

Early management of polytrauma and severe musculoskeletal trauma:

The role of the anaesthetic team

East Midlands Regional Trauma Network

2011 Guidelines for Nottingham University Hospital

These guidelines reflect current 'best practice' at QMC, and as such are constantly evolving. They are the result of extensive consultation between a multispecialty / multidisciplinary group. Hard copies of all standard operating procedures (SOP's) are kept in the ED resuscitation bays.

In addition to the essential knowledge and skills for management of these complex and challenging patients, a sound grasp of the human factors and team leadership / membership skills is fundamental.

As the anaesthetist, you are the person who has the best overview of the patient's pathway in the hospital. The potentially multiple transitions between different areas, teams, and leaders within the hospital can be particularly difficult, and the use of repeated briefing / debriefing can ensure agreed clinical understanding, goals and expectations. **The factors most commonly causing clinical problems are decision-making and effective communication within and between teams. Particular attention needs to be paid to documentation of decisions and interventions.**

Trauma team

The anaesthetic trauma bleep will most usually be carried by the 3rd on-call trainee anaesthetist. There will be occasions when this bleep is carried by the 2nd on call / Fellow according to seniority, experience and emergency case mix. Trauma calls are a priority and should be attended immediately. The 1st on-call, if a basic trainee, should also try to attend trauma calls as part of their education but cannot attend as a substitute for the more senior trainees. We have a clear role of airway management in an unfamiliar, so called 'hostile' environment and it is absolutely inappropriate for this to fall to the most inexperienced member of the on call team. If this causes logistic problems owing to theatre work, the on call consultant must be called.

In Nottingham, the trauma team is:

**Emergency Department Consultant and/or SpR
Emergency Department SHO
Anaesthetic SpR + ODP**

**General Surgery SpR
T&O SpR
Radiology SpR
Senior Emergency Department nurse**

In addition, the haematology (blood bank) technician will be aware of the call (but not attend) as will be the on-call radiographer, and AICU trainee.

The team leader will usually be the Emergency Department Consultant, or SpR with consultant support.

Occasionally, a consultant from another specialty will act as team leader.

The trauma team will assemble in the resuscitation room in the Emergency Department. You will be shown the resuscitation area (resus) of ED and the relevant equipment as part of your induction to QMC. It is your duty to ensure that you are familiar with airway, ventilatory, vascular access and monitoring equipment. Please take time to do so. A standardised QMC Difficult Airway Trolley is kept in resus bay one.

There are specific Trauma Team activation criteria and the team may be alerted before arrival of the patient. You must identify yourself to the Trauma Team leader on arrival and will primarily be expected to manage the patient's airway and breathing. You will be expected to wear a role-labelled lead gown. An ODP from theatre will be called as part of this primary response. If there is any delay or problem regarding their attendance, you should communicate this to the theatre coordinator (Ext 64668 or bleep 784 3201) as a CEPOD 1 emergency requiring ODP assistance, and in the interim notify the team leader that you are working without skilled trained assistance and should be allocated temporary help.

You are in prime position from the 'top' of the patient to see all that goes on, and have specialist training in the recognition and management of acute physiological derangement, including haemorrhage and shock. Please communicate your findings, and concerns clearly to the team leader.

If at anytime you need more senior advice or support, call the anaesthetic consultant immediately. These are challenging cases in a challenging environment. Trauma calls are complex and dynamic situations.

Once you think of it, call the consultant.

If you find yourself amongst consultants from other specialties, call the consultant.

Do not be offended if a consultant from ED or surgery asks you to call a consultant. Likewise, do not be afraid to suggest that trainees from other specialties call their consultant.

In general, resuscitation in the East Midlands Trauma Network will follow ATLS guidelines but there are some additional local guidelines and Standing Operating Procedures (SOP's) that you must be aware of. Most of these are based upon recent experience in the wars in the Middle East and will eventually be incorporated into ATLS.

If it is obvious that the patient will require treatment in critical care, please contact ITU early. They may be able to provide additional expertise in the resuscitation room and an early alert will allow them to start planning beds etc.

