority of the axillary artery
- ❓ Axillary incision and extending longitudinally down the arm in the medial bicipital groove
 - ▶ for the most distal part of the axillary artery and upper brachial artery
 - ▶ Control below the upper part of the brachial artery is achieved with a tourniquet.

Pelvis

- ▶ For rapid haemorrhage control by pelvic packing
 - ❓ extraperitoneal approach via a lower mid-line incision
 - ❓ by direct packing via a laparotomy. **17**

Lower limb

- ▶ Control of external iliac vessels by
 - ❓ direct dissection via a laparotomy
 - ❓ extraperitoneal approach by laterally extending a **19** longitudinal groin incision
- ▶ Control distal to the upper part of the superficial femoral artery is achieved with a tourniquet.

MI surgical/proximal haemorrhage control

The following approaches are for rapid access to achieve life saving vascular control. They are not necessarily the best approaches for planned vascular surgery.

Surgical approaches to control catastrophic haemorrhage in the following regions:

Neck:

- ▶ Zone 1 injuries may require proximal control of the great vessels via a median sternotomy. If necessary, divide the left brachiocephalic (innominate) vein to improve access.
- ▶ The carotid tree and internal jugular vein can be accessed in Zones 2 and 3 by an oblique longitudinal incision along the anterior edge of the sternocleidomastoid muscle. The sternal head can be divided as can omohyoid and the facial vein. Preserve the hypoglossal nerve. With good retraction it is possible to reach the base of the skull via a distal extension of this incision.

Thorax:

- ▶ All large vessels in the thorax can be accessed via a 4th intercostal space clamshell incision.
- ▶ A 4th intercostal space anterolateral thoracotomy alone can be used for diagnosis, relief of cardiac tamponade, internal cardiac massage and control of the descending thoracic aorta. It does not give easy access to other vessels.
- ▶ The left subclavian artery is more easily accessed via a median sternotomy.

Abdomen:

- ▶ Probable high abdominal injuries and peri-arrest situations may be addressed more quickly by control of the descending thoracic aorta via a 4th space anterolateral thoracotomy.
- ▶ All other approaches to the aorta and common iliacs should be via a midline laparotomy.
- ▶ For large vessel injury rapid control is achieved by supra-coeliac compression immediately below the diaphragm or infra-renal compression at the root of the mesentery – depending on the level of the injury.
- ▶ For organ injury rapid control is achieved by packing.
- ▶ Further dissection is dictated by the exact location of the vascular injury or organ involved.
- ▶ Access to the main vessels is achieved by entry into the retroperitoneum either directly at the root of the mesentery or by medial visceral rotation from the left or right.

Upper limb:

- ▶ Control of the subclavian vessels as they cross the first rib and the most proximal part of the axillary artery can be achieved via a medial supraclavicular incision running parallel to the clavicle. This requires division of the clavicular head of sternocleidomastoid and then the anterior scalene muscle with preservation of the phrenic nerve. The trunks of the brachial plexus are in close proximity.
- ▶ The majority of the axillary artery is accessed through a lateral horizontal infraclavicular incision. The fibres of pectoralis major should be split horizontally and then the deeper pectoralis minor muscle divided through its tendon. This then reveals the axillary vessels in a fat-pad. The cords of the brachial plexus are in close proximity.
- ▶ It is rare to need to violate the clavicle but if access to the exact portion of the axillary artery beneath it is required it can be divided with a saw in its mid portion.
- ▶ The most distal part of the axillary artery and upper brachial artery are best approached via an axillary incision and extending longitudinally down the arm in the medial bicipital groove. If necessary, infraclavicular and bicipital groove incisions can be joined with the vessels exposed by dividing the pectoralis major tendon at its humeral insertion.
- ▶ Control below the upper part of the brachial artery is achieved with a tourniquet.

Pelvis:

- ▶ Rapid control by pelvic packing can be achieved by an extraperitoneal approach via a lower mid-line incision or by direct packing via a laparotomy.
- ▶ Common and internal iliac vessels are most rapidly control by direct dissection via a laparotomy.

Lower limb:

- ▶ External iliac vessels can be controlled by direct dissection via a laparotomy or by an extraperitoneal approach by laterally extending a longitudinal groin incision and dividing the inguinal ligament lateral to the deep ring.
- ▶ The common femoral artery to beyond its bifurcation and the lower part of the external iliac vessels are accessed via a longitudinal groin incision centred over the mid-inguinal point.
- ▶ Control distal to the upper part of the superficial femoral artery is achieved with a tourniquet.

MI surgical/proximal haemorrhage control (Additional options for vascular exposure)

- ▶ Use extensile incisions
- ▶ Incision can incorporate wound line as required
- ▶ Aim to achieve proximal/ distal control outside of any haematoma or zone of injury

Pelvis

Incision: lower midline laparotomy into extra peritoneal plane to level of SI joints 17

- ▶ allows pelvic packing with an extensile incision

Example wound for use:

- ▶ pelvic injury without requirement for laparotomy

Incision: supra inguinal 18

2 cm above and parallel to the inguinal ligament, extending from the lateral rectus sheath to a point 2 cm cephalad to the anterior superior iliac spine

- ▶ allows extra peritoneal control of proximal external iliac vessels

Incision: longitudinal groin 19

Over the femoral pulse with 1/3rd of the incision above the inguinal ligament and 2/3rds below inguinal ligament

- ▶ if no palpable pulse then incision should extend longitudinal through mid point between pubic symphysis and ASIS

Proximal control: distal external iliac vessels

Distal control: common femoral vessel bifurcation

Example wound for use:

- ▶ exposure of injured femoral segment in conjunction with more proximal and distal control
- ▶ proximal control for thigh injury

Abdomen

Incision: midline laparotomy from xiphisternum to pubic symphysis 15

Proximal control: supra coeliac aortic supra coeliac and intra abdominal IVC. Visceral vessels.

Distal control: distal external iliac vessels and proximal internal iliac vessels

Example wound for use:

- ▶ penetrating or blunt abdominal/ pelvic injury

Lower limb

Incision: thigh - parallel to the anterior-lateral border of the sartorius muscle 20

Proximal control: femoral and profunda femoris vessels

Distal control: proximal 1/3rd popliteal vessel segments

Example wound for use:

- ▶ proximal control for popliteal artery injury

Improve exposure: Connect groin and thigh incisions 21

- ▶ allows full exposure of common femoral and femoral vessels

Incision: 1 cm behind the posterior border upper half of tibia 22

- ▶ incorporate into leg fasciotomy wounds where used

Proximal control: distal 1/3rd popliteal vessel segments

Distal control: Origin of anterior tibial artery, tibial peroneal vessels and proximal posterior tibial and peroneal vessels

Improve exposure: Connect thigh and leg incision 23

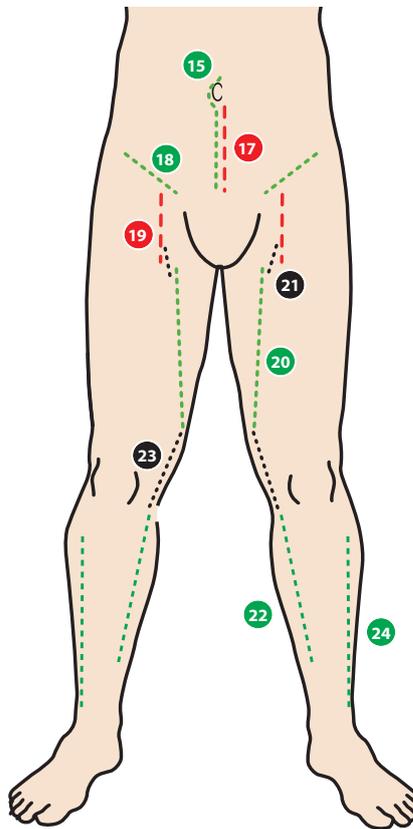
- ▶ allows exposure of middle 1/3rd popliteal vessel segments through division of dividing the tendons of the semitendinosus, gracilis, and sartorius muscles

Incision: Anterolateral leg 24

- ▶ incorporate into leg fasciotomy wounds where used

If no fasciotomy then a longitudinal incision is made in the anterolateral leg halfway between the tibia and fibula over 10-15cm

- ▶ allows exposure of mid anterior tibial artery



KEY

Primary (Rapid Access) incisions:

- 17. Lower midline laparotomy for pelvic packing (can be extended to 15)
- 19. Longitudinal groin incisions for proximal control of leg vessels

Alternative incisions for Vascular Access:

- 15. Midline laparotomy incision
- 18. Supra inguinal incision
- 20. Anterior-lateral thigh
- 22. 1 cm behind the posterior border upper half of tibia
- 24. Anterior-lateral leg

Extensions:

- 21. to extend/connect 19 and 20 to allows full exposure of common femoral and femoral vessels
- 23. to connect 20 and 22 to improve exposure of popliteal vessels

MI surgical/proximal haemorrhage control (Additional options for vascular exposure)

Neck

Incision: longitudinal incision along the anterior border of the sternocleidomastoid muscle (ABSCM), extending from the clavicular head to the retromandibular region 1

- ▶ should be curved slightly and extended just inferior to the lobe of the ear at its distal end.

Proximal control: Common carotid artery to root of neck

Distal Control: Internal carotid artery to base of skull

Example wound for use:

- ▶ zone 2 carotid vessel injury

Improve exposure 2

Connect bilateral ABSCM incisions distally and lift a sub platysema flap for good vascular aerodigestive tract exposure
for example in a through- through penetrating injury

Thorax

Incision: Median Sternotomy 3

2cm above sternal notch to 2cm below xiphoid process

Proximal control: origin of aortic branch vessels

Distal control: distal extent of intra thoracic aortic branch vessels

Example wound for use: zone 1 carotid vessel injury

Improve exposure

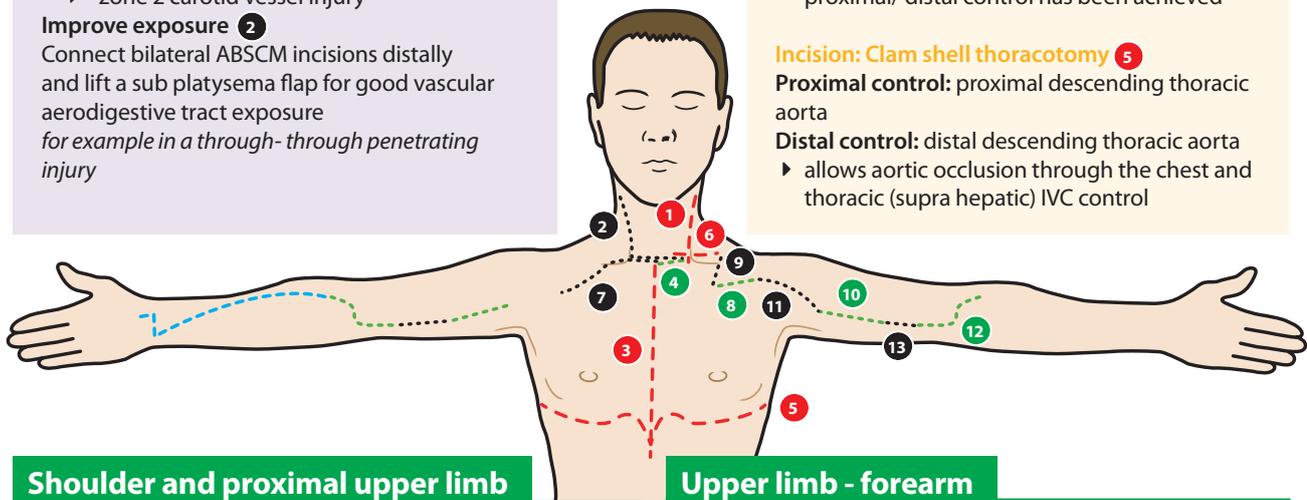
Connect median sternotomy incision to ABSCM incision 4

- ▶ allows junctional exposure of wound once proximal/ distal control has been achieved

Incision: Clam shell thoracotomy 5

Proximal control: proximal descending thoracic aorta

Distal control: distal descending thoracic aorta
▶ allows aortic occlusion through the chest and thoracic (supra hepatic) IVC control



Shoulder and proximal upper limb

Incision: supraclavicular 6

An incision is made 1 cm above and parallel to the clavicle, beginning at the clavicular head and extending approximately 8 cm laterally

Proximal control: extra thoracic subclavian vessels, vertebral artery

Distal control: extra thoracic subclavian vessels

Example wound for use: shoulder/upper limb junctional wound

Improve exposure 7

Connect supraclavicular (+/- division of clavicle), median sternotomy and 5th space left anteriolateral (trap door)

- ▶ allows improved exposure to root of neck and left intrathoracic apex

Incision: infraclavicular 8

A horizontal skin incision is made 2 cm below the middle 1/3rd of the clavicle, extending for approximately 8 cm)

Proximal control: proximal 1/3rd axillary vessels

Distal control: middle 1/3rd axillary vessels

Example wound for use: shoulder/ upper limb junctional wound

Improve exposure 9

Connect supraclavicular and infraclavicular incisions with division of clavicle

- ▶ allows improved exposure of proximal 1/3rd axillary vessels

Upper limb - forearm

Incision: along groove between biceps and triceps 10

Proximal control: brachial vessels

Distal control: brachial vessels/ brachial bifurcation

Example wound for use: mid- distal brachium wound

Improve exposure 11

Connect to infraclavicular incision

- ▶ allows junctional exposure of axillary vessels through delto pectoral approach

Incision: medial to lateral lazy S across anti-cubital 12

Fossa (M-LLSACF) - from biceps/triceps groove to mid forearm, 2-3cm above and below elbow crease

Proximal control: Distal brachial vessels/ brachial bifurcation

Distal control: Distal brachial vessels/ brachial bifurcation

Example wound for use: proximal and mid forearm wound

Improve exposure 13

Connect biceps/ triceps groove incision to M-LLSACF incision

- ▶ allows full exposure of brachial vessels

Incision: use/ adapt forearm volar fasciotomy incision 14

where possible (M-LLSACF to radial mid forearm to distal ulna, transverse at wrist crease to line of radial boarder of ring finger to kaplan's cardinal line)

Proximal control: Distal brachial vessels/ brachial bifurcation

Distal control: mid forearm radial vessels, distal ulnar vessels

- ▶ allows exposure of forearm vessels without additional volar fasciotomy incision

MI vascular trauma

Do the **MINIMUM surgery to preserve life and limb, in that order**

Remember:

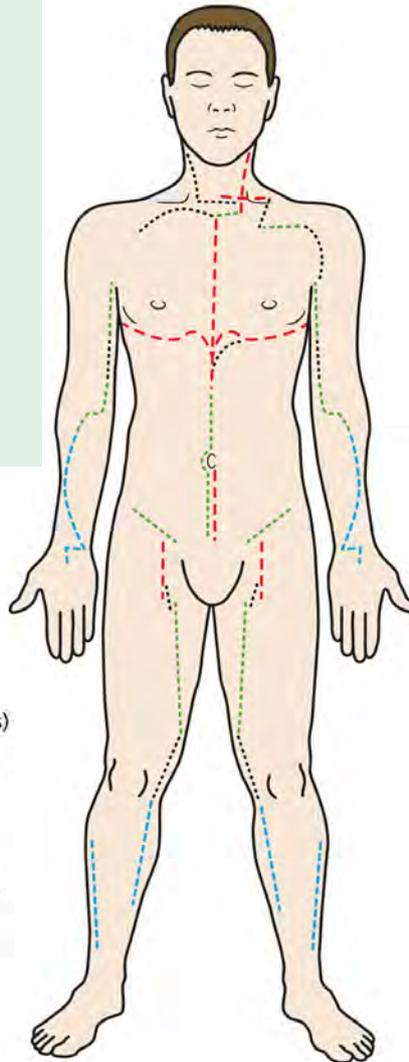
- ▶ Non-vascular specialists may need to undertake vascular interventions due to casualty numbers
- ▶ Temporary vascular shunts and vessel ligation will be the mainstay of treatment for vascular injury and not reconstruction. Amputation rate may be high. Recognise futility in limb reconstruction; decision to amputate should be made by two surgical consultants.
- ▶ Interventional radiology has a limited role in mass casualty situations, however IR could be utilised for diagnostics to provide the most effective targeted interventions in theatre, such as thoracic aortic stenting or IVC filter placement

Catastrophic haemorrhage

- ▶ gain proximal control and **STOP THE BLEEDING**
- ▶ In uncontrollable haemorrhage, patient should go direct the theatre and can have a CT Traumagram/imaging once the bleeding is controlled

Initial management

- ▶ Orientate force to compress wound against the underlying axial skeleton
- ▶ Small wounds can be managed with a single gauze swab and digital pressure
- ▶ Larger cavities can be managed with internal gauze packing (eg. kurlax) and palmar pressure
- ▶ Manage pain with IV opiate analgesia concurrent with any wound manipulation
- ▶ Avoid application of haemostats to any visible vessels
- ▶ Transfer to theatre as soon as possible



- Primary (Rapid Access) Incisions
- Alternative Vascular Access Incisions
- Extensions
- Fasciotomy Incisions (that can be used for vascular access)

Temporary vascular shunts

Indications

- ▶ All axial vessels above knee/elbow
- ▶ Distal axial vessels, if all continuity lost
- ▶ As a shunt, prior to application of external fixator:
 - ▶ ensure you account for movement created by orthopaedic surgeon when you choose length of shunt.
 - ▶ be at the table when the orthopaedic surgeon is placing the shunt

What to use

- ▶ Vascular shunt (e.g. Pruitt, if available)
- ▶ Sterile plastic tube of appropriate sized for vessels (IV tubing/Nasogastric / Nasopharyngeal tubes – whatever is available and appropriate)

How to use

- ▶ Confirm inflow and back bleed (embolectomy may be required)
- ▶ Fill shunt with Heparinised saline (5000U in 500 ml saline) and clamp
- ▶ Place shunt in uninjured vessel above and below zone of injury
- ▶ Secure with tie around vessel and shunt
- ▶ Shunt can remain in place for up to 48 hrs

Document

- ▶ That a shunt has been placed
- ▶ Frequency of distal limb checks (eg. every 30 mins)
- ▶ Actions if shunt falls out away from theatre (where to press/which vessel loops to pull)

i KEY POINTS

- Stop the bleeding
 - ▶ Proximal/distal control
 - ▶ Shunt or ligate to stop further blood loss
 - ▶ Consider simple repair (if possible) to restore blood supply
 - ▶ Temporary vascular shunt as a bridge to definitive repair
 - ▶ Liberal use of fasciotomy (should be default)
 - ▶ Anticoagulation is not needed for shunts
 - ▶ Antibiotics & Tranexamic acid as per standard guidelines

Clinical features of vascular injury

- | | |
|----------------------------------|--|
| Hard signs | Soft signs |
| Pulseless cold pale limb | History of active bleeding |
| Expanding haematoma | Non-expanding haematoma |
| Palpable thrill or audible bruit | Neurological deficit |
| Active bleeding | Penetrating injury close to major vessel |

MI vascular trauma

Surgical planning

Plan

- ▶ Use a (truncated) WHO checklist
- ▶ Communicate injuries identified
- ▶ Damage control plan (priorities)
- ▶ Equipment required
- ▶ Cavity or cavities to be opened
- ▶ Communicate to staff that plan may change at short notice e.g. open an additional cavity
- ▶ Set parameters to alert surgeon (blood product use threshold) – recognise intraoperative futility; resources may be best invested elsewhere – communicate early through coordinators; arbitration from senior clinician may be required

Intraoperative phase

- ▶ Place in cruciform position
- ▶ Prepare to enter multiple cavities
- ▶ Must have access to be able to gain proximal and distal control
- ▶ Gain control through the access you are most comfortable with (e.g. laparotomy for junctional control of the iliac artery if unfamiliar with Rutherford Morrison approach; median sternotomy for Zone 1 neck injury).
- ▶ Plan regular communication between anaesthetist and surgeon. You must all be aware of: physiological status, inotrope requirements, transfusion situation and evolving operative plan (set alarm and update each other every 15 minutes)
- ▶ Use of Doppler is key in assessing flow
- ▶ On table angiography may be indicated if flow is not restored despite appropriate manoeuvres (vascular dissection)
- ▶ Limb viability should be assessed prior to revascularisation or amputation by two surgeons

Postoperative phase

- ▶ Document operative details carefully, anticipate relook surgery may be performed by another team or even in another hospital
- ▶ List antibiotics/anticoagulation/psychological parameters for return to theatre/actions for major bleeding
- ▶ Plan to return the patient to theatre for reconstruction when stable (typically 24-48 hours) and when vascular specialist available (liaise with your regional Network coordinators who can arrange for a specialist surgeon to come to you)

MI thoracic trauma

Do the MINIMUM necessary surgery to save life: keep on-table time as short as possible. At 1 hour, operating should be finished or finishing.