Adult ITU: Ext 62762 or 62758

Primary Survey - cABC

Exsanguinating external haemorrhage is rare in civilian practice but does occur. These are the guidelines provided for the T+O trainees.

1. In the limbs, apply direct pressure to the wound and then immediately apply a military tourniquet (which should be available in the Resuscitation room)
2. Write the tourniquet time on the patient in indelible ink.
3. Call the on-call consultant.
4. The patient will need to go to theatre rapidly so inform the theatre team so that they can be prepared.
Theatre coordinator numbers: Ext 64668 or Bleep 784 3201.

Airway

The airway is your first priority, and may be very challenging in trauma cases. You may be required to intubate and ventilate the patient at an early stage.

Actual and impending airway compromise and ventilatory insufficiency are clear indications for intubation, but this may also be an important component in the management of a patient with haemorrhage and shock, particularly in the presence of an evolving metabolic acidosis. Early and repeated blood gas analysis will help you enormously in this decision making. You should be aware of NICE Guidelines for intubation and ventilation in the presence of brain injury. Do not be offended if intubation is requested / suggested by the team leader who will have an overview of the whole patient, imaging and impending treatment priorities.

In addition, intubation and ventilation may be essential for the safe assessment of a very agitated patient (remember hypoxia and hypovolaemia are prime causes of agitation), or may be humanitarian

in the presence of multiple painful injuries and the inevitability of theatre and / or A&ICU destination.

You will be using RSI to facilitate intubation and ventilation. Anaesthetic drugs and labels are kept in the 'Head Boxes' in ED. The available induction agents are ketamine, thiopentone, and propofol. Ketamine is not contraindicated in the presence of head injury, and will confer protection of CPP by minimising hypotension in the hypovolaemic patient with abnormal cerebral autoregulation. Alfentanil (5mg/10ml) is available in ED to obtund the pressor reflex in the head injured. We no longer use etomidate as an induction agent, because of the SE of adrenal suppression. Maintenance of anaesthesia can be achieved using midazolam and a propofol infusion in combination with NDNMB.

Trauma intubations are always more difficult owing to the requirement for C-spine neutrality. **Do not try to intubate the patient with a collar in place. The C-spine should be protected by manual in line immobilisation during intubation, and the collar subsequently replaced.** Have a very low threshold for the use of a bougie to facilitate intubation, and do not necessarily try to obtain the 'best possible' view of the glottic opening. Achieve a good enough view to facilitate easy passage of the bougie. This will minimise potential neck movement.

Cervical spine

It is imperative to maintain spinal precautions during airway management and intubation. During this phase of management, the safest option is manual in line stabilisation. A well fitting semi rigid collar will make a difficult airway potentially impossible for you to manage.

The T+O guidelines for c-spine management are as below;

1. Full cervical and spinal immobilisation should be instigated and follow ATLS guidelines.
2. The Nottingham guidelines for radiological clearance of the spine should be followed.
3. The T&O SpR is not expected to clear the spine. Continue full spinal immobilisation and follow the guidelines.
4. Plain x-rays of the cervical spine will not be obtained in the early phase of patient management.

Breathing

Assessment of breathing can be challenging and is a dynamic process. If the patient is conscious, ask for symptoms of respiratory difficulty eg chest tightness, subjective shortness of breath, throat swelling.

There is no substitute for a full and careful clinical evaluation. Repeated blood gas analysis may offer the clue to evolving respiratory embarrassment.

- CXR is one of the two primary survey X rays, and should be performed at the earliest opportunity, but both rib fracture and pneumothorax (particularly anterior) may be missed on the X ray and only detected clinically or on CT scan.
- The T&O or general surgery SpR may be asked to insert chest drains and should be familiar with this procedure.
- Trochars must not be used for insertion of chest drains. Follow ATLS and British Thoracic Society guidelines.
- At no time should chest drains be clamped.
- If there is a deterioration in clinical status, assume and check for drain malfunction.

Should the patient require intubation and ventilation there are Oxylog ventilators in resus, with which you must familiarise yourself at the induction visit. These must be used to transport the patient to CT scan, AICU or theatres

Aim to keep VTe at 6-8 mls/kg and Pmax < 30.

Aim for normocapnia (4.5 – 5 kPa) in all patients, including the head injured. The first exception to this being increased ventilation as a temporising measure in the presence of impending coning, after expert advice (AICU or Consultant). The second exception is the use of permissive hypercapnia in the presence of lung injury. This is a strategy to keep within lung protection guidelines, again with expert advice.

Monitor ventilation with end-tidal CO₂, and regular ABG's. Changing airway pressure may be an early clue to deterioration in compliance due to pneumothorax or lung injury.

Circulation

Recognition of haemorrhage may be very challenging. It is important to use all available clinical information rather than relying on just numbers.

Consider the mechanism of injury, injury patterns, and trends in physiological parameters and ABG's rather than absolutes. Changing level of peripheral perfusion (temperature) is a very subtle, but useful, indicator. These factors should all be interpreted in the light of required supportive treatment (fluid and pharmacological).

Intravenous (iv) access will normally be obtained by the ED doctors, but you may be required to assist when this is difficult. Ideally use wide bore peripheral access for resuscitation. Central access is usually only required for monitoring once the patient has been imaged and transferred to Theatre or AICU and should be placed under aseptic

conditions, which are very difficult to achieve in ED. Under extenuating circumstances, central access may be the only option for iv resuscitation, please use an appropriate gauge line. Invasive arterial monitoring may be very helpful, but should not cause delay in transfer to CT and should never delay the transfer to theatre of an unstable patient requiring operative control of haemorrhage or other life saving surgery. If you plan to site and use these lines in theatre, advance notice to the team in theatre via the theatre coordinator will be valuable.

All fluids should be warmed. There are Ranger plate warmers in ED in addition to a Level One warmer. Be aware of the NPSA warning re the Level One and air embolism.

In the early stages of resuscitation we recommend Permissive Hypotensive Resuscitation (remember the hypotension is not the aim!), except in the presence of head injury (see below).

1. Give 250ml boluses of Hartmann's solution and titrate against response.
2. Do NOT give large volumes of crystalloid fluids (e.g. no more than 2 litres). The amount of crystalloid fluid administered pre-hospital must be established.
3. The aim initially is to maintain a palpable radial pulse.
4. This will give a sBP of 70-80mmHg.
5. If there is suspicion of head injury then aim for a higher sBP (>90mmHg). BTF recommend a MAP of 80mmHg.
6. Fluid replacement should be with blood +/- blood products as soon as they are available.
7. For trauma with uncontrolled haemorrhage and persistent hypotension, rapid surgical control is life saving. Most cases will involve torso injuries and the decision to immediately transfer the patient to theatre will be made by the General Surgeons and the Trauma Team leader.
8. For penetrating chest trauma where cardiac injury is suspected call the Consultant Cardiac Surgeon on-call (not the SpR!), and Consultant General Surgeon. The cardiac surgeon should be contacted via City Hospital bleep desk (ext 56155). The NUH guidelines are that the patient should be transferred to the QMC Emergency Theatre anaesthetic room for continued resuscitation. The cardiac surgeon will go directly there to assess the patient. **Ideally do not anaesthetise, intubate and ventilate the patient until the cardiac / operating surgeon is present, as this is often the point at which cardiovascular decompensation may occur.**
9. If you are going to theatre immediately, warn them!
Theatre Coordinator: Ext 64668 or bleep 784 3201
Theatre 1 (General Surgery): Ext 64253
Theatre 7 (Trauma): Ext 64235

Decision-making regarding ‘stability’ for transfer from ED to other clinical areas can be very difficult; do not hesitate to seek senior advice. Consider what is required to produce the current clinical condition, the need for transfer and the risks versus benefits.