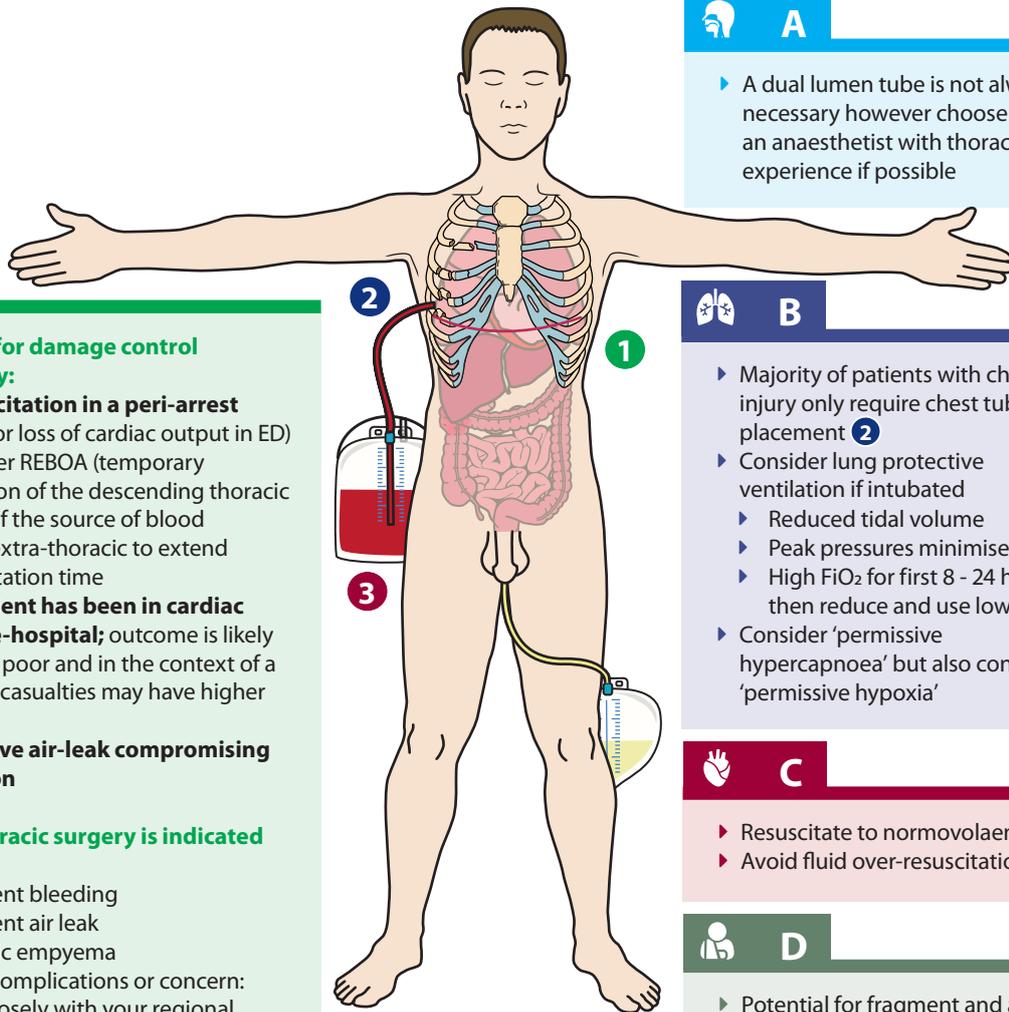
In a mass casualty context, surgery should be complete within 1 hour. Clam-shell thoracotomy is the incision of choice. **1** Surgery should be physiological not anatomical (for non-anatomic resection use gastrointestinal staplers, and consider pulmonary tractotomy for penetrating lung injury before attempting lobar resection).

Fragments from blast and other ballistic projectiles do not respect anatomical boundaries:

- Be prepared to operate on junctional area (eg. neck) and enter adjacent body cavities e.g. laparotomy if there is evidence of co-existing abdominal injury

Catastrophic haemorrhage

- Immediate return from chest tube of approx. 1.5 litres in an unstable patient **3**
- On-going blood loss of approximately 200 ml/hr



A

- A dual lumen tube is not always necessary however choose an anaesthetist with thoracic experience if possible

B

- Majority of patients with chest injury only require chest tube placement **2**
- Consider lung protective ventilation if intubated
 - Reduced tidal volume
 - Peak pressures minimised
 - High FiO₂ for first 8 - 24 hours then reduce and use lowest FiO₂
- Consider 'permissive hypercapnoea' but also consider 'permissive hypoxia'

C

- Resuscitate to normovolaemia
- Avoid fluid over-resuscitation

D

- Potential for fragment and air embolisation (from IPPV)

E

- Examine the back and posterior chest

Indications for damage control thoracotomy:

- For resuscitation in a peri-arrest patient**, (or loss of cardiac output in ED)
 - Consider REBOA (temporary occlusion of the descending thoracic aorta), if the source of blood loss is extra-thoracic to extend resuscitation time
- If the patient has been in cardiac arrest pre-hospital**; outcome is likely to be very poor and in the context of a MCI other casualties may have higher priority
- For massive air-leak compromising ventilation**

Delayed thoracic surgery is indicated for:

- Persistent bleeding
- Persistent air leak
- Thoracic empyema
- Other complications or concern: liaise closely with your regional thoracic surgical team

⚠ Thoracotomy does not have to be done 'routinely' to retrieve fragments following ballistic injury

i KEY POINTS

Select appropriately-sized chest drains, as a rule of thumb:

- Infant: 12-16F
- Child: 16-24F
- Adult: 24-32F

- For every patient with chest injury: ensure pain relief and chest physiotherapy
- Early antibiotics are essential; however, surgical antibiotic prophylaxis is not often required beyond chest drain insertion or the duration of the primary operation

MI thoracic trauma

Prepare for a damage control thoracotomy

Plan for a damage control operation (with planned re-look when the patient is stable)

- ▶ **Place patient supine with arms abducted** (crucifix position)
- ▶ For unilateral injury, a bolster bag (e.g. pressure infusor bag) behind the patient's chest on the injured side help but DO NOT formally turn the patient on their side as endo-bronchial bleeding from an injured lung can contaminate the (dependent) un-injured lung and turn a crisis into a disaster.
- ⊕ Double-lumen tubes are not often necessary
- ▶ **Prep patient's chest and abdomen to knees**; once prepped, patient can be draped appropriately and covered to maintain temperature.

- ▶ **Make a clamshell incision**: limited left thoracotomy gives insufficient access.
- ▶ Always open the pericardium to exclude or treat haemopericardium.
- ▶ Remember to control the internal mammary vessels on the underside of the sternum; above and below your incision.
- ▶ Non-anatomic resection of damaged lung can be done with gastrointestinal staplers.
- ▶ Pulmonary tractotomy should be done when possible to control bleeding and/or air leak from penetrating pulmonary injury rather than attempting major resection.
- ▶ **Remember to check the diaphragms and think of abdominal injury.**

- ▶ Use the vacuum-pack technique for temporary thoracic closure, attaching the dressing to wall suction at 120mmHg. Patients should be intubated and ventilated after trauma thoracotomy and managed in an ICU setting.

- ✔ Maintain intra-operative dialogue with your anaesthetic team. You must be aware of:
 - ▶ physiological status including inotrope requirements
 - ▶ transfusion situation
 - ▶ how long you have been operating

- ▶ **Plan to take the patient back to theatre at 24-48 hours with a thoracic surgeon**; liaise with your regional Network coordinators who can arrange for a specialist surgeon to come to you.

MI abdominal trauma

Do the **MINIMUM** necessary surgery to save life: think **DAMAGE CONTROL**.

Remember:

- ▶ Fragments from blast and other ballistic projectiles do not respect anatomical boundaries.
- ▶ Look for 'paired' injuries in hollow organs
- ▶ Be prepared to enter adjacent body cavities e.g. you may need to do a thoractomy after exploratory laparotomy if the source of on-going bleeding is from the chest and blood is coming through a diaphragmatic injury.

Catastrophic haemorrhage

- ▶ Gain proximal control and **STOP THE BLEEDING**
- ▶ In uncontrollable haemorrhage, patient should go direct to theatre for proximal control. Patient can have a CT Traumagram with 4 quadrant abdominal packing in situ, once the bleeding is controlled

A

Standard Care

B

Lower rib fractures from blunt trauma may cause significant hepatic or splenic injuries **2**

C

Resuscitative laparotomy +/- thoracotomy may form part of the primary survey, in the seriously injured patient. **Primary and secondary survey must be completed once the patient is stabilised**

Young patients may tolerate significant blood loss before deteriorating

Old patients have little physiological reserve and are at risk of early cardiovascular collapse

D

Serial abdominal examinations are required in suspected abdominal trauma

Regular blood gases to monitor condition

Early urinary catheter is advised, as UO is a sensitive measure of end organ perfusion and resuscitation status of patient **3**

Actively look for missed injuries

→ A full MDT review of imaging and a top-to-toe survey is mandatory

E

→ Examine the back and posterior chest

Selection for laparotomy

- ▶ Use your clinical judgement: examine the patient carefully and don't forget to roll the patient and inspect the back
- ▶ Use CT sparingly to help guide selection for surgery

Pre- laparotomy

- ▶ WHO Checklist
- ▶ Senior decision making
 - ▶ A senior team (surgeon plus anaesthetist is ideal) to maintain oversight of departmental activity, to act as point of contact for incident commanders and to act as arbiter for difficult surgical decisions (such as transfer to palliation)

KEY POINTS

- ▶ Have "two consultant" operating where possible
- ▶ Make a full midline incision **1**
- ▶ The priorities are:
 - ▶ First: stop the bleeding
 - ▶ Then: control contamination
- ▶ Do not do definitive intestinal repairs or stoma formation
- ▶ Make a temporary abdominal closure and plan for re-look at 24-48 hours
- ▶ Get the patient off the table as soon as possible: at 1 hour you should be finished or finishing
- ▶ Maintain a dialogue between surgery and anaesthesia and don't get 'task fixated' on complex reconstructive surgery

MI abdominal trauma

Damage Control Laparotomy

Maintain intra-operative dialogue with your anaesthetic team: you must be aware of:

- ▶ physiological status including inotrope requirements
- ▶ transfusion situation
- ▶ the time your surgery is taking (regular updates from anaesthesia will improve situational awareness)
- ▶ wider context of demands on theatres and the evolving major incident (are new patients still arriving?)

Pre-laparotomy

- ▶ Antibiotics are essential prior to your incision; however, you do not need to continue surgical antibiotic prophylaxis beyond the duration of the primary laparotomy.
- ▶ The WHO Checklist should be used.
- ▶ "Two consultant" operating is very helpful, if staff are available.
- ▶ If possible; have a senior surgeon in the department moving between operating rooms to maintain oversight of departmental activity, to act as point of contact for incident commanders and to act as arbiter for difficult surgical decisions (such as transfer to palliation).

Patient positioning

- ▶ Place patient supine with arms abducted (crucifix position).
- ▶ Prep patient's: chest & abdomen to knees; once prepped, patient can be draped appropriately and covered to maintain temperature.

The operation

- ▶ Make a full midline incision: xiphisternum to pubis.
- ▶ Firstly, aim for haemorrhage control. In a very unstable patient - your assistant should digitally occlude the aorta at the hiatus while the surgeon evacuates blood and clot and then finds the source of blood loss and controls it.
- ▶ Next goal is control of contamination: do not attempt definitive intestinal surgery (i.e. with repair, resection & anastomosis or formation of stoma). If there are multiple bowel injuries in one segment, or destructive injury, use stapling devices to resect damaged bowel and leave the bowel ends 'stapled in discontinuity' in the abdomen. Minor injuries can be simply over-sewn with sutures.
- ▶ Do a thorough exploration once you have control of bleeding and contamination.
- ▶ Beware the following areas:
 - ▶ Diaphragm, left and right
 - ▶ High on stomach around OGJ
 - ▶ Lesser sac
 - ▶ Mesenteric border of intestine
 - ▶ Retroperitoneal colon
- ▶ Think about extraperitoneal rectal injury; on table sigmoidoscopy (flexi if possible) may help you make the diagnosis.
- ▶ In a patient with continuing instability despite apparent control in the abdomen, think about adjacent cavities: chest / pericardium. A pericardiectomy can be done via your laparotomy incision.

- ▶ Look for 'paired' injuries in hollow organs; think about the retroperitoneum, be prepared to operate on junctional area and enter adjacent body cavities e.g. thoractomy after laparotomy if the source of on-going bleeding is from the chest and coming through diaphragmatic injury.

▲ **Un-paired holes in the bowel are a marker of missed injury.**

Temporary abdominal closure

- ▶ Use the vacuum-pack technique for temporary abdominal closure, attaching the dressing to wall suction at 120mmHg.
- ▶ Patients can be woken and extubated with this form of temporary abdominal closure but ensure the dressing is properly applied, as there is an increased risk of evisceration in an awake patient compared to a patient intubated in an ICU setting.

Planned re-look

- ▶ Plan to take the patient back to theatre at 24-48 hours. At first re-look laparotomy: do a thorough exploration of the entire abdomen & pelvis to exclude missed injury.
- ▶ Over-sewn intestinal injuries should be taken down and re-done. There is always a 'zone of injury' with penetrating injury and so the bowel should be debrided to healthy, vascularized bowel and then re-repaired. The extent of the debridement will vary according to the energy of the injurious mechanism (minimal for knife or low energy fragment, more extensive for GSW or destructive fragment) if (at first re-look) the patient is relatively stable, restoration of bowel continuity by anastomosis is a real option with avoidance of stoma in both small and large bowel injury in many cases. Formation of a colostomy may be appropriate in the most severely injured, with massive transfusion, on-going inotrope requirement etc.
- ▶ Form a defunctioning colostomy for patients with penetrating rectal injury; repair the injury if you can access it and manually remove faeces from rectum and washout. The 'damage control' technique for rectal injury is as above, but don't mature the colostomy – divide colon with stapling device and leave ends inside.

Imaging

- ▶ CT is not mandatory; rely on your clinical indications for laparotomy; reserving scarce CT scan resources for patients who need them (patients can always be scanned later in their clinical course if necessary).
- ▶ Thoughtful clinical examination and surgical judgement is required; remember the abdomen has a posterior aspect, examine the back thoroughly during the log roll, do a PR.
- ▶ Look carefully for penetrating injury.
- ▶ Catheterise early, blood in the urinary tract is a helpful physical sign.
- ▶ Evisceration of bowel and or omentum is relatively common after blast injury.
- ▶ If a patient has had CT: remember blast-injured patients may have pneumo-peritoneum without visceral injury; look for corroboration (clinical status or associated evidence of organ injury on CT-such as free fluid) before operating.

MI pelvic and long bone injuries

Key considerations

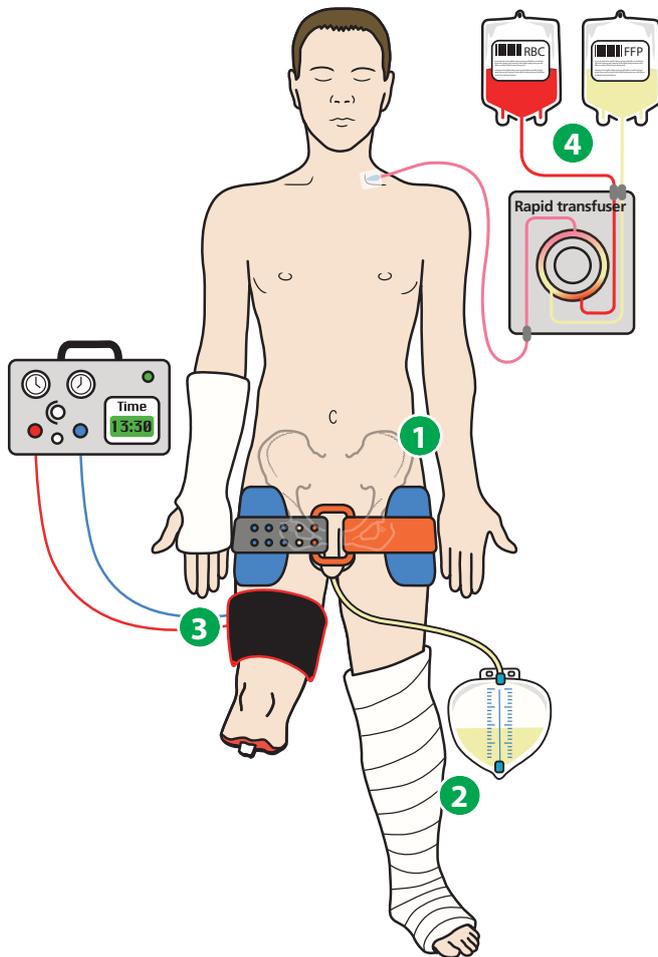
- ❓ Could the casualty have a pelvic injury?
- ❓ In limb injuries, is the wound open or closed?
- ❓ Is there uncontrolled haemorrhage?

⚠️ Blast Lower Limb injury?

- ✔️ Re-discuss case with Resus Surgeon Commander. High priority for theatre.
- ➔ Apply pelvic binder
- Consider:
 - ❓ lung protective ventilation
 - ❓ antibiotics

Catastrophic haemorrhage

- ✔️ Actively resuscitate with red cells and plasma. Avoid crystalloids, give platelets early.
- ➔ Get MTP 1* (4U blood and 4U FFP)



1 – Pelvic injury

- ➔ Apply pelvic binder, 1 reassess and x-ray
- ⚠️ Aim to keep binder time < 6 hours

- ❓ Could the pelvic bleed be managed by IR?
 - Transfer to IR Suite
- ❓ Does patient need to go to theatre? If so:
 - Pack against binder not ex-fix
 - Anticipate coagulopathy
 - Perform coagulation studies and treat aggressively with platelets and fibrinogen
 - Confirm urethral continuity
 - Catheterise

2 – Closed limb injury

⚠️ Have you excluded compartment syndrome?

- ❓ Can the patient simply be splinted?
 - Realign limb
 - Apply POP backslab 2
 - Use Thomas splints/skin traction/pre-fabricated splints if suitable
 - Only ex-fix if clinically indicated
- ➔ Regular distal neurovascular checks
- ❓ Perform fasciotomies
- ❓ Peripheral nerve blockade required?
- ❓ Does the patient really need to go to theatre now? Can it wait?

Specialty checklist

- Repeat primary survey
- Give TXA (bolus or infusion as appropriate)
- Give regular antibiotics
- Keep patient warm
- ✔️ Give blood proactively – plan for one MTP* per destroyed lower limb 4
- ✔️ Carry out the coagulation studies available in your unit

*MTP 1 – or blood products available in your unit as starter 'shock pack' for red blood cells and plasma

3 – Actively bleeding limb

- ➔ Apply pressure dressing and
- ⚠️ change prehospital tourniquet to a pneumatic tourniquet – 3 inflate it and note tourniquet start time
- Realign limb and splint it
- ❓ Does patient now need to go to theatre to stop the bleeding?
 - Get proximal control
 - Ligate distally
 - Fasciotomise (shunt only if needed)
 - Repair vessel – only if time
- ⚠️ Do not operate longer than 60 minutes

MI immediate wound management

Aim: to make a diagnosis for each wound to a sufficient degree that priority for surgery and need for specific specialties can be correctly informed.

- ▶ All wounds must be examined so all dressings must come off. Be methodical. Don't forget the back.
- ▶ Photograph or review with a surgeon present to avoid unnecessary re-looks, especially in complex wounds and for vascularity issues. **4**
- ▶ Consider examining sequential areas rather than the whole body in a single go.

Catastrophic haemorrhage

▲ Junctional and intra-cavity ongoing bleeding is an indication for surgery (or IR).

- ▶ If the situation is calm then do not rush for tourniquets. Try a pressure dressing with elevation (if practicable) first.
 - Use tourniquets if that fails
- Give TXA as soon as possible

Age

Young – may have significant blood loss but normal physiology
 Older patients have impacting comorbidities and medications eg β -blockers or anticoagulants.

Time

May be a risk of compartment syndrome or pressure effects if prolonged tourniquet use, entrapment or unknown LOC.

Mechanism

Initially treat the patient, then the wound – do not treat the weapon. Be aware of the mechanism but do not be distracted by it.

Injuries

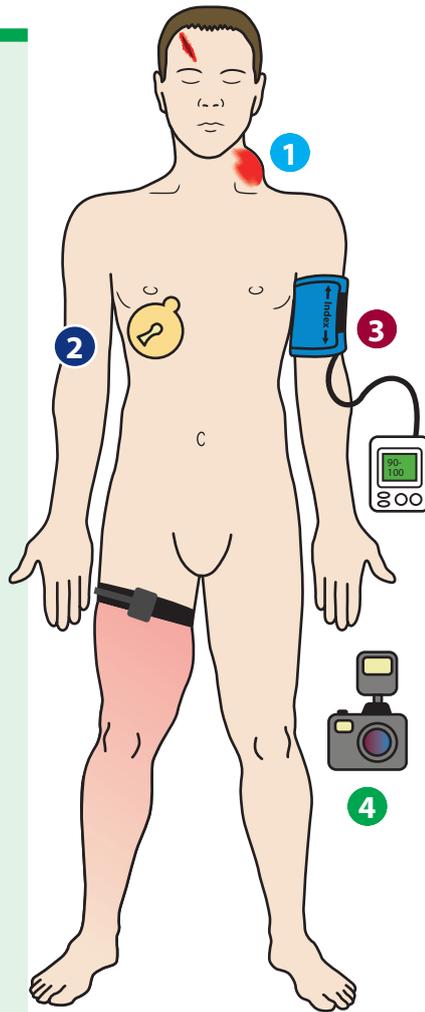
Look for more wounds than were handed over.

Signs and symptoms

Listen to the patient.
 Note the pre-hospital observations.

Treatment given

Any tourniquets/pressure dressings/haemostatic dressings?
 Know the tourniquet time.
 Any pre-hospital drugs? eg. TXA, ABx.



A

- ❓ Airway risk; any face or neck wounds that might have on-going bleeding or emerging swelling? **1**
- ▶ If practicable and appropriate, sit the patient up.

B

- ▶ Adhesive chest seal dressings are good for:
 - ▶ any initial wound management **2**
 - ▶ chest and abdominal wounds.

C

- Bleeding, even from significant wounds may have been controlled. Beware of over resuscitation because of reports of 'large blood loss' at scene.
- ▶ Continued significant bleeding, refer to management of catastrophic haemorrhage
 - ▶ Fluid replacement should be by blood products and based on patients physiology, their response and coagulation profile. **3**

D

- ❓ Reduced level of consciousness that doesn't fit with the pattern of wounds
 - ▶ alcohol/drugs, head injury, hypoxia
 - ▶ missed injury, hypovolaemia,
 - ▶ chemical/biological weapon?

E

- ✔ Keep the patient warm.

Specialty checklist

- ✔ Administer systemic antibiotics as per microbiology guidelines (local/Trust or MI guidelines).
- ❓ Are there any obvious wounds that require the patient to go immediately to theatre without further assessment?
 Uncontrollable haemorrhage is probably the only indication.
- ❓ Are there any wounds that require immediate attention to prevent deterioration?
- ❓ Any exposed viscera/brain? → Place a saline soaked gauze on these, do not use antiseptic solutions.
 - ▶ In all types of blast and ballistic wounding, a CT 'whole body' scan should be performed.

MI immediate wound management

Examination of wounds

Aim: to diagnose each wound to a sufficient degree such that the decision and priority for surgery and the need for specific specialties can be correctly identified.

- ✔ All wounds must be examined so all dressings must be removed.
 - ▶ Do this in a methodical and thoughtful manner.
 - ▶ Don't forget the back.
 - ▶ Consider doing it with a surgeon present to avoid unnecessary re-looks. Particularly relevant in complex wounds and for vascularity issues.
 - ▶ Consider doing sequential areas rather than the whole body in a single go.
 - ▶ If there is a risk of significant haemorrhage when removing a dressing, consider doing under tourniquet control.
- ❓ Note the general state of the patient in terms of clothing (torn? shredded? burnt?) and dirt (dust? soil? soot?). Non-specific but helps with the overall assessment. A patient covered in dirt has a higher risk of dirty wounds.
- ❓ Are there any patterns to the wounding?
 - ▶ Aim to get as much information as possible without exploring the wound. By simple observation it is normally possible to ascertain:
 - ▶ Is there obvious contamination with foreign bodies?
 - ▶ Is it obvious that the deep fascia has been breached?
 - ▶ Is bone exposed?
 - ▶ Then formally examine for vascular, nerve and tendon deficits.
- ⚠ **Probing the wound with instruments or fingers provides no further useful information and is potentially harmful.**

Documentation and planning

- ✔ Once the wounds have been fully assessed the findings must be documented.
 - ▶ Take quality photographs if it is at all possible.
 - ▶ Have pre-agreed (in the plan!) who has responsibility for documenting the forensic description of the wounds (precise anatomical location, exact size and structures involved) because it must be done at some-point. Probably best done by the surgical team in theatres supplementing the CT findings.
 - ▶ The findings must be presented to the relevant clinical coordinator for planning of next steps. This will generate a priority list for timings to theatre and dictate where the patient will be held until it is their turn.
 - ▶ If there is any penetration of a body cavity or deep fascia, exposed bone or open fractures or alteration in normal function there is requirement for the wound to be formally explored. This should be done in an operating theatre.

Timing of wound management

- ▶ For patients likely to go to theatre within **the next 12 hours**:
 - ▶ Place a saline soaked swab on the wound and secure with an outer dressing. Do not be tempted to irrigate the wound. There is no evidence to support the use of antiseptic solutions.
- ▶ In significant mass casualty situations, patients with soft tissue wounds may not get to theatre in the first 12 hours.

In this case there is still no clear evidence to support irrigation in ED or the ward even with such a delay to formal debridement.

- ▶ The presence of **grossly contaminated wounds** should be part of the surgical triage assessment, and these patients prioritised **for theatre before 12 hours where possible**.
- ▶ Administration of systemic antibiotics as early as possible has been shown to reduce the proliferation of contaminating bacteria and so does buy time. Application of a saline soaked swab will suffice.
- ▶ For those with **superficial wounds** (where there is no evidence of damage to deeper or important structures and the degree of contamination is such that formal debridement in theatre is not considered necessary)
 - ▶ These wounds can be cleaned according to usual practices under appropriate analgesia.
- ⚠ **No ballistic wounds should be primarily closed.**
 - ▶ Provision must be made for follow up of the patient to ensure appropriate delayed closure occurs.

Non-surgical control of haemorrhage

- ▶ General oozing from the wound can be controlled with a **pressure dressing** and/or elevation.
- ▶ There are several types of **topical haemostatic agents** available. These are primarily designed for pre-hospital use to mitigate for a lack of surgical capability where tourniquets and pressure dressings prove inadequate, such as in junctional areas. Once within a hospital, where surgeons and operating theatres are available, the approach to continuously bleeding wounds should be formal surgical control. The use of haemostatic dressings within hospital should be limited to extreme situations only.
- ▶ If the patient has a **tourniquet** in place either from pre-hospital or applied on arrival during the primary survey this should be evaluated before the wound is addressed. An inflated tourniquet makes a patient a priority for theatre.
 - ▶ If the tourniquet is a simple windlass type, as is common for pre-hospital use, this should be replaced by a **pneumatic tourniquet**, as soon as is practicable.
 - ▶ This can be placed proximal to the windlass but not inflated initially nor applied too tightly such that it restricts venous outflow. The windlass can then be released and the wound observed.
 - ▶ If there is no significant haemorrhage then the pneumatic tourniquet does not need to be inflated immediately but should remain in place as a precaution or for use during debridement. At this point an assessment of distal vascularity can be made.
- ▶ If on releasing the windlass tourniquet there is significant bleeding, then inflate the pneumatic tourniquet and formal surgical vascular control should be obtained as a priority.

- ⚠ **If the initial tourniquet has been on for significantly more than two hours, discussions about managing the patient's general condition, overall distal viability and potential need for fasciotomies should be had, before the tourniquet is released.**

MI universal fasciotomies

Universal fasciotomies have been design to decompress compartments and allow adequate vascular access, without compromising future soft tissue reconstruction.

- ▶ Use extensile incisions
- ▶ Incision can incorporate wound line as required
- ▶ Aim to achieve proximal/ distal control outside of any haematoma or zone of injury

Fasciotomy Incisions (that can be used for vascular access)

Volar Forearm fasciotomy ¹⁴

Medial leg fasciotomy ²²

Lateral leg fasciotomy wound, allows exposure of mid anterior tibial artery and decompression of lower leg compartments ²⁴

Two incision, four compartment fasciotomy for the lower leg

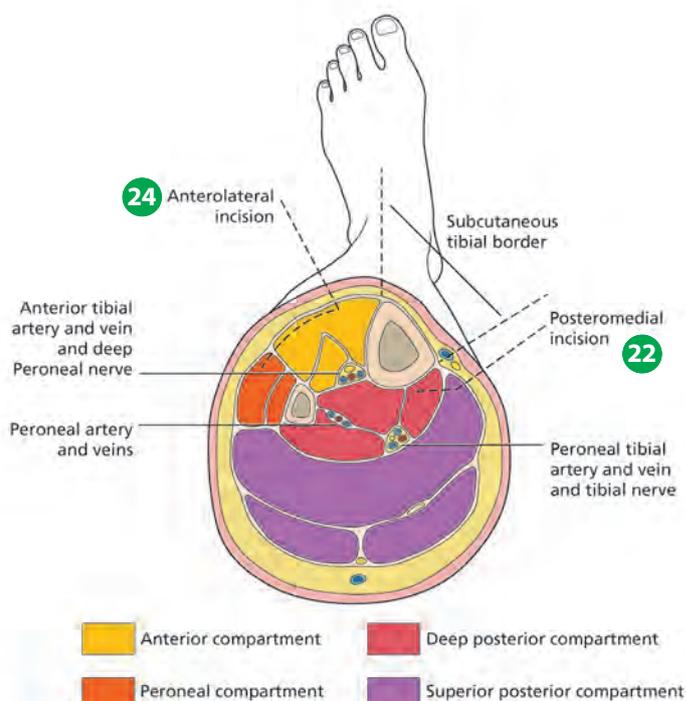
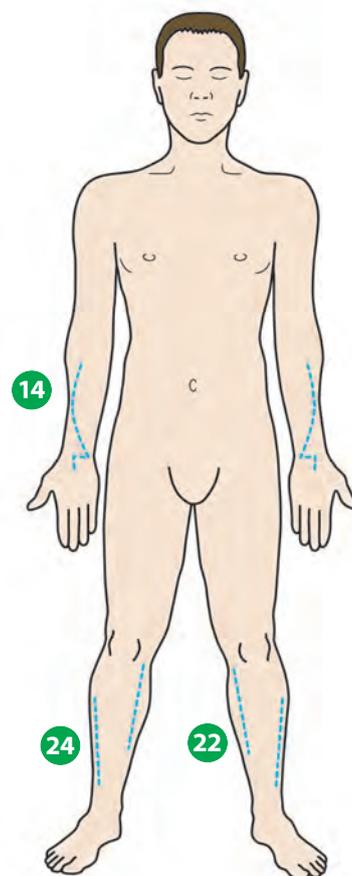
Use a skin marker to draw the surface markings of the medial and anterior borders of the tibia.

Release of superficial and deep posterior compartments:

- ▶ Make an incision through skin 2 cm posteromedial to the marked medial border of the tibia from the tibial flare down to behind the medial malleolus.
- ▶ Deepen the incision without undermining the skin and then incise the fascia along the whole length of the skin incision. This will have fully released the superficial posterior compartment.
- ▶ Identify the posterior tibial neurovascular bundle, most easily done distally, and incise the thinner fascia over it. This will have gained entry into the deep posterior compartment.
- ▶ Extend this along the whole length of the skin incision to fully release the compartment.
- ▶ Access to the more proximal part will require dissecting the soleus muscle off the tibia.

Release of the anterior and lateral compartments:

- ▶ Make an incision through skin 2 cm anterolateral to the marked anterior border of the tibia from the tibial flare down to just in front of and above the lateral malleolus.
- ▶ Deepen the incision without undermining the skin and then incise the fascia along the whole length of the skin incision. This will have fully released the anterior compartment.
- ▶ Sweep the exposed muscle bellies medially and follow the deep aspect of the fascia laterally until the fibular is felt. This will have revealed the intramuscular septum.
- ▶ Incise this along the whole length of the skin incision to fully release the lateral compartment.