Massive Transfusion Protocol

The aim is to restore / maintain oxygen carrying capacity and haemostatic capacity in those patients at risk for acute coagulopathy of trauma. **The assumption, based on evidence, is that these patients are coagulopathic at presentation.**

1. This will be activated by the Trauma Team leader using the key phrase “Code 911” to the haematology technician.
2. It is used for all trauma patients presenting with sBP < 80mmHg.
3. It should be considered in all trauma patients at high risk of coagulopathy, such as severe pelvic fractures and those with multiple long-bone fractures, who may not initially present with hypotension. In these situations you should confirm that activation of the Massive Transfusion Protocol has occurred, and that a cross match specimen has been sent and received by blood bank.
4. If you have activated this protocol, call the anaesthetic consultant, both for hands and senior experience.

The aim of the Massive Transfusion Protocol is to replace blood loss with blood and prevent coagulopathy, severe haemodilution and hypothermia. Blood, fresh frozen plasma (FFP) and platelets are transfused in 2:1:1 adult dose ratios.

These transfusions must be warmed and rapid.

FFP and platelets should be given as soon as they are available: Do not wait for abnormal coagulation tests – it is too late! They are in the pack and will be wasted if you don’t give them.

In Nottingham, the transfusion products will arrive in a series of trauma packs:

Pack 1

4 units of O-negative packed red cells (PRC)

Pack 2

6 units of cross-matched PRC

6 units of FFP

1 bag of platelets

1 adult dose cryoprecipitate

rFactor VIIa (adult dose)

Pack 3

6 units of cross-matched PRC
6 units of FFP
1 bag of platelets
1 adult dose cryoprecipitate
rFactor VIIa (adult dose)

The haematology SpR and consultant on-call will be informed if the Massive Transfusion Protocol is activated. They will advise on further transfusion requirements after pack 3. Coagulation studies should be sent at regular intervals and, in the near future, thrombo-elastography may be used to guide treatment. The latter is available in the 'Block room' (adjacent to theatre 7) and on AICU.

rFactor VIIa may be considered in patients who do not respond and remain severely hypotensive (sBP < 80mmHg). However, Factor VII is only really shown to be of benefit if used in conjunction with normothermia, normal pH and near normal platelet count. It is associated with a significantly increased risk of arterial thrombosis and should only be used with caution. **This is an 'off-label' prescription and it must be authorised by a consultant.**

Patients receiving a massive blood transfusion may become hypocalcaemic. **Ionised calcium levels should be checked and corrected if necessary using 5mls 10% calcium gluconate.**

All blood and blood products should go with the patient to theatre and the haematology technician should be informed that the patient is being transferred. As anaesthetist you are the most logical person to be Medical coordinator and should ensure that the technician is aware of this change.

If the Massive Transfusion Protocol is instigated but then not required (e.g. unexpected rapid response or patient death) please let the haematology technician know so that blood (+ products) are not wasted.

Tranexamic Acid

Tranexamic acid should be administered early to all trauma victims with a sBP < 110mmHg and evidence of haemorrhage and injury, ideally within 3 hours of injury.

The recent CRASH-2 study suggests a significant reduction in mortality from bleeding with few adverse events.

Dose: 1g IV stat followed by 1g infusion over 8 hours.

Tranexamic acid is available in the Resuscitation room.

Pelvic fractures

Severe pelvic fractures cause life-threatening haemorrhage and may be associated with severe intra-peritoneal injuries. Call consultant help for all specialities as these are extremely challenging patients.

Beware! – They are not always tachycardic at presentation, and may not initially be hypotensive. If the mechanism of injury (MOI) is significant, have a high index of suspicion.

The initial management aims to:

- Splint the pelvis to provide tamponade and prevent movement, protecting blood clots that have already formed.
- Detect the presence of a pelvic fracture with an early x-ray.
- Differentiate between pelvic and intra-abdominal bleeding or visceral injury.

The following is the Standard Operating Procedure:

1. Blunt trauma + sBP < 110 mmHg: Apply pelvic binder.
Don't wait for an x-ray!
2. Pelvic binder can be applied even if lateral compression injury is suspected.
3. Familiarise yourself with the Binders available in ED (T-pod).
4. The Binder should be placed around the trochanters not the iliac crests. The aim is to close the pelvis, not compress it.
5. If Binder applied pre-hospital leave it in-situ, check it is positioned correctly, and x-ray.
6. sBP < 90mmHg: Activate massive transfusion protocol.
7. Do NOT examine the pelvis for mechanical stability.
8. Do NOT logroll the patient until the pelvis is cleared.
9. Do NOT catheterise a male patient until the pelvis is cleared.

Obtain an early pelvic x-ray to clear the pelvis.

A single, good quality AP Pelvic x-ray has a high sensitivity and should demonstrate 97% of significant fractures. If this x-ray is normal, the pelvis is cleared: remove binder whilst monitoring carefully for any evidence of haemodynamic instability, and then repeat x-ray (an AP compression – open book – injury can be perfectly reduced by the binder so that the plain x-ray and CT scan is completely normal. A check x-ray after removal of the binder will identify this problem). If there is any haemodynamic instability, replace the binder.

If a pelvic fracture is present:

1. You can leave binder in place for up to 24 hours unless patient has severe neurological deficit (e.g. paraplegia).
2. Examine carefully for open wounds, especially in the perineum.

3. If there is an open wound, including vaginal lacerations, antibiotics must be administered. Unless contraindicated, Augmentin, Gentamicin and Metronidazole are recommended.
4. How essential is the logroll?
 - a. If unilateral pelvic injury: log-roll to opposite side
 - b. If bilateral pelvic injury: avoid log-roll if at all possible
5. Female patient: catheterise
6. Male patient:
 - a. In the absence of any concerning features, in particular blood at the meatus, or any history of haematuria since accident, a single, gentle attempt at passing a urinary catheter may be undertaken. Sterile technique must be used and the procedure performed by an experienced surgeon: this is not the time to teach the technique.
 - i. If clear urine drains then all good
 - ii. If there is any element of blood staining in the fluid draining from the catheter then a contrast study (retrograde cystogram) is mandated.
 - iii. Retrograde cystogram: inject 100ml diluted (50% saline, 50% contrast) IV contrast medium into the catheter. Clamp catheter and then take AP pelvis x-ray (or CT if the patient is having one).
 - b. If there is any blood at the meatus prior to catheterisation, or any history of haematuria since accident, then a retrograde urethrogram is indicated before attempts at catheterisation.
 - c. Retrograde urethrogram: use 50ml diluted (50% saline, 50% contrast) IV contrast medium in bladder syringe. Insert size 10 Foley catheter so that balloon is just past the meatus then gently inflate balloon with 5mls saline. Hold in place whilst assistant injects contrast into catheter and take AP pelvis x-ray.
 - d. Urethrogram positive: call Consultant Urologist. Decisions now very difficult. If a suprapubic catheter is needed suggest discussion with the pelvic and acetabular surgeons (Mr Hahn or Mr Forward) as this will have major implications for any internal fixation.
 - e. Retrograde urethrogram negative: Catheterise. If haematuria perform retrograde cystogram
7. Pelvic fracture + persistent hypotension – call all consultants if you haven't yet. If general surgery SpR hasn't called their consultant, suggest they should! If T+O SpR hasn't called their consultant, suggest they should too!!
8. Pelvic fracture + persistent hypotension = very high risk of coagulopathy. Activate massive transfusion protocol if not already done.
9. Key question now = Pelvic or abdominal bleeding?
 - a. Clinical abdominal examination is NOT reliable in this situation.