MI universal fasciotomies

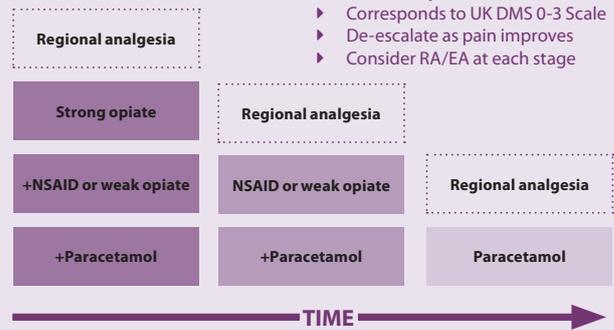
Pain management in a major incident

'Reverse' the WHO pain ladder in complex injury and establish effective pain control early; then reduce and stop pain medications as appropriate

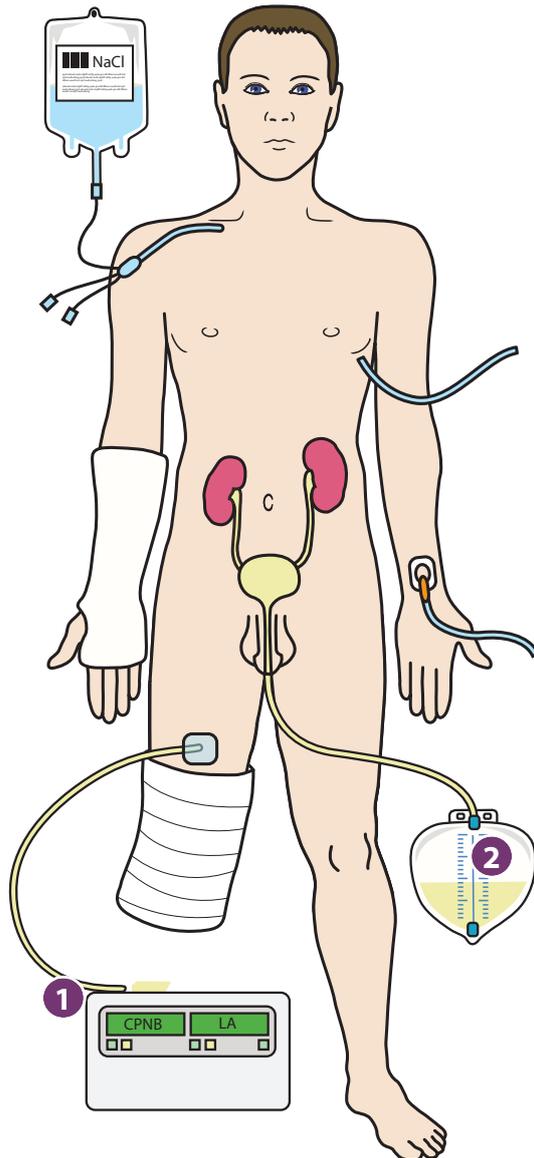
- ▶ Start analgesia as soon as possible
- ▶ Use multi-nodal medication principles
- ❓ Consider peri-operative nerve blocks

'Reverse' WHO pain ladder

- ▶ Corresponds to UK DMS 0-3 Scale
- ▶ De-escalate as pain improves
- ▶ Consider RA/EA at each stage



After initial surgery



1 – Chest injury

- ❓ Intercostal nerve blocks
- ❓ Serratus plane blocks

2 – Abdominal injury

- ❓ Transverse abdominus plane (TAP) block
- ❓ Epidural Analgesia or LA (Lignocaine) infusion

3 – Limb injury

- ❓ Single shot nerve block
- ❓ +/- Indwelling nerve catheter for continuous infusion **1**

❓ Regional or epidural analgesia

Consider regional analgesia at every step

- ▶ Single shot block +/- continuous nerve blockade

- ❓ If spinal and epidural analgesia
 - ✓ Urinary catheter may be required **2**

⚠ Beware:

- ▶ Hypovolaemia
- ▶ Coagulopathy
- ▶ Distorted spinal anatomy *eg* crush fractures in explosive injury

❓ Direct or anticipated nerve injury

- ❓ Pregabalin
- ❓ Tricyclic anti-depressants

i KEY POINTS

- ▶ Start analgesia as soon as possible
- ▶ Use multi-nodal medication principles
- ▶ 'Reverse' WHO pain ladder
- ❓ Consider peri-operative nerve blocks

Pain management in a major incident

Establish pain control early and stop medications as appropriate.

Pharmacology

Multi-modal analgesia using the reverse WHO pain ladder (overleaf)

I. Opioids eg morphine

- ▶ Morphine is 'most familiar'. Multiple routes available but in acute situation is best given by intravenous bolus: 1–5 mg as bolus and then additional 1–2 mg doses, every 2–5 minutes, titrated to effect.
- ▶ Relatively large doses may be required in young athletic casualties and analgesia is slow in onset.
- ▶ Fentanyl is a quicker alternative. 50 micrograms i/v as a bolus and repeat doses of 25–50 micrograms every 2–5 minutes.
- ▶ Degree of sedation more closely related to acute overdose than respiratory rate
- ▶ Accidental overdose requires intravenous naloxone. Take one ampoule (0.4 mgs) and dilute to 8 mls with water for injection. Inject 1 ml (0.05 mgs) and repeat until sedation reversed and respiratory rate ≥ 8
- ▶ Effect is short acting – observe casualty closely

II. Weak opioids eg Tramadol, Codeine

Tramadol

- ▶ Synthetic weak opioid with noradrenergic and serotonergic effects.
- ▶ Alternative to codeine
- ▶ Recognised role in neuropathic pain.

III. Non-opioids

NSAIDs

- ▶ Avoid with acute haemorrhage/coagulopathy or critical illness.
- ▶ Side effects more likely in elderly patients. Ibuprofen (200–400 mgs tds, po, pr) or diclofenac (50 mgs tds, po, iv, pr) commonly used.

Paracetamol

- ▶ 1g iv/po/pr QDS (500 mgs if body weight less than 50 kgs)
- ▶ Few contraindications.
- ▶ Will have some opioid sparing effect.

Adjuncts – Co-analgesics

A. Ketamine

- ▶ 10–20 mg intravenous aliquots can be used de novo or to supplement opiate analgesia. Particularly effective prior to patient movement or splint procedures
- ▶ Effect will persist for 10–15 minutes
- ▶ Administrator should be resuscitation proficient as anaesthesia possible with inappropriate dosage

B. Tricyclic Antidepressants

- ▶ Neuropathic injury – start as soon as possible. Reassess need at two weeks
- ▶ Amitriptyline often assists sleep at night – a useful effect.
- ▶ Start amitriptyline dose at 25mg and titrate to effect

C. Gabapentinoids eg. Pregabalin

- ▶ Start as soon as possible – reassess need at two weeks
- ▶ Initial dose = 75mg bd
- ▶ Review every day, increasing dose if necessary and tolerated
- ▶ Dose range is 150 to 600 mg per day PO given in either two or three divided doses

D. Clonidine

- ▶ Anxiolytic/ analgesic.
- ▶ PO 50 – 600 mcg 8 hourly (150–200 mcgs per 24hrs typical co-analgesic dose)
- ▶ IV bolus – 50–150 mcg over 1–10 mins. May be repeated eight hourly
- ▶ Infusion in HDU/critical care: 1–2 mcg/kg/hour

E. Lignocaine

- ▶ Can assist in difficult situations – alternative to epidural in abdominal surgery
- ▶ 1–2 mg/kg iv bolus over 30 mins
- ▶ Infusion – 0.5–2 mg/kg/hr

Input from hospital acute pain services

Patient Controlled Analgesia (PCA)

- ▶ Encourage use of PCA when appropriate.
- ▶ PCA can be employed prospectively before surgery.

Antimicrobial prophylaxis

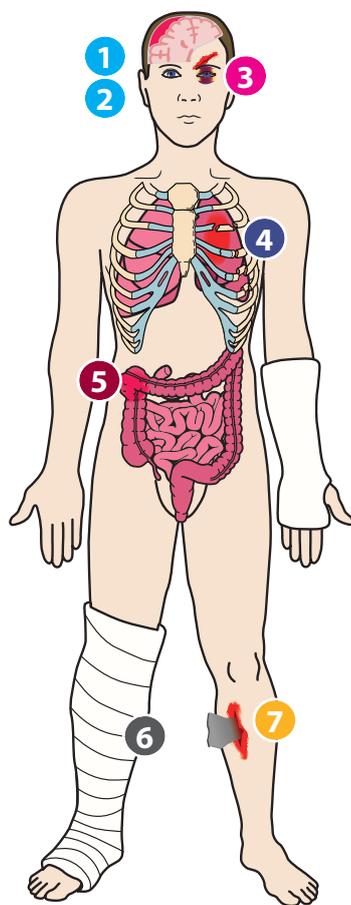
Introduction

Blast wounds are extensive and contaminated (and will remain so even after extensive debridement, or will rapidly become recolonised); whereas **gunshot wounds (GSW)** are relatively clean. Give your microbiologist as much information as possible.

- ▶ How was the injury sustained?
- ▶ What was the environment in which it was obtained?
- ▶ Any organic contamination or water exposure?

Keep to simple measures and antibiotics

Recognise your patient will have a huge inflammatory response and it may not be due to an infection.



⚠ If patient is known to be colonised with MRSA, CPE, ESBL+ve, or other resistant organisms: Discuss with a microbiologist

CSF leak post skull fracture 1

- ▶ No antibiotics required
- ▶ Give Pneumovax (if sinus/auditory canal breached)

Penetrating CNS injury 2

- ▶ Ceftriaxone 2g bd iv + Metronidazole tds iv
- ⚠ **Non-severe Penicillin allergy: Meropenem 2g tds iv**
- ⚠ **Severe Penicillin Allergy (Anaphylaxis): Ciprofloxacin 400mg bd iv + Vancomycin 1g bd iv + Metronidazole 500mg tds iv**
- ⌚ All courses two weeks duration

Penetrating eye injury 3

- ▶ Ciprofloxacin 400mg bd iv + Clindamycin 450mg tds iv
- ⌚ Give for ≥ two weeks after removal of foreign body

Penetrating chest trauma 4

- ▶ Co-amoxiclav 1.2g tds iv (if unavailable, give Cefuroxime 750mg tds iv and Metronidazole 500mg tds iv)
- ⚠ **Penicillin allergy: Clindamycin 450mg qds iv**
- ⌚ One to two weeks, depending on progress or presence of intercostal drains

Penetrating abdominal trauma 5

- ▶ Co-amoxiclav 1.2g tds iv (if unavailable, give Cefuroxime 750mg tds iv and Metronidazole 500mg tds iv)
- ⚠ **Penicillin allergy: Clindamycin 450mg qds iv**
- ⌚ One to two weeks, depending on progress or presence of intercostal drain(s)

Open fracture limb/hands 6

- ▶ Co-amoxiclav 1.2g tds iv (if unavailable, give Cefuroxime tds iv and Metronidazole 500mg tds iv)
- ⚠ **Penicillin allergy: Clindamycin 450mg qds iv**
- ⌚ Until soft tissue cover or 72 hours, whichever is soonest (BOAST4 guidelines)

Penetrating soft tissue injury 7

- ▶ Co-amoxiclav 1.2g tds iv (if unavailable, give Cefuroxime 750mg tds iv or Metronidazole 500mg tds iv)
- ⚠ **Penicillin allergy: Clindamycin 450mg qds iv**
- ⌚ Until first surgical debridement/washout

i KEY POINTS

Bacterial infection in blast or ballistic injury, is the same as other wounds but don't just treat the microbiology report.

- ⚙ Consider if this is colonisation or infection?
 - ▶ Close liaison with a microbiologist within the multidisciplinary team is essential.
 - ▶ Common things occur commonly, but be on alert for an unusual clinical picture.
 - ▶ Tell the lab about the unexpected findings or unusual clinical picture, as diagnostic labs are set up to look for common pathogens and may overlook others.

⚙ Be aware or suspicious of wounds with evolving (unexpected) necrosis.

⚙ **Post event transfers:** Infection Prevention and Control (IPC) teams need advance notice of patient movements and suspect organisms if possible, to ensure the receiving unit is prepared and can mitigate risk (*ie* there is a side room available?).

Antimicrobial prophylaxis

Prevention of Blood Borne Virus Transmission (Hepatitis B, C and HIV)

Follow principles of Inoculation Accident Injury.

Obtain blood sample from patient

- ✔ As soon as possible, a blood sample from the patient should be stored for baseline.
- ▶ Refer to **Bloodborne viruses: managing risk in bomb blast victims** [PHE Guideline on BBV](#) 

Hepatitis B Vaccination

- ✔ Start vaccination course within 48 hours of injury.
- ✔ Give accelerated vaccine schedule.
- ✔ Store blood and check for seroconversion at three and six months.
- ▶ Will have some opioid sparing effect.

Hepatitis C Vaccination

- ▶ No vaccine/antiviral strategy possible.
- ✔ Store blood and check for seroconversion at three and six months.

HIV

- ▶ Post exposure prophylaxis not routinely recommended.
- ▶ Risk assessment will be directed by Public Health England.
- ✔ Store blood and check for seroconversion at three and six months.

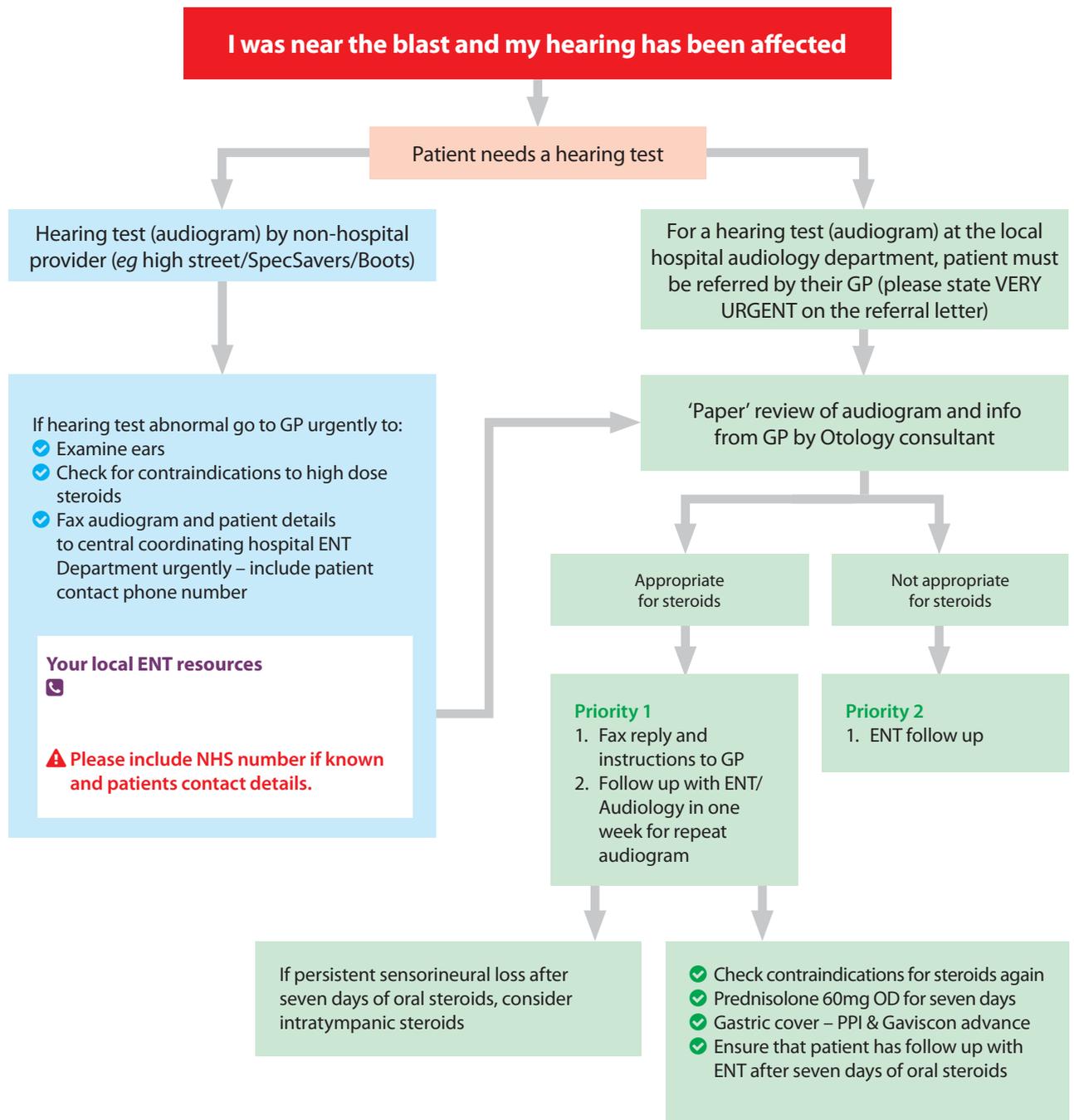
Blast ear and hearing loss in a major incident

Adults and Young Adults (16 or over)

The middle and inner ear are highly susceptible to injury after blast, and the most often missed as the trauma teams manage life threatening injuries first. Patients may self present days later, to the ED or GPs. Patients with abnormal audiograms should be referred and reviewed urgently and if appropriate steroids given. Symptoms common to blast ear are: tinnitus, earache, hearing loss or vertigo.

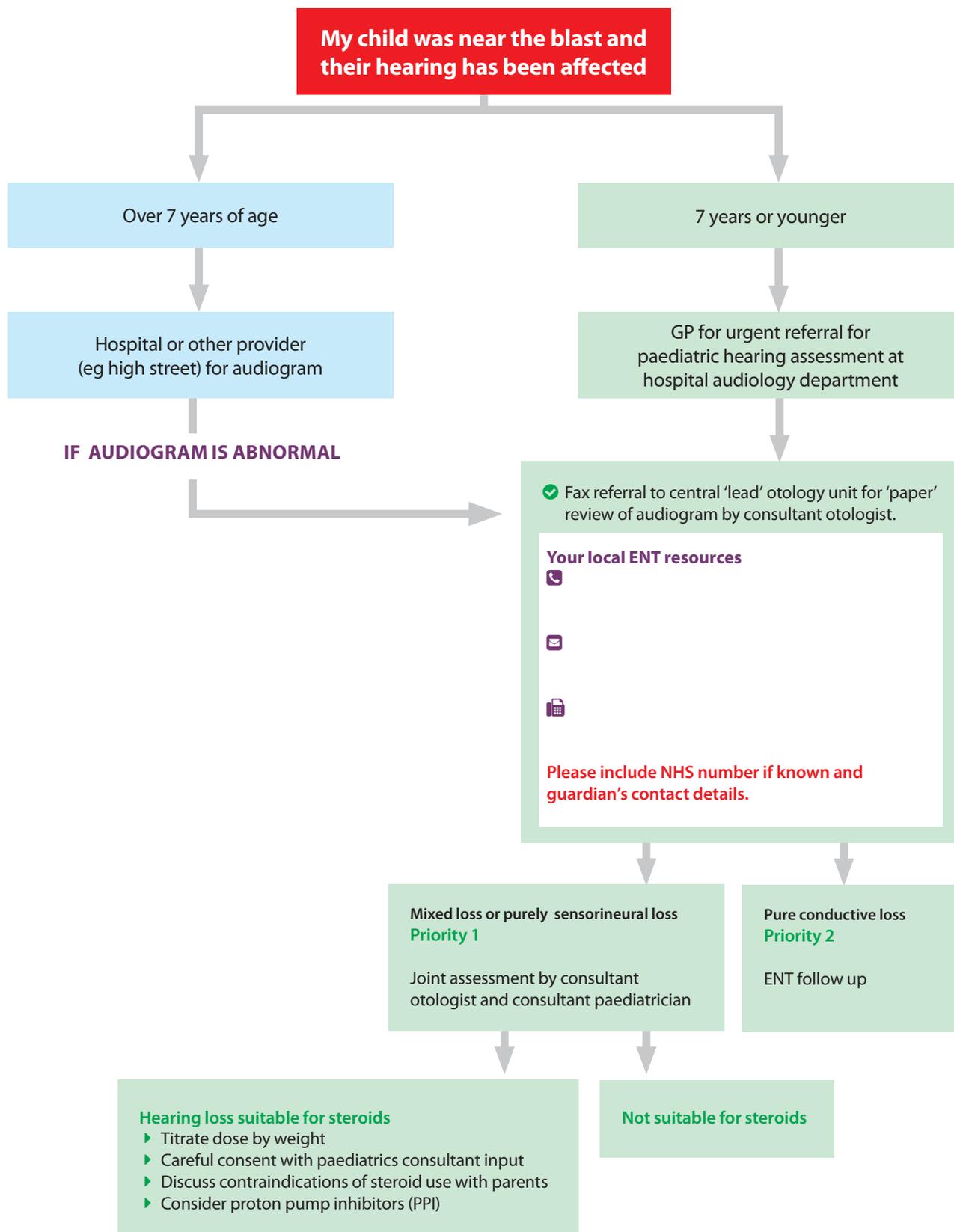
This flowchart aims to guide the management of hearing injury without associated temporal bone trauma and is based on idiopathic sudden sensorineural hearing loss management. A pragmatic approach has been adopted for the rescue of sensorineural hearing loss associated with noise and blast exposure as the evidence matures.

- ▶ If hearing tests are normal no further action is needed.
- ▶ If abnormalities are detected, results should be passed on urgently, to the central coordinating ENT department for assessment. If the loss is purely conductive (which may be due to blood in the external auditory canal), tympanic membrane perforation or ossicular discontinuity, no immediate action is needed.
- ▶ If hearing loss is mixed or purely sensorineural, steroids may be beneficial. Prednisolone, 1mg per kg to a max of 60mg OD for 7 days is the initial preferred option.



Blast ear and hearing loss in a major incident

Children (under 16)



Blast lung in a major incident

Introduction

Casualties with a primary blast lung injury (PBLI) will probably be symptomatic by the time they reach hospital. Casualties with PBLI will develop varying degrees of respiratory distress with impaired gas exchange. They may require supportive care in a high dependency or intensive care environment and up to 80% will require mechanical ventilation. **The combination of blast exposure and hypovolaemic shock is especially life threatening.**

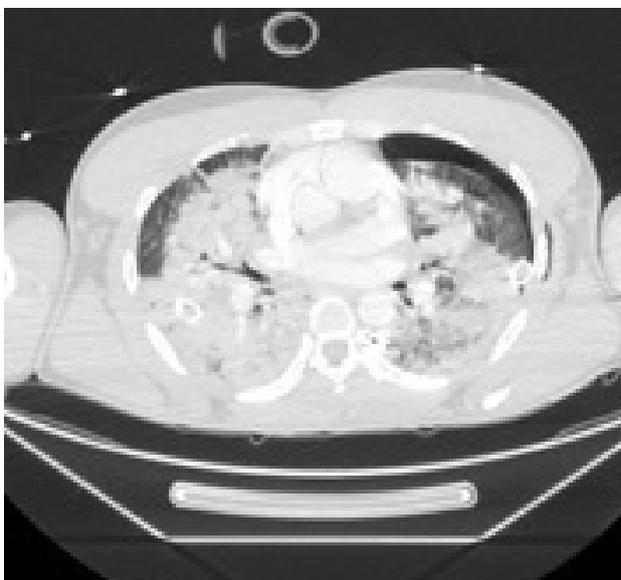
Casualty identification

- ▶ If asymptomatic at two hours, patient will not need mechanical ventilation.
- ▶ If asymptomatic at six hours, then significant PBLI is unlikely to occur.

Risk factors

- ▶ Explosion in confined space
- ▶ Close proximity to explosion.

⚠ **Tympanic membrane rupture is not a risk factor.**



Catastrophic haemorrhage

- ▶ Catastrophic haemorrhage may result from a massive haemothorax
- ➔ Needs prompt damage control surgery and haemostatic resuscitation

A

- ▶ May have haemoptysis

B

Patient may present with:

- ▶ mild to moderate respiratory distress
- ▶ Pneumothorax/pneumatoceles
- ▶ Broncho-pleural fistula in severe cases
- ✓ CT chest to exclude pneumohaemothorax

C

- ▶ Hypotension may be due to myocardial impairment and decreased SVR
- ⚠ Consider vasopressor use to avoid excess administration of IV fluids

KEY POINTS

Intensive Care Management

- ▶ Ventilate in accordance with current best practice.
- ▶ Moderate PEEP levels on case by case basis if broncho-pleural fistula
- ▶ Use pAPRV and/or ECCO₂R (local experience and resources permitting)
- ▶ Euvolaemic volume status
- ▶ Expect a good recovery

Other Considerations:

- ⚠ Early CPAP at 5cm H₂O, once pneumothoraces are drained.
- ⚠ Toxic industrial chemical exposure (eg Chlorine/ Phosgene / Cyanide).
- ⚠ Other toxic or smoke exposure.

Blast lung in a major incident

Background

Primary blast injury syndrome is a potentially life-threatening multi-system injury in which Primary Blast Lung Injury (PBLI) predominates. **PBLI is defined as “radiological and clinical evidence of acute lung injury occurring within 12 hours of exposure and not due to secondary or tertiary injury”.** It results from exposure to the supersonic high energy shock wave emanating from a high explosive detonation. In an open air environment, the energy within the shock wave dissipates quickly and casualties close enough to suffer PBLI will most likely have burns, penetrating and/or blunt injury as well (secondary and tertiary injury). In an enclosed environment, the shock wave reflects and augments itself, greatly increasing the risk of mortality and morbidity due to primary injury.

Diagnosis and presentation

When receiving casualties from an explosive incident eliciting the following details will help identify those at risk of PBLI.

- ❓ blast in a confined space?
- ❓ distance from blast?
- ❓ time since blast? Is patient symptomatic yet?
- ❓ any haemoptysis?

Exposure within a confined space is a significant risk factor and for open-air explosions the approximate distance from ground-zero should be estimated.

- ▶ Tympanic membrane rupture is not a sensitive or specific risk factor for PBLI.

Casualties with PBLI will normally be symptomatic by the time they reach hospital. Casualties will be in varying degrees of respiratory distress with impaired gas exchange and may have haemoptysis. Hypotension also occurs.

- ▶ **Plain film radiography will demonstrate contusions, denser on the side of the incident shock wave, which may be extensive. The distribution of consolidation may be in the characteristic ‘bats-wing’ distribution when the casualty has been exposed to blast in a confined space although this is not typical. Associated pneumothoraces or haemothoraces may be seen.**
- ▶ **CT scanning will reveal ground glass shadowing, which may progress to dense consolidation as haemorrhage persists, with associated air bronchograms and pneumatoceles.** Again, secondary features include pneumothorax, haemothorax, bronchopulmonary fistula, lung laceration and trachea-bronchial injuries.

Patients who are adequately breathing spontaneously two hours after injury are unlikely to need mechanical ventilation because of PBLI alone. Patients who are asymptomatic six hours after blast exposure are unlikely to develop PBLI.

Medical management

Casualties with PBLI require supportive care in a high dependency or intensive care environment.

- ▶ Some 80% will require mechanical ventilation.

⚠ The combination of blast injury and haemorrhagic shock is particularly life threatening and requires rapid and aggressive treatment.

- ▶ No specific therapy for PBLI currently exists and patients should be ventilated as per current best practice for acute lung injury.
- ▶ There is no role for Tranexamic Acid or FVIIa.
- ▶ The experience of the UK military in recent conflicts suggests that even in severe PBLI, Extracorporeal Membrane Oxygenation (ECMO) has not been required. Whilst untested in this context, extra-corporeal carbon dioxide removal (ECCO₂R) and very low tidal volume ventilation makes empirical sense in patients who are otherwise suitable for this therapy.

Burns in a major incident

Referral guidelines

Use normal routine, nationally agreed guidelines for referring burn injuries to the local burns network.

Refer if there are:

- ▶ Full thickness areas
- ▶ Circumferential burns
- ▶ Airway involvement
- ▶ Chemical and electrical burns
- ▶ Burns to hands, face or genitals

Refer all burns that are:

- ▶ >2% in a child
- ▶ >3% in an adult

In a MI event, smaller burns can go to burns unit or facility.

Refer directly to the Burns Centre if:

- ▶ Under 1 year old with burn over 15%
- ▶ 1–15 years with burns over 30%
- ▶ 16 or over with inhalation injury and burns over 25%
- ▶ 16 or over without inhalational injury and burns over 40%

National Burn Bed Bureau

01384 679 036

Your local burns resources

☎ Local Burns Network Point of Contact:

☎ Regional Adult Burns Centre:

☎ Regional Paediatric Burns Centre:

☎ Local Burns Unit:

☎ Local Burns Facilities:

i KEY POINTS

Cyanide poisoning

- ▶ Consider administering Hydroxocobalamin if smoke inhalation injury, raised carboxyhaemoglobin, acidosis, reduced consciousness.

Chemical burns

- ▶ Irrigate with tepid water for at least 30 minutes, without delay. Beware of hypothermia.
- ▶ If Diphtherine is available, use as per locally agreed guidelines.



⚠ Ensure the burning process has been stopped. Prolonged cooling of the burn (20-30 minutes) is beneficial.



A

Upper airway injury will cause swelling and potential loss of airway

- ▶ If available, use local expertise to assess airway burns.

Consider intubation if:

- ▶ signs of impending upper airway obstruction:
 - ▶ central facial burns
 - ▶ intra-oral burns or swelling
 - ▶ soot on back of tongue or in sputum
- ▶ respiratory distress
- ▶ GCS<12. Can be caused by carbon monoxide and cyanide poisoning
- ▶ circumferential burns to neck, chest or abdomen

Provide supplemental oxygen wherever possible



B

Circumferential full thickness torso burns can cause restriction of respiratory movements.

- ▶ early chest escharotomy may be indicated.
- ▶ in children, circumferential abdominal burns may require early escharotomy (younger children are abdominal breathers)



C

- ▶ If hypotension not responsive, consider other injuries.
- ▶ Circumferential full thickness burns can cause limb ischaemia, requiring release by escharotomy.



D

Reduced consciousness may be due to other injuries than the burn.

- ▶ Consider head injury, hypoxia, drugs/alcohol, noxious chemical and inhalational injuries.



E

- ▶ Complete the secondary survey.
- ▶ Use Lund and Browder chart to determine size of burn.
- ▶ Clean burns, remove blisters.
- ▶ Dress wounds with clingfilm. Proprietary water gel dressings are not indicated.
- ▶ Prevent hypothermia.

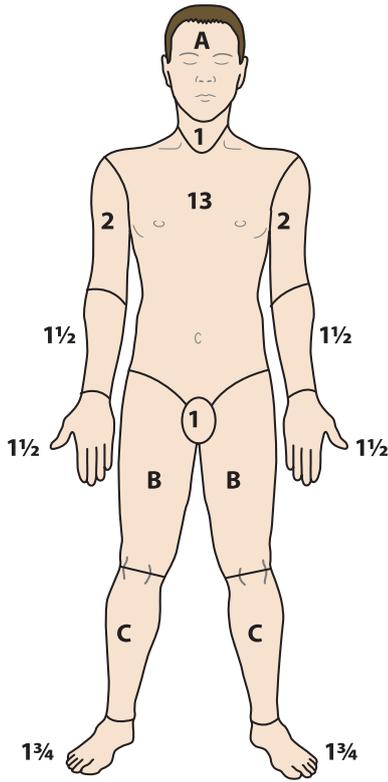
'Burn Shock'

Start fluid replacement as soon as possible to prevent 'Burn Shock' (see overleaf)

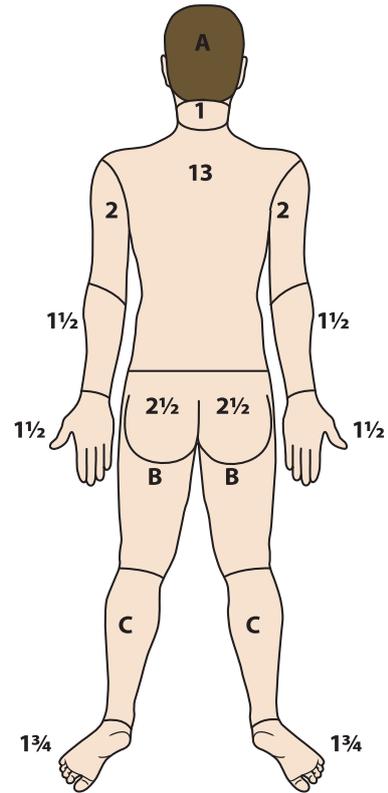
⚠ **Having a burn does not exclude other injuries!**

- ▶ Have low threshold for trauma CT scan
- ▶ If there are other injuries requiring blood product resuscitation, ignore the burn formula and give blood and blood products according to the patient's physiology.

Burns in a major incident



REGION	%	
	PTL	FTL
Area		
Head		
Neck		
Ant. trunk		
Post. trunk		
Right arm		
Left arm		
Buttocks		
Genitalia		
Right leg		
Left leg		
Total burn		



Area	Age 0	1	5	10	15	Adult
A = 1/2 of head	9 1/2	8 1/2	6 1/2	5 1/2	4 1/2	3 1/2
B = 1/2 of one thigh	2 3/4	3 1/4	4	4 1/2	4 1/2	4 3/4
C = 1/2 of one lower leg	2 1/2	2 1/2	2 1/2	3	3 1/4	3 1/2

Management of 'Burn Shock'

Start fluid replacement as soon as possible to prevent 'Burn Shock'.

- ▶ Crystalloid based IV Fluids (e.g. Hartmanns) is better than normal saline.
- ▶ Calculate 2mls/kg/%TBSA (this is the total volume for the first 24 hours)
- ▶ Give half of this volume in the first 8 hours, and the second half over the next 16 hours.
- ▶ Titrate fluids to urine output. 0.5mls/kg/hr (adults) and 1.0mls/kg/hr (Children)
- ▶ REDUCE fluid input if urine output exceeds this amount.

Palliation of unsurvivable burns injury

Local non-burns specialists staff should not make decisions on survivability of burns injuries without discussion with the burns network, even in a MI. The decision to invoke the P4 casualty category for expectant patients will be made by NHS England. This decision will be time limited, continually under review and only used at a time when NHS resources are overwhelmed.

Forensic awareness in a major incident

Critical patient treatment takes precedence over evidence collection. These guidelines have been created for clinicians forced to disturb items of potential evidential importance by treating a patient.

- ✔ Make at least one record of any items with potential evidential significance;
 - ▶ Photograph and/or Clinical Sketch (with scale) and/or written notes/description
 - ▶ Avoid contamination between patients (crime scenes), or by introducing material of your own (DNA, fibres etc)

Major crime scenes are complex events, and admissions to hospital tend to occur at their outset before a clear investigative structure has been established.

Dealing with multiple casualties from a single suspicious incident

If you are dealing with multiple casualties from the same suspicious incident, be aware of the risks of cross-contamination between them.

- ▶ If possible, request that other staff deal with one of the casualties.
- ▶ If not, ensure you change all of your protective equipment between the two casualties and document the change.

Injuries

- ▶ The recording of injuries before treatment can provide vital evidence. Police photographers are likely only to record the injury once it has been stitched, glued or dressed/bandaged.
- ✔ Take scaled photographs of an injury;
 - ▶ one wide 'locating shot' showing where the injury is,
 - ▶ and another detailed shot showing its extent is ideal.
- ✔ Clinical sketches and clear written notes are also very valuable.

Clothing and footwear

Fibre, DNA and blood pattern evidence on clothing, and damage to clothing, can assist in reconstructing the nature and sequence of an attack.

- ▶ When removing/cutting clothing avoid cutting through existing cuts and tears in the fabric.
- ▶ Avoid putting items with wet bloodstains in a single plastic bag. Rather, package items in individual plastic bags before grouping them together in a single plastic bag.
- ▶ Do not clean seized footwear. When removing footwear from a patient, avoid obvious bloodstains when cutting through the uppers.

Drugs

If you find a substance on a patient that you believe might be a form of drug:

- ▶ Avoid direct contact with the substance. Handle it sparingly with a gloved hand.
- ▶ Store the substance in a plastic bag somewhere secure.
- ▶ When describing a substance in notes, exhibit labels or in statements, describe what it looks like but do not guess what it may be.

Weapons

Edged weapons (knives etc)

⚠ If an edged weapon is found on a patient, be mindful that it might harbour evidence on both the handle and the blade.

- ▶ Consider your safety; handle the weapon minimally and with care.
- ▶ Handle sparingly with gloved hands.
- ▶ Move the knife by handling uncommon points of contact, such as the edges of the hilt or the pommel (base).
- ▶ Place into a clean rigid tub, rather than a plastic bag.

Firearms

⚠ If you recover what you believe to be a firearm, do not touch or handle it. Call the police to inspect the weapon and make it safe.

Ammunition components (bullets, shot or wadding)

⚠ A round (a bullet with a metal cartridge containing propellant) or shotgun cartridges are potentially live. You should inform the police immediately.

- ▶ A bullet or shot removed from a suspected gunshot wound will have been expended and is no longer live.
- ▶ These can be packaged individually in a small plastic pot lined with a plastic bag to stop it rattling. Shotgun shot can be stored collectively.

Forensic awareness in a major incident

*These guidelines have been created for clinicians forced to disturb items of potential evidential importance by treating a patient. They are not intended to act as a professional reference for forensic collection

Communication

Police/Forensic teams present at the hospital may not understand your clinical priorities, or know what items the victim/suspect had on their person.

- ✔ Assist the police by noting:
 - ▶ The number, position and description of injuries.
 - ▶ What clothing and footwear has been removed from the victim/suspect.
 - ▶ How these removed items have been packaged and where they are currently stored.
- ✔ Make good clear clinical notes, with time and place, as these may be used as evidence in any subsequent inquiry.