- b. Decision making is difficult – **CALL THE CONSULTANTS!**
- c. FAST (Focused Abdominal Sonography for Trauma) may help.
- d. sBP > 90mmHg: Immediate Trauma CT scan.
- e. sBP 70 - 90mmHg: CT scan will provide a great deal of useful information. Decision to take patient to scan is difficult - follow guidelines on CT below.
- f. sBP < 70mmHg and non-responder: Take to Operating Theatre now!
- g. If Laparotomy performed leave Pelvic Binder on: It should be around the greater trochanters to allow access to the abdomen.
- h. The decision whether to control pelvic or intra-abdominal bleeding first is difficult and will need to be made by consultation between the T&O and General Surgery consultants.
- i. Pelvic bleeding can be stopped by angiography and embolisation.
- j. If there is combined pelvic and intra-abdominal bleeding or isolated pelvic bleeding plus severe hypotension (sBP < 70mmHg) this should be performed in theatre: Inform theatre staff (there is an Embolisation equipment box stored in trauma theatres) and request radiolucent operating table and the vascular theatre image intensifier.
- k. If there is isolated pelvic haemorrhage with a reasonable BP (sBP > 70mmHg), embolisation may be undertaken in the angiography suite, depending on the requirements of the interventional radiologist. This is an isolated environment, distant from theatres, blood bank and AICU. The anaesthetic team are key players in the decision to take a patient to angio. You should discuss this with the anaesthetic consultant on call.
- l. During working hours the interventional radiologist can be contacted via switchboard.
- m. Outside working hours there is no on-call service for interventional radiology in Nottingham. The consultants can be contacted via switchboard to request advice but this should be done by the on-call T+O consultant.
- n. Extraperitoneal packing of the pelvis can also be used to control pelvic haemorrhage. The decision to do this will depend upon the experience of the T&O consultant and available resource.
- o. In general, at QMC, the following are the most likely scenarios where pelvic packing will take place:
 - i. Extremis patient with abdomen already open (e.g. for spleen or liver). Few will survive (or, indeed, do so anywhere).
 - ii. Severe hypotension from pelvic bleeding and no interventional radiologist available.

- iii. Continued (venous) haemorrhage with hypotension despite angiography and pelvic splint.
- p. There is little place for pelvic external fixation in the early management of these injuries. This is a consultant T+O decision.

Trauma CT Scan

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

Having said this, there is an increasing move to early CT scan to aid in the identification of actual and potential threat to life. Good communication and teamwork are essential to the safe conduct of these scans.

1. It should be obtained as early as possible. In centres of excellence the scan plus a report of immediately life-threatening injuries is obtained within 30 minutes of arrival. This should be our aim and the anaesthetist is central to facilitating the safe transfer of the patient.
2. To facilitate this, plan and swap to transfer monitoring at your earliest convenience i.e. whilst other activity is ongoing. Exchange of monitoring should not be what delays transfer.
3. The transfer should be made using the scoop. This is compatible with CT and does not need to be removed during the CT scan. Aim to get the patient from the spinal board onto the scoop as soon as possible. All members of the trauma team, including the anaesthetist, must be familiar with how the scoops available in ED work.
4. A formal full log-roll to 90° is not required to transfer the patient to the scoop – it can be done by log-rolling the patient to about 20° on both sides. The anaesthetist is in charge of this move. Full protection of the neck, spine and pelvis must be maintained throughout.
5. CT4 is the scanner of choice as it is next to the resuscitation room. It is the quickest and best quality scanner. There is no anaesthetic machine or equipment, so prepare and take with you what you need.
6. The ultimate decision on scanning is with the Trauma Team Leader, anaesthetist and specialty consultants.
7. If a patient with a sBP < 90 mmHg is to go to CT, this must be discussed with the on-call Consultant Anaesthetist.
8. Patients with sBP 70-90 mmHg may benefit greatly from the diagnostic accuracy of a scan but the decision is difficult:
 - If high volumes of IV fluid or vasoactive drugs are required to maintain this level of BP, a CT scan may not be safe.
 - Consultant Anaesthetist must be aware.
 - If intra-abdominal bleeding suspected, Consultant General surgeon must be aware.

- Trauma team must accompany patient to CT.
- 6. Patient with sBP < 70 mmHg should probably go to theatre not CT.
- 7. Trauma CT should be from vertex to symphysis pubis.
- 8. IV contrast to be used unless contraindication e.g. allergy.
- 9. Peripheral injuries e.g. pilon or plateau fractures may be scanned at the same time provided the patient is fit enough. The rapid sequence scanner in CT4 will facilitate this.

Secondary Survey

For your information, these are the abbreviated T+O guidelines re secondary survey:

The T&O SpR is responsible for the secondary survey of the limbs:

1. Document all wounds, grazes and degloving.
2. Evaluate each joint and long-bone for dislocation / stability / fracture.
3. Neurovascular examination of all limbs.
4. Record presence or absence of key peripheral pulses & neurological findings.
5. Splint fractures