Exhibits

An exhibit is any item, image or document entered into the police chain of custody (see below).

An item isn't covered by the rules of evidence before it is seized, but you should still take sensible precautions to optimise any potential value as evidence by:

- ✔ Recording the appearance, location and nature of an item of interest.
 - ▶ This will avoid confusion about the nature and origin of an item that later becomes an exhibit.

Exhibits will be packaged and stored according to the evidence types associated with it by the police/forensic teams.

- ✔ Allow police to collect discarded clothing/items for example a shirt with bloodstaining might be packaged in a tamper evident bag and frozen for DNA analysis.
- ✔ If you are likely to handle multiple exhibits from the same suspicious incident, be aware of the risk of cross-contamination by wearing two pairs of nitrile gloves and discarding the outer pair after handling each item.

For further information regarding continuity, statement writing and giving evidence in court, please refer to the supplementary papers that accompany this guidance.

Head, face and neck injuries in a major incident

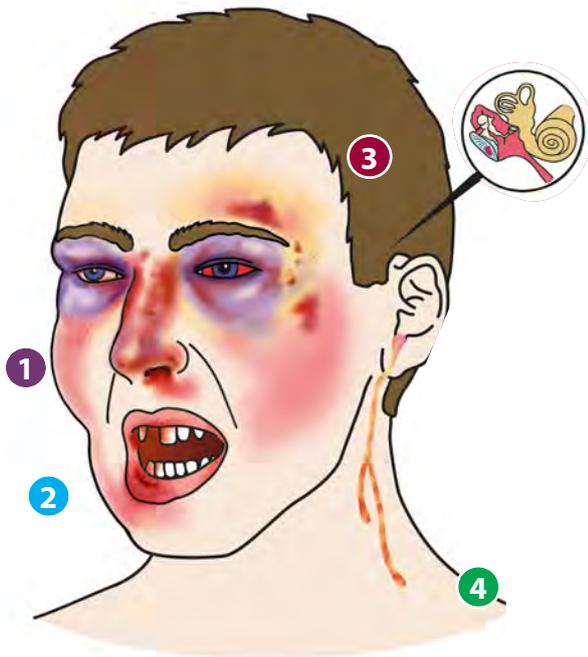
Severe trauma to the head, face and neck rarely results in exsanguination despite appearances, and facial injuries are only addressed during the primary survey if bleeding is impacting on airway or circulation.

However, important significant life changing disability can result if injuries to visual, auditory, gustatory, vestibular and olfactory systems are not recognised and the psychological impact of facial disfigurement can be devastating.

Catastrophic haemorrhage

- ❓ Excessive bleeding from a scalp laceration
 - ▶ Tight compression bandage
 - ▶ Within the hairy scalp, haemostats, staples or deep silk sutures can be used tamponade the bleeding
- ❓ Facial arterial bleeding. If direct pressure fails, consider applying pressure proximally
 - ▶ Chin, lip, midface, nose (facial artery). Apply pressure to the lower border of the mandible, just anterior to masseter muscle. **Do not blindly place haemostats due to risk of damaging the facial nerve**
 - ▶ Scalp above the ear (superficial temporal artery). Apply pressure to the scalp, just anterior to the crux of the pinna

⚠ Severe facial trauma should be regarded as an indicator of potential intracranial trauma or cervical spine injury. ①



A

C-Collar: may cause a patient with maxillofacial injuries to obstruct.

- Sit patient up, face forwards if conscious and no spinal injury, or consider if C-Spine can be cleared to remove C-Collar as soon as possible
- ❓ Distally displaced loose maxilla (Le Fort fracture) causing obstruction of the airway.
 - (Intubated patient) Use two fingers on the soft palate to reduce the fracture and clear the nasopharynx.
- ❓ Comminuted mandible fractures.
 - De-rotate the mandible fragments to clear the oropharynx.
- ❓ Distally displaced tongue obstructing airway.
 - ▶ Anterior tongue silk suture can be used to secure tongue .
- ❓ Other causes of airway obstructions:
 - ▶ Missing teeth/fractured dentures ②
 - ▶ Congealed blood and vomit

B

- ✓ As per standard trauma resuscitation

C

- ✓ As per standard trauma resuscitation

D

Head and neck wounds

- ▶ All wounds deep to the platysma muscle should be explored in theatre
- ▶ Facial wounds and abrasions with grit and foreign particles are at risk of tattooing if not scrubbed out
- ▶ If direct pressure does not stop a bleeding neck wound, then a foley catheter can be inserted into the wound and filled with saline, to tamponade the bleed

Nasal haemorrhage

- ▶ Anterior nasal packing with ribbon gauze or nasal tampons (*ie* Rapid Rhino®)
- ▶ Posterior nasal haemorrhage may require both posterior and anterior nasal packing (*ie* Epistat® or Foley catheter with additional anterior packing)

Head, face and neck injuries in a major incident

Important injuries in the head and neck

Eyes

- ▶ Globe perforation
- ▶ Retrobulbar haemorrhage
- ▶ Foreign bodies (incl contact lens)
- ▶ Retinal detachment
- ▶ Children's white eye blow out
- Check visual acuity

Ears

- ▶ Tympanic membrane rupture **3**
- ▶ Inner ear damage
- Hearing test in the next few days

Nose/ears

- ▶ CSF leak or bleeding from the nose or external auditory meatus

Maxilla

- ▶ Distally displaced Mobile Le Fort fractures (airway obstruction)

Mandible

- ▶ Communitated fractures, especially in the elderly, may allow airway obstruction
- ▶ The tongue may lose its anterior attachments and displace distally, obstructing the airway

Teeth

- ▶ Missing teeth – are they on the floor, in the lip or lung(s)?

Face

- Soft tissue laceration with deep structure involvement
- ❓ Is there potential risk to the parotid duct or facial nerve?
 - ▶ Must be assessed prior to surgery/GA

Neck **4**

- ⚠ Penetrating neck trauma is potentially fatal**
- ▶ Look for external haemorrhage or an expanding haematoma that may indicate a vascular injury
 - ▶ Penetrating objects should not be removed

Zone 1

Clavicle to cricoid cartilage

- ❓ great vessels
- ❓ trachea
- ❓ oesophagus (dysphagia, haematemesis)
- ❓ lung apices
- ❓ brachial plexus

Zone 2

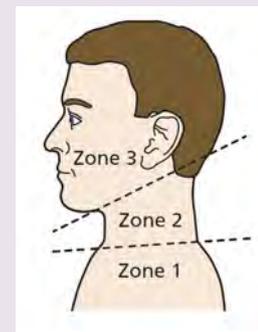
Cricoid cartilage to angle of the mandible

- ❓ carotid arteries
- ❓ internal jugular vein
- ❓ larynopharynx (stridor, haemoptysis, surgical emphysema, hoarseness of voice)

Zone 3

Between angle of mandible and skull base

- ❓ internal carotid artery
- ❓ internal jugular vein
- ❓ cranial nerves (IX-XII)



How to pack anterior and posterior nasal cavities

- ▶ Insert Epistat catheter along the nasal floor until the tip passes the soft palate. Fill the posterior balloon with < 10mls saline. Pull gently on the catheter until it meets resistance and then fill the anterior balloon with <30mls.
- ▶ A Foley catheter (12-14G) can also be used, with additional anterior packing such as ribbon gauze and saline/TXA.

Paediatric casualties in a major incident

This guideline has been created for non-paediatric specialists. The paediatric groups are defined as:

Baby 0–6 months, Infant 6–12 months, Toddler 1–2 years, Child >3 years.

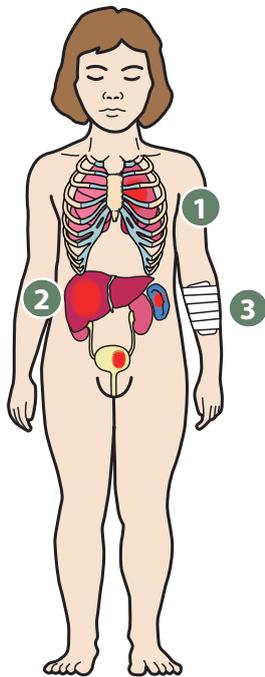
>12 years can cautiously be managed as an adult

History – take an AMPLE history

- A** Allergies
- M** Medications
- P** Past medical history .
- L** Last food/liquids
- E** Event

Extras

- ❓ Is child up to date with routine vaccinations?
- ❓ Birth History: As child becomes older, this is less significant.
- ❓ In infants, postnatal respiratory difficulties may contribute to a condition worsening beyond what would be expected based on injury



Normal paediatric vital signs by age group

Age group	Resp rate	Heart rate	Min sys BP
Term baby	40–60	100–170	50
3 month	30–50	100–170	50
6 month	30–50	100–170	60
1 year old	30–40	110–160	70–90
1–2 years	25–35	100–150	80–95
2–5 years	25–30	95–140	80–100
5–12 years	20–25	80–120	90–110
>12 years	15–20	60–100	100–120



A

- ✔ Place infant head in neutral position (larger occiput than adults)
- ▶ Fulcrum of C-Spine is C1-2 (high C-Spine injury more likely)



B

- ▶ Ribs are horizontal, therefore can only move up. Limited ability to increase tidal volumes
- ▶ Difficult to localise chest sounds on auscultation
- ▶ Decompress stomach early to improve breathing. The diaphragm is an important respiratory muscle in infants and action may be compromised by a full stomach.
- ▶ Children fatigue earlier than adults
- ▶ Normal respiratory rates vary greatly with age
- ▶ Infants become bradycardic when hypoxic



C

- ▶ Blood volume is relatively larger 80–90mls/kg (adult 65–70mls/kg)
- ✔ Record all blood loss (100mls in a 5kg child = 10% of total blood volume)
- ▶ Hypotension is a late sign
- ❓ If there small vessels: consider IO, scalp veins and ext. jugular vein



D

Head

- 0–18 months have open sutures and fontanelles
 - ▶ Bulging fontanelle = intracranial bleeding (↑ ICP)
 - ▶ Sunken fontanelle = significant blood loss

Chest

- ▶ The force transmitted may not fracture ribs but may still cause significant internal injuries ①
- ▶ Mobility of mediastinum increases the likelihood of a simple pneumothorax developing into a tension pneumothorax, or a mediastinal vessel transection.

Abdomen

- ▶ Thin abdominal wall, with less muscle and sub-cutaneous fat, offers less protection to abdominal organs than in adults ②
- ▶ Increased likelihood of bladder, liver and spleen injury

Musculoskeletal

- ▶ Fractures through growth plates may influence x-ray interpretation, however if missed can seriously affect future growth of the fractured bone ③



E

- ▶ Increased risk of multiple organ involvement from blunt trauma
- ✔ Monitor plasma glucose. Children have a higher metabolic rate and smaller glycogen stores than adults.
- ▶ Heat loss: large surface area to volume ratio therefore increased risk of heat loss. Remember the patient's exposed head

Management of a pregnant casualty in a major incident

<20 weeks

Fundus below the umbilicus

- ✓ Gynaecology input

>20 weeks

Fundus above the umbilicus

- ✓ Obstetric team for emergency LSCS
- ✓ Midwife input for baby

⚠ Predict need for blood/fluids early

- ▶ Maternal hypotension due to shock is a late sign of haemorrhage – associated with 80% foetal mortality.
- ▶ **Treating the mother gives the best outcomes for the child.**

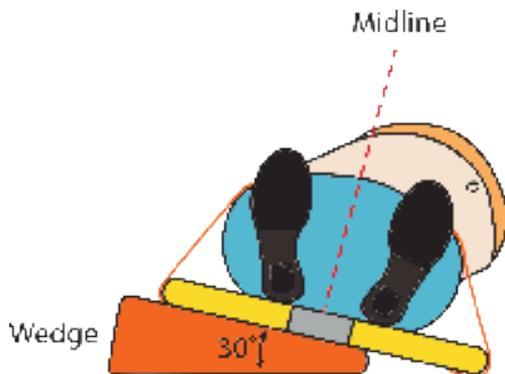
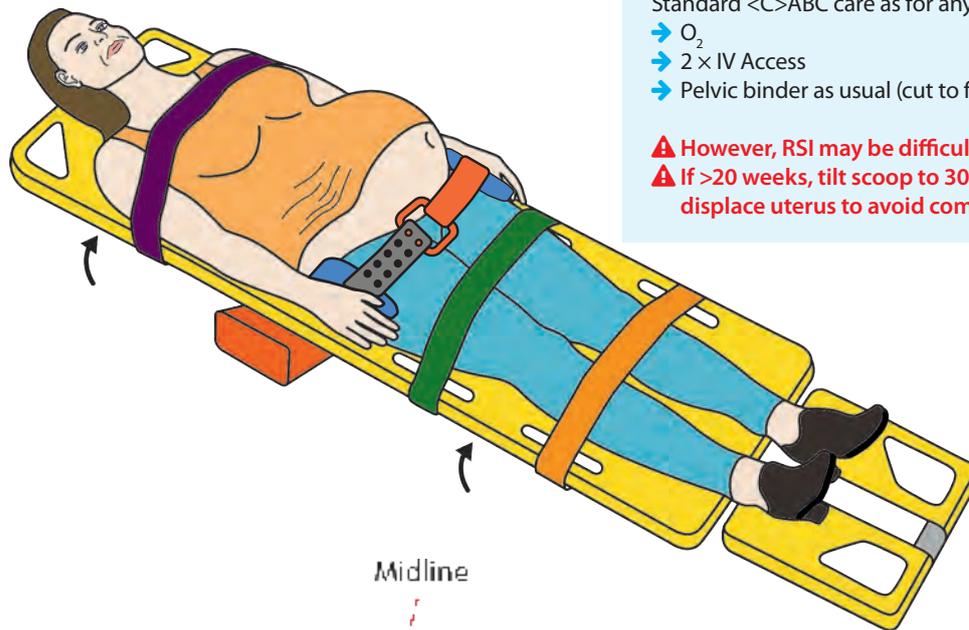
Primary survey

Standard <C>ABC care as for any trauma patient

- O₂
- 2 × IV Access
- Pelvic binder as usual (cut to fit if necessary)

⚠ However, RSI may be difficult

- ⚠ If >20 weeks, tilt scoop to 30° to the left or manually displace uterus to avoid compression of IVC.



Secondary survey

- ✓ Secondary survey as usual

Plus observe for:

- ? uterine contractions
- ? vaginal bleeding
- ? amniotic fluid PV
- ▶ Obstetric team should do the vaginal exam

Trauma checklist

Tranexamic Acid (TXA)

- ▶ Give if strong suspicion of significant haemorrhage
- ▶ If LSCS is planned, give after delivery of the child

Bloods

- ▶ Inform blood bank that patient is pregnant
- ▶ Add Kleihauer test (extra FBC bottle and G&S bottle)
- ▶ Consumptive coagulopathy can develop rapidly

i KEY POINTS

- ▶ If mother is Rh D-ve, consider Rh Immunoglobulin therapy. Discuss with Haematology. If needed, should be given within 72 hours.
- ▶ Maternal bicarb is low in pregnancy
- ▶ Obstetric ward is not appropriate place for patient requiring head injury monitoring
- ▶ Discuss with obstetrics for destination after ED

How can I help myself or others to overcome these difficulties?

Do:

- Take time out to get sufficient sleep (your normal amount), rest and relax, and eat regularly and healthily.
- Tell people what you need. Talk to people you trust. You don't have to tell everyone everything but telling nobody anything is often unhelpful.
- Take care at home or when driving or riding - accidents are more common after a traumatic or stressful event.
- Try to reduce outside demands on you and don't take on extra responsibilities for the time being.
- Make time to go to a place where you feel safe and calmly go over what happened in your mind. Don't force yourself to do this if the feelings are too strong at the moment.

Don't:

- Bottle up these feelings. Think whether it would be helpful to talk about them with somebody you trust. The memories may not disappear straight away.
- Get embarrassed by your feelings and thoughts, or those of others. They are normal reactions to a very stressful event.
- Avoid people you trust.

More information on post trauma reactions

www.rcpsych.ac.uk/healthadvice/problemsdisorders/posttraumaticstressdisorder.aspx
www.nhs.uk/Conditions/Post-traumatic-stress-disorder/Pages/Treatment.aspx

Where to find more help?

Contact your **GP** or **NHS111** about possible symptoms of anxiety, depression, or post traumatic disorder, visit **NHS Choices** - www.NHS.uk or call the **Samaritans** on **08457 90 90 90**



Coping with stress following a major incident

You may find this leaflet helpful if you have been involved in, or affected by, a traumatic incident.

It provides information on how you may expect to feel in the days and months ahead, and to help you understand and have more control over your experience.

You might need help if you have been experiencing any of the following reactions for several weeks and there is no sign of them getting better:

- You want to talk about what happened and feel you don't have anyone to share your feelings with.
- You find that you are easily startled and agitated.
- You experience vivid images of what you saw and have intense emotional reactions to them.
- You have disturbed sleep, disturbing thoughts preventing you sleeping or dreams and nightmares.
- You are experiencing overwhelming emotions that you feel unable to cope with or experience changes in mood for no obvious reason.
- You experience tiredness, loss of memory, palpitations (rapid heartbeat), dizziness, shaking, aching muscles, nausea (feeling sick) and diarrhoea, loss of concentration, breathing difficulties or a choking feeling in your throat and chest.
- You feel emotionally numb.
- Your relationships seem to be suffering since the incident.
- You are worried about your alcohol or drug use since the incident.
- Your performance at work has suffered since the incident.
- Someone who you are close to tells you they are concerned about you.

In addition, if a child has witnessed or experienced a traumatic event it is quite natural for them to be stressed. They may be very upset and/or frightened. This should not usually last beyond four weeks.

If symptoms of being very upset continue beyond four weeks, this may indicate Post Traumatic Stress Disorder (PTSD) and it is important to seek help for your child.

These are typical reactions after a traumatic event:

- Nightmares.
- Memories or pictures of the event unexpectedly popping into their mind.
- Feeling as if it is actually happening again.
- Playing or drawing about the event time and time again.
- Not wanting to think or talk about the event.
- Avoiding anything that might remind them of the event.
- Getting angry or upset more easily.
- Not being able to concentrate.
- Not being able to sleep.
- Being more jumpy and being on the lookout for danger.
- Becoming more clingy with parents or carers.
- Physical complaints such as stomach aches or headaches.
- Temporarily losing abilities (e.g. feeding and toileting).
- Problems at school.

How to help your child:

- Try to keep things as normal as possible: keeping to your usual routine and doing normal activities as much as you can, will help your child feel safer more quickly.
- Be available to talk to your child as and when they are ready. If it is difficult for you to do this, ask a trusted adult such as a family member or teacher to help.

- Try to help your child understand what has happened by giving a truthful explanation that is appropriate for their age. This may help reduce feelings of confusion, anger, sadness and fear. It can also help correct misunderstandings that might, for example, lead the child to feel that they are to blame. They can also help reassure the child that although bad things can happen, they don't need to be scared all the time.

- In the event of a death, particularly a traumatic one, it can be difficult to accept the reality of what has happened. It is important to be patient, simple and honest in response to questions about a death. Some children, for example, will seem to accept a death but then repeatedly ask when that person is coming back. It is important to be patient and clear when dealing with these questions: for example, it is better to say "John has died" than "John has gone on a journey".

What to look for:

- Children experiencing PTSD might show that they think differently either about themselves or other people. They might:
 - Blame themselves or show lowered self-esteem.
 - Describe thinking that they are a bad person or talk about thoughts of deserving bad things to happen to them.
 - Show less trust in other people and be less able to experience a sense of safety.
 - Experience overwhelming feelings in the form of shame, sadness and fear.
- Avoid situations that they fear could increase their emotional response – i.e. might make them feel more frightened, threatened, ashamed or reminded of the event.

What to do:

If you have any concerns about your child, it is important to seek help via your GP. There are some very effective treatments including Cognitive Behavioural Therapy (CBT) for children and young people experiencing the effects of trauma.



Psychosocial support for staff after a major incident

'Psychosocial' refers to the emotional, cognitive, social and physical experiences of people in the context of particular social and physical environments.

Mental healthcare refers to delivering biomedical interventions from which people with disorders may benefit.

After a major incident, staff who attended to support as first responders and those who worked to provide subsequent care in hospital settings, are at risk of developing mental health disorders.

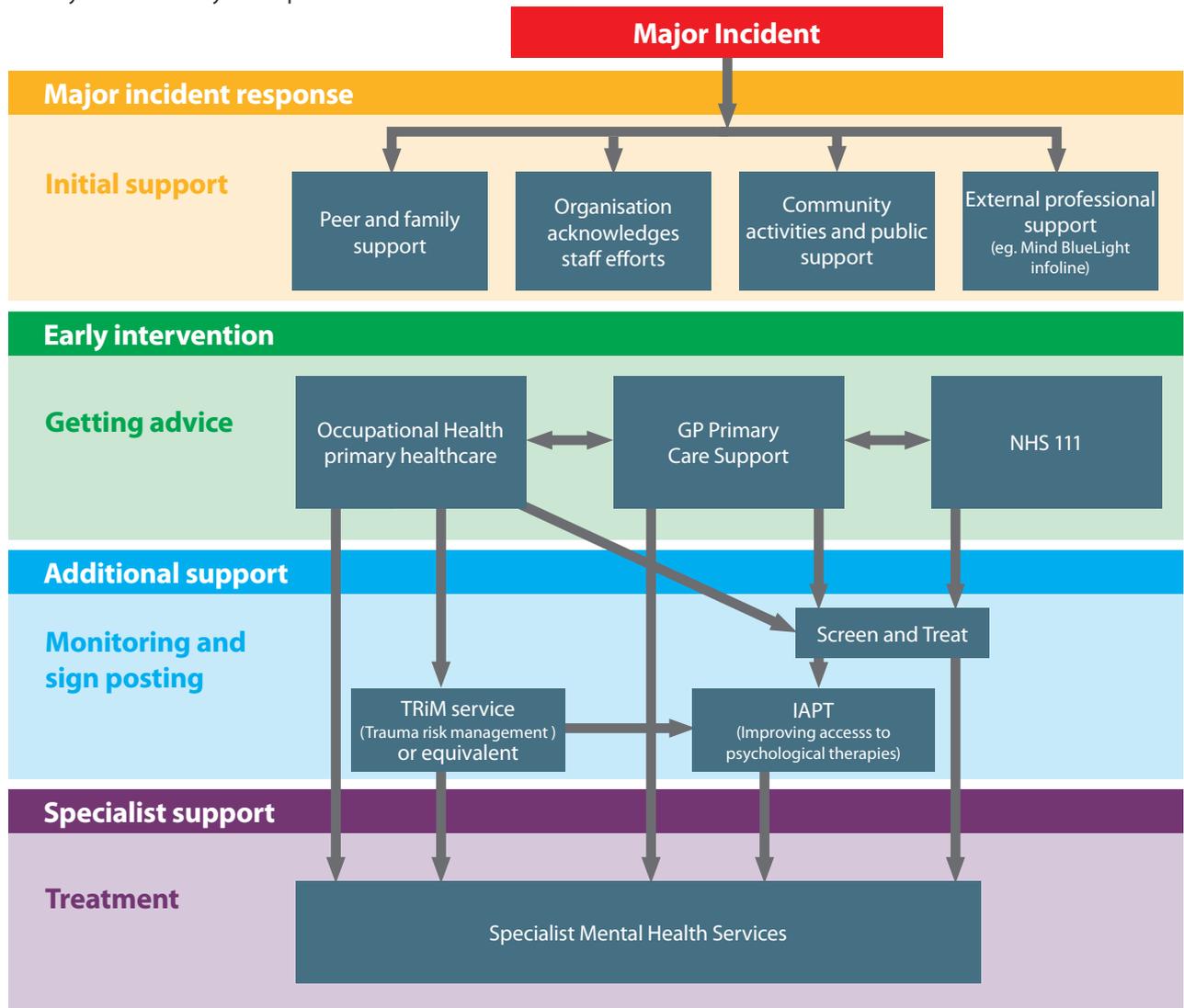
Most people involved in a major incident are likely to suffer short-term effects. In most cases, distress is transient and not associated with dysfunction or indicative of developing mental health disorders. Some people's distress may last longer and be more incapacitating, for example where there are social factors maintaining their distress (e.g. separation from family, loss of home and possessions, social isolation).

A small proportion of people may require access to specialist mental healthcare. However, it is important to access the right help at the right time. Immediately following a traumatic event, personal, brief, single session interventions that focus on the particular event, should not be routine practice and do not need to be organised. Instead, follow Phase 1 advice below.

Depending on the nature of events, around 70% or more of all people who are affected by major incidents are psychosocially resilient, despite their distress. Distress reduces in severity if they receive support they perceive as adequate and intervening early can reduce the risks of people developing disorders later.

The majority of staff who respond cope well and recover after emergencies if social support is available from relatives, friends and colleagues. Employers should support staff by ensuring that they are well briefed, well led and offered effective social and peer support. Recent research shows that events encountered in emergency departments affect the psychosocial wellbeing of staff, and the cumulative effects may be negative and long-lasting.

The following phased strategy is advised to support all those involved in a major incident, to prevent mental disorders and to identify those who may need specialist mental health services.



Psychosocial support for staff after a major incident

Phase 1 Initial support

🕒 Launched in reaction to the event

- ▶ Psychological first aid (PFA) and peer support
- ▶ Includes the employer's leadership response to a major incident by communicating key messages of acknowledgement, self-care and support services, internal and external to the organisation
- ▶ Access to advice and support as necessary through existing universal services (community, primary care/GP and specialist services)
- ▶ Intervene using low level interventions such as peer support leaving biomedical mental healthcare for people who need it

Advice available from:

- ▶ **Coping with Stress following a major incident (NHS Guidance)** assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/617321/nhs_trauma_leaflet.pdf
- ▶ **Traumatic Stress Guidance (London Ambulance Service)** londonambulance.nhs.uk/stress-management-policy
- ▶ **MIND** mind.org.uk/news-campaigns/coping-with-traumatic-events

Phase 2 Getting advice

🕒 Weeks two to four

- ▶ Psychosocial support
- ▶ Aim to manage distress, but an emphasis on maintaining social connectedness and people receiving social support
- ▶ Involves listening, advice and support
- ▶ With their consent, some staff may be referred to a programme that offers monitoring over a longer period of time and access to screening

Advice available from:

- ▶ **Mind Blue Light Programme** mind.org.uk/news-campaigns/campaigns/bluelight
- ▶ **NHS 111 (to signpost to an appropriate service)**

Phase 3 Additional support/getting help

🕒 From two weeks onwards

Continuing psychosocial support

Monitoring staff at risk via occupational health

This may include referring people to:

- ▶ Primary care
- ▶ The TRiM service or equivalent (if available)
- ▶ Specially created services to identify people who may need continuing support beyond four weeks
- ▶ The IAPT service for more intensive psychosocial care

Advice available from:

- ▶ **Primary Care/own GP (for referral to IAPT)**
- ▶ **Improving access to Psychological Therapy Services (IAPT) for specialist PTSD support** england.nhs.uk/mental-health/adults/iapt
- ▶ **Mind Blue Light Programme** mind.org.uk/news-campaigns/campaigns/bluelight

Phase 4 Specialist support/getting more help

🕒 When symptoms are still present between four and twelve weeks after an event

People with a history of the following may be at higher risk of developing a mental disorder than the general population:

- ▶ Staff injured in the event or during the response
- ▶ Exposure to high-severity of trauma
- ▶ Close proximity to event
- ▶ Dissociative response during the event
- ▶ Significant (pre- or post-event) personal trauma, including developmental trauma and previous history of a mental disorder
- ▶ Personal or significant family psychiatric history
- ▶ Perceived absence of social support network
- ▶ Substance misuse
- ▶ Traumatic bereavement

⚠️ If people are distressed or have symptoms of a mental disorder after 4 weeks and any of these risk factors are present, an early referral to a specialist mental health service may be advised.

Advice available from:

- ▶ **Primary care/own GP (for referral to IAPT)**
- ▶ **Improving access to Psychological Therapy Services (IAPT)** england.nhs.uk/mental-health/adults/iapt

Rehabilitation co-ordination and medical support in a major incident

High quality hyperacute rehabilitation methods can support the major incident response and optimise patient outcomes

Roles of the hyperacute rehab team in a major incident:

- ▶ To assist in creating capacity in the whole healthcare community to create beds (Back door)
- ▶ Hyperacute rehabilitation for new patients (Front door)

Ideas to create capacity (Back door)

- ▶ At any one time in a Major Trauma/Neuroscience Centre, there will be a significant number of patients who are 'transfer ready'
- ▶ Usually there are more than 20 patients with medical clearance and more than 20 patients with predominantly R&R needs but partial medical clearance

When creating capacity:

- ▶ Ensure routine healthcare is not put on pause
- ▶ Understand that creating capacity takes time
- ▶ Too much capacity is the default position in a major incident

Estimate the scale of the response required and over-react

Example: How the rehab team could support a major incident response

Step 1

- ▶ Liaise with the MI Duty Physician to permit displacement of patients from priority beds
- ▶ Prioritise specialist beds for creating capacity – neurosurgery, orthopaedics, ICU, Burns/Plastics – and focus on these

Step 2

Form up into a hyperacute team, consisting of:

- ▶ an occupational therapist
- ▶ a physiotherapist
- ▶ a discharge liaison nurse
- ▶ an administrator/clerical support

Step 3

Identify 'Transfer Ready' patients

- ▶ Can the next care provider admit the patient now?
- ▶ Is there a community based rehab bed suitable for the patient?
- ▶ Can support be provided for families wishing to have patients at home?
- ▶ Can they be safely moved to an alternate bed within the hospital?
- ▶ Can any behavioural or care needs be met with the next provider?
- ▶ Are there any equipment issues? Can these be met by the next care provider?

Step 4

For each patient transferred:

- ▶ Identify the level of medical clearance and if community follow up is required?
- ▶ Ensure equipment, care and rehab plans have been arranged.
- ▶ Liaise with next providers and families.
- ▶ Record discharge destinations and contact numbers centrally, for all displaced patients

If a regional response is required to meet the scale of capacity expected:

- ▶ Alert other regional rehab services to create/declare capacity
- ▶ Alert community trusts to open Level 2b and 3 rehab beds
- ▶ Contact Care Commissioners: They may be able to release/prioritise funding for exceptional cases or additional capacity



KEY POINTS

- ▶ Back door processes first - hyperacute rehab teams should assist in creating capacity in a major incident
- ▶ Front door processes second – hyperacute rehab optimises patient outcomes and supports the early major incident response

Rehabilitation co-ordination and medical support in a major incident

High quality hyperacute rehab methods can support the major incident response and optimise patient outcomes

Front door hyperacute rehabilitation

For patients with;

Acquired Brain Injury

- ▶ Does the patient have a Traumatic brain injury (TBI) or Hypoxic-ischaemic brain injury (HIBI)?
- ▶ Classification of Injury (Diffuse axonal injury(DAI), mild traumatic brain injury(mTBI), minimally conscious state (MCS) or vegetative state (VS)
- ▶ Prognosis and Triage – futility?
- ▶ CRASH Algorithm <http://www.crash.lshtm.ac.uk/Risk%20calculator/index.html>
- ▶ Differential diagnosis: drugs, toxins, fat embolism, metabolic causes

Spinal Cord Injury

- ▶ ASIA assessment
- ▶ Establish early spinal clearance or spinal plan
- ▶ Early respiratory support – Cough Assist, diaphragmatic screening
- ▶ Application of the ‘Spinal Bundle’ care plan incl. bowel regime, feeding/nutrition
- ▶ Cervical collar prescription and application
- ▶ Spinal cord injury (SCI) centre referral (Gold standard- within 4 hours)

Plexopathy

- ▶ Early identification is key
- ▶ Imaging
- ▶ Peripheral nerve injury- surgical referral

Peripheral nerve injury

- ▶ Clinical and neurophysiology assessment
- ▶ Orthotics (ie futuro splint for wrist drop in brachial plexus nerve injury)

Seizures and seizure prevention

Movement disorder

Functional neurological disorder and dissociation

Spasticity

- ▶ Identify and treat (Consider early antispasmodics: baclofen, early botulinum toxin (BTX-A))
- ▶ Identify afferent stimuli acting as triggers
- ▶ Identify and treat paroxysmal sympathetic hyper-reactivity
- ▶ Positioning and splinting
- ▶ Identify and treat heterotrophic ossification

Injuries to Special Senses

Vision

- ▶ Fundoscopy: Purtscher’s retinopathy, eye trauma
- ▶ Orbital haematoma
- ▶ Visual function assessment with Optokinetic Nystagmus (OKN)
- ▶ Hearing disturbances especially in blast injury
- ▶ Pain, especially neurogenic pain

Agitation and Delirium

- ▶ Exclude underlying causes
- ▶ Treat to protocol with lorazepam/carbamazepine/olanzapine
- ▶ Identify environmental triggers and de-escalate

Post acute Interventions

Orthotics and Prosthetics:

- ▶ Collars and braces
- ▶ Pressure relief ankle foot orthoses (PRAFO)’s/Dorsi-Wedges
- ▶ MDT Amputation planning including surgeons, rehab team and prostheticians
- ▶ Targetted re-innervation planning

Cognitive Assessments

- ▶ Post Traumatic Amnesia (PTA) assessment
 - ▶ Classification and prognosis
 - ▶ Breaking bad news
 - ▶ Forensic and witness issues
- ▶ Functional Neurological disorder

Communication tools

- ▶ Open circuit ventilation (eg Phillips V60 + Passey Muir Valve)
- ▶ Pointing charts
- ▶ Partner assisted scanning charts
- ▶ Over-bed mirrors
- ▶ Adapted call switches

Contributors

The project is indebted to the following for their guidance, expert knowledge and access to extensive professional networks.

Professor Sir Keith Porter KBE

Consultant Trauma Surgeon, University of Birmingham NHS Trust, Birmingham
Professor of Clinical Traumatology, University of Birmingham, Birmingham

Professor Chris Moran

Consultant Trauma Surgeon, Nottingham University Hospital, Nottingham
Professor of Orthopaedic surgery, Nottingham University Hospital, Nottingham
National Clinical Director for Trauma, NHS England.

Brigadier Timothy Hodgetts CBE QHS

Honorary Professor of Emergency Medicine
Senior Health Adviser to the British Army

Initial Project Working Groups

Prof. Toni Belli, Professor of Neurosurgery, QEH, Birmingham
Lt Cdr Jenny Buck, Defence Specialist Advisor in Perioperative Care, MOD
Col Tim Davies, Commanding Officer 203 (Welsh) Field Hospital, RAMC
Col Heidi Doughty, Consultant in Transfusion Medicine for NHS Blood and Transplant
Stephen Groves, National Head of EPRR, NHS England
Lynn Hyatt, Head of Emergency Preparedness and Resilience, QEH, Birmingham
Pete Jefferson, EPRR Locality Lead for West Midlands
Miss Justine Lee, Major Trauma Specialty Doctor, QEH, Birmingham
Prof. Pete Mahoney, Consultant Anaesthetist, RCDM and QEH, Birmingham
Prof. Chris Moran, National Clinical Director for Trauma, NHS England
Dr Rob Moss, Anaesthetic Consultant, QEH, Birmingham
Col Paul Parker, Consultant Trauma and Orthopaedic Surgeon, QEH, Birmingham
Prof. Sir Keith Porter, Professor of Clinical Traumatology, QEH, Birmingham
Jane Tovey, Head of Medical Illustration, QEH, Birmingham
Mr Harald Veen, Consultant Trauma Surgeon, World Health Organisation, Geneva
Dr Paul Wood, Consultant Anaesthetist, QEH, Birmingham

Contributors

Lt Col Mark Ballard RAMC

Consultant Radiologist
Army Consultant Adviser in Radiology
Queen Elizabeth Hospital, University Hospitals Birmingham NHS
Foundation Trust, Birmingham
Royal Centre for Defence Medicine, Birmingham, UK

Professor Tony Belli

Consultant Neurosurgeon
Queen Elizabeth Hospital Birmingham, University Hospitals
Birmingham NHS Foundation Trust, Birmingham
Director of the NIHR SRMRC
Professor of Trauma Neurosurgery, University of Birmingham, UK

Mr Duncan Bew

Consultant Trauma and Acute Care Surgeon
Clinical Director for Trauma and Surgery, Kings College Hospital NHS
Foundation Trust, London

Surg Cdr Steve Bland RN

Consultant Emergency Medicine
Defence Consultant Advisor CBRN Medicine, Joint medical Group
United Kingdom

Col Doug Bowley

Consultant Trauma and Colorectal Surgeon
Heartlands Hospital, Birmingham
Royal Centre for Defence Medicine, Birmingham, UK

Debra Carr PhD CEng FIMMM FCSFS

Impact and Armour Group, Centre for Defence Engineering, Cranfield
University, Defence Academy of the UK, Shrivenham
Defence and Security Accelerator, Porton Down, Salisbury, UK

Col Jon Clasper

Consultant Orthopaedic Surgeon
Frimley Park NHS Foundation Trust, Frimley, UK
Past Defence Professor Trauma & Orthopaedics, RCDM, UK

Surg Cdr Philip Coates RN

Consultant Interventional Radiologist
Derriford Hospital, Plymouth, UK

Col Tim Davies MBE

Commanding Officer 203 (Welsh) Field Hospital, RAMC

Dr Heidi Doughty OBE MBA Dr Philos

Consultant in Transfusion Medicine
Honorary Consultant, Department of Clinical Trauma, Queen Elizabeth
Hospital Birmingham
Honorary Senior Research Fellow, University of Birmingham, UK

John Etherington CBE FRCP Col L/RAMC

Director of Defence Rehabilitation,
Defence Consultant Advisor Rheumatology, Rehabilitation and Sport
and Exercise Medicine

Contributors

Dr Martin J Gill

Consultant Medical Microbiologist
Queen Elizabeth Hospital, University Hospitals Birmingham NHS
Foundation Trust, Birmingham
Civilian Consultant Adviser Microbiology (ARMY)

Stephen Groves

National Head of Emergency Preparedness, Resilience and Response
NHS England

Dr Karl Harrison DSc PhD MSc MCIfA

Lecturer in Forensic Archaeology
Cranfield University, Defence Academy of the UK, Shrivenham

Lt Col M Kerry Herd RAMC

Consultant in Oral and Maxillofacial Surgery
Northampton General Hospital NHS Trust, Northampton, UK

Lt Col Simon Horne RAMC

Consultant in Emergency Medicine
Defence Medical Services, UK
Emergency Department, Derriford Hospital, Plymouth UK

Pete Jefferson

Emergency Preparedness Response and Resilience Locality lead for
Birmingham, Solihull and the Black Country,
NHS England – West Midlands

Lt Col Steven Jeffery

Consultant Burns and Plastic Surgeon
Queen Elizabeth Hospital, University Hospitals Birmingham NHS
Foundation Trust, Birmingham
Royal Centre for Defence Medicine, Birmingham, UK

Lt. Col. Andy Johnston RAMC

Consultant in Critical Care
Queen Elizabeth Hospital, University Hospitals Birmingham NHS
Foundation Trust, Birmingham
Royal Centre for Defence Medicine, Birmingham, UK

Col Alan Kay

Consultant Burns and Plastics Surgeon
Queen Elizabeth Hospital, University Hospitals Birmingham NHS
Foundation Trust, Birmingham
Royal Centre for Defence Medicine, Birmingham, UK

Ms Verity Kemp

Director
Healthplanning Ltd

Miss Justine Lee

Specialty Doctor in Major Trauma
Major Trauma Service, Queen Elizabeth Hospital, Birmingham
Clinical Reference Group Emergency Preparedness, Resilience and
Response, NHS England

Col Peter Mahoney CBE TD QHS PhD

Past Defence Professor Anaesthesia,
Queen Elizabeth Hospital, University Hospitals Birmingham NHS
Foundation Trust, Birmingham
Royal Centre for Defence Medicine, Birmingham, UK

Dr Deborah Mortiboy

Consultant Microbiologist
Queen Elizabeth Hospital, University Hospitals Birmingham NHS
Foundation Trust, Birmingham
Civilian Consultant Adviser Microbiology (RAF)

Dr Suzy Morton

Consultant in Haematology and Transfusion Medicine
Queen Elizabeth Hospital, University Hospitals Birmingham NHS
Foundation Trust, Birmingham

Dr Tina Newton

Consultant in Paediatric Emergency Medicine
Clinical Lead for Emergency Medicine and Trust Lead for Major Trauma
Birmingham Children's Hospital, Birmingham

Lt Col Linda Orr RAMC

Consultant ENT/Head & Neck Surgeon
Queen Elizabeth Hospital, University Hospitals Birmingham NHS
Foundation Trust, Birmingham
Royal Centre for Defence Medicine, Birmingham, UK
Military Research and Clinical Innovation - Lead hearWELL Collaboration

Col Paul Parker RAMC

Trauma & Orthopaedic Consultant
Queen Elizabeth Hospital, University Hospitals Birmingham NHS
Foundation Trust, Birmingham
Royal Centre for Defence Medicine, Birmingham, UK
Senior Lecturer in Special Operation Medicine, University College, Cork,
Ireland

Surg Cdr Tim E Scott RN

Consultant in Anaesthesia and Intensive Care Medicine
The Royal Stoke University Hospital, Stoke
Lecturer Academic Department of Military Anaesthesia and Critical Care

Mark Sewell

Emergency Preparedness, Resilience and Response Portfolio Manager
(National)
NHS England

Surg Capt Jason Smith RN

Consultant in Emergency Medicine
Emergency Department, Derriford Hospital, Plymouth
Defence Professor of Emergency Medicine,
Royal Centre for Defence Medicine, Birmingham, UK

Surg Lt Cdr Tom Stevenson RN

PhD Student
Cranfield Forensic Institute University, Cranfield University, Defence
Academy of the UK, Shrivenham

Mr Richard Steyn

Consultant Cardiothoracic Surgeon and Deputy Medical Director
Heartlands Hospital, Birmingham
Queen Elizabeth Hospital, University Hospitals Birmingham NHS
Foundation Trust, Birmingham

Professor Steve Sturman

Consultant Neurologist (Neurorehabilitation)
Queen Elizabeth Hospital, University Hospitals Birmingham NHS
Foundation Trust, Birmingham

Surg Lt Cdr James Vassallo RN

Post Doctoral Research Fellow
Emergency Department, Derriford Hospital, Plymouth
Academic Department of Military Emergency Medicine,
Royal Centre for Defence Medicine, Birmingham, UK

Professor Richard Williams

Emeritus Professor of Mental Health Strategy, Welsh Institute for Health
and Social Care
University of South Wales

Dr Paul R Wood MBE

Consultant Anaesthetist
Queen Elizabeth Hospital, University Hospitals Birmingham NHS
Foundation Trust, Birmingham
Royal Centre for Defence Medicine, Birmingham, UK

Contributors

Production Team

Editor-in-chief	Justine Lee
Copy Editor	Jenny Hudson
Lead Graphic Designer	Justin Still
Graphic Designers	Derek Winckles Paolo Imbibo
Medical Artist	Andrew Dakin

Many thanks to all of the Medical Illustration team at QEH, Birmingham and to Yvonne Yau, Personal Assistant to Prof. Mahoney

Guideline MOI/1 graphics were produced by Clare Pratchett, Art Director, Learning Services at Cranfield Defence and Security, UK
Guideline MOI/5 graphics were produced by Surg Cdr Steve Bland RN

These guidelines have been heavily influenced by many military and open source materials:

Clinical guidelines for operations (CGOs) (JSP999) Ministry of Defence
<https://www.clinicalguideforops.co.uk>

Advance Trauma Life Support
(USA) <https://www.facs.org/quality-programs/trauma/atls/about>
(UK provider) <https://www.rcseng.ac.uk/education-and-exams/courses/search/advanced-trauma-life-support-atls-provider-programme/>

Hospital Major Incident Medical Management and Support (HMIMMS)
Advanced Life Support Group <https://www.alsg.org/home>

Oxford Desk Reference Major Trauma
Jason Smith, Ian Greaves, Keith M. Porter

Role 4 Trauma Website and Combat Trauma App
www.4trauma.org.uk
'Combat Trauma' is available for download from the App Store - Apple (UK) (tablet only)
RCDM – Royal Centre for Defence Medicine, Birmingham, UK

Glossary/list of terms

ABO	refers to blood group types A,B and O
ABSCM	Anterior Border of the SternoCleido Mastoid muscle
ABx	Antibiotics
ATD	Adult Therapeutic Dose
ALS	Advanced Life Support
A-line	Arterial line
AK47	Automatic Kalashnikov assault rifle
AMPLE	Allergies, Medications, Past Medical History, Last eaten, Events leading up to injury
ARDS	Adult Respiratory Distress Syndrome
ASIA	American Spinal Injury Association
ATLS	Advanced Trauma Life Support
ATMIST	Age, Time, Mechanism of Injury, Injuries, Signs (vital signs), Treatments given
AVM	Arterio-Venous Malformation
AVPU	Alert, Voice, Pain, Unresponsive (levels of consciousness)
BBV	Blood Borne Virus
BM stix	Trade name for blood glucose test strip (Boehringer Mannheim, now called Roche)
BOAST4	British Orthopaedic Association Standards for Trauma Pathway 4, for patients with open lower limb injuries
BP	Blood Pressure
BTX-A	Botulinum Toxin Type A
big bang	a serious transport accident, explosion or series of smaller incidents
°C	degrees centigrade
C1	Cervical Spine 1 (Atlas)
CABC approach	Catastrophic Haemorrhage, Airway, Breathing, Circulation (standard ATLS/ALS assessment routine)
CABCDE	Catastrophic Haemorrhage, Airway, Breathing, Circulation, Disability, Environment/Exposure
CBRN	Chemical, Biological, Radiation, Nuclear
C-Collar	Cervical spine immobilisation collar
CCS	Casualty Clearing Station
CK	Creatine Kinase
clotting screen	eg. INR, PT, APTT, Fibrinogen
cloud on the horizon	a serious threat such as a significant chemical or nuclear release developing elsewhere and needing preparatory action
CPAP	Continuous Positive Airway Pressure
CPE	CPE Carbapenemase producing Enterobacteriaceae
C-Spine	Cervical Spine
CSF	CerebroSpinal Fluid
CT	Computed Tomography scan/imaging
CT Hot Report	first report issued by radiologist reviewing a trauma CT scan, usually within 15mins
CTwb	Computed Tomography whole body imaging
D50	Dextrose 50% in water
DAI	Diffuse Axonal Injury
DNA	DeoxyriboNucleic Acid
Dr1, Dr2	Doctor 1, Doctor 2
EA	Epidural Analgesia
ESBL	Extended Spectrum Beta-Lactamase
ECCO₂R	Extra Corporeal Carbon Dioxide Removal
ECMO	Extra Corporeal Membrane Oxygenation
ECOSA	Emergency Co-ordination Scientific Advice system
ED	Emergency Department
EDH	Extra Dural Haemorrhage
ENT	Ear, Nose and Throat surgical specialty
EPRR	Emergency Preparedness, Resilience and Response
ET	Endotracheal tube
Ex-Fix	External Fixator
EZIO®	battery powered intra-osseous driver with needle
fVIIa	Factor VIIa
FAST	Focussed Assessment with Sonography in Trauma
FBC	Full Blood Count
FFP	Fresh Frozen Plasma
FiO₂	Fraction of Inspired Oxygen

Glossary/list of terms

FTL (Fwd)CCP	Full Thickness Loss (in burns) (Forward) Casualty Collection Point
GA	General Anaesthesia
GCS	Glasgow Coma Score
GP	General Practitioner
GSW	GunShot Wound
HALO	Hospital Ambulance Liaison Officer
HAZMAT	Hazardous Material, accidental incident involving hazardous material
headline news	public or media alarm about an impending situation, reputation management issues
HIBI	Hypoxic-Ischaemic Brain Injury
HIV	Human Immunodeficiency Virus
HME	Heat and Moisture Exchanger
hot debrief	meeting that occurs immediately after an incident or period of duty
HR	Heart Rate
L/hr	litres per hour
LEH	Local Emergency Hospital
IAPT	Improving Access to Psychological Therapies
ICD	Intercostal Chest Drain
ICP	IntraCranial Pressure
ICU	Intensive Care Unit
IED	Improvised Explosive Device
in	inches
IO	Intra-Osseous
IOR	Initial Operational Response
IPC	Infection Prevention & Control
IPPV	Intermittent Positive Pressure Ventilation
IV	Intra-Venous
IVC	Inferior Vena Cavae
LA	Local Anaesthetic
LCSC	Lower Segment Caesarean Section
LFTs	Liver Function Tests
mass casualty	typically events with casualties in the 100s, where the normal major incident response must be augmented with extraordinary measures
METHANE	Major Incident?, Exact location, Type of incident, Hazards?, Access/arrival/egress, Number of casualties, Emergency services on scene
MCE	Mass Casualty Event
mcg	micrograms
MCS	Minimally Conscious State
MDT	Multi Disciplinary Team
mg	milligrams
MHP	Massive Haemorrhage Pack
MIND/Mind	mental health charity, Mind, delivers the blue light programme for all first responders
mmHg	millimetres of mercury, eg. unit of blood pressure measurement
M-LLSACF	Medial to Lateral Lazy S across the Ante Cubital Fossa incision
MPTT-24	Modified Physiological Triage Tool-24
MRSA	Methicillin Resistant Staphylococcus Aureus
MSK	Musculoskeletal
mTBI	Moderate Traumatic Brain Injury
MTF	Medical Treatment Facility
MTFA	Marauding Terrorist, Firearms Attack
MRI	Magnetic Resonance Imaging
MI	Major Incident, Myocardial Infarction
mm	millimetres
mls/hr	millilitres per hour
MTC	Major Trauma Centre
NA	Nerve Agent
NaCl	Sodium Chloride (normal saline)
NGO	Non Government Organisation
NHS	National Health Service
NHSBT	NHS Blood Transfusion Service

Glossary/list of terms

NBM	Nil by mouth
NPIS	National Poisons Information Service
STEP1-2-3PLUS	safety triggers for emergency personnel in CBRN events
O₂	Oxygen
OD	omni die, every day
ODP	Operating Department Practitioner
OGJ	Oesophageal Gastric Junction
OPD	Outpatient department
P1	Priority 1, needing life-saving resuscitation or intervention
P1 Hold	Expectant, serious injuries with a poor chance of survival, or needing extensive treatment, casualties receive treatment compatible with resources
P2	Priority 2, needing early resuscitation and/or surgery, but some delay is acceptable
P3	Priority 3, requires treatment but a longer delay is acceptable
P2S	Pradidoxime (nerve agent antidote)
pAPRV	partial Anomalous Pulmonary Venous connection
PBLI	Primary Blast Lung Injury
PCA	Patient Controlled Analgesia
PEEP	Positive End Expiratory Pressure
PEP	Pre-Event Planning, Post-Exposure Prophylaxis
PFA	Psychological First Aid, Psychosocial First Aid
PHE	Public Health England
PO	per os, by mouth, orally
POC	Point Of Care
PPI	Proton Pump Inhibitor
PR	per rectum, rectal examination, rectal administration of medication
PRAFO	Pressure Relief Ankle-Foot Orthoses
PTA	Post Traumatic Amnesia
PTL	Partial Thickness Loss
PTSD	Post Traumatic Stress Disorder
PV	per vaginam, vaginal examination, describes vaginal blood loss through the vagina
QDS	quarter die sumendum, four times a day
R&R	Rest and Relaxation
RA	Regional Analgesia
RBC	Red Blood Cell(s)
Resus	Resuscitation area in the emergency department
REBOA	Resuscitative Endovascular Balloon Occlusion of the Aorta
RhD	Rhesus D, a protein found on surface of RBCs
rising tide	a developing infectious disease epidemic, or capacity/staffing crisis or industrial action
ROTEM	ROtational ThromboElastoMetry
RSI	Rapid Sequence Induction
RT	Rapid Transfuser
RT1/2	Rapid Tranfusionist 1 and 2
Rx	prescription, prescribes
scribe	medic who records results and actions during a trauma alert
shock pack	'pack' issued by blood bank in response to massive haemorrhage
SIEVE	Initial on scene triage of casualties by ambulance/pre-hospital services
SORT	Secondary triage of casualties
SI(J)	Sacro-Iliac (Joint)
SVR	Systemic Vascular Resistance
TAP	Transverse Abdominis Plane
TBI	Total Brain Injury
TBSA	Total Body Surface Area (used in Burns)
TDS	ter die sumendus, three times per day
TEG	ThromboElastoGraphy
TIC	Trauma Induced Coagulopathy
TM	Tympanic Membrane
TRS	Terror Related Stab (injury)
TTL	Trauma Team Leader
trauma bloods	FBCs/U&Es/G&S/Clotting (PT, APTT, fibrinogen), Ca ²⁺ , lactate, A/VBG, (plus ROTEM if available)
Trauma ID	patient identifier

Glossary/list of terms

TRiM	Trauma Risk Management
TU	(major) Trauma Unit
TXA	Tranexamic Acid
U	Unit
U&Es	Urea and Electrolytes
UK DMS	United Kingdom Defence Medical Services
USS	UltraSound Scan
VBG	Venous Blood Gas
VHA	Viscoelastic Haemostatic Assays
VS	Vegetative State
VTE	Venous Thrombo Embolic (disease)
VX	nerve agent
WBCT	Whole Body Computed Tomography
WHO	World Health Organisation
Hot debrief	immediately after the incident or period of duty
Cold/Structured/ Organisational debrief	within 2 weeks post incident
Multi-agency debrief	within 4 weeks of the close of the incident
Post incident reports	within 6 weeks of the close of the incident
P1	Priority 1, needing life-saving resuscitation or intervention
P1 Hold	Expectant, serious injuries with a poor chance of survival, or needing extensive treatment, casualties receive treatment compatible with resources
P2	Priority 2, needing early resuscitation and/or surgery, but some delay is acceptable
P3	Priority 3, requires treatment but a longer delay is acceptable
P4	Dead or for palliation. Use of this category can only be authorised by NHS England
M	Major Incident?,
E	Exact location,
T	Type of incident,
H	Hazards?,
A	Access/arrival/egress, from the scene or from hospital
N	Number of casualties,
E	Emergency services on scene
C	Catastrophic Haemorrhage, also <C>, CatHaem, bigC
A	Airway,
B	Breathing,
C	Circulation
D	Disability
E	Exposure (of the patient), Environment, Everything Else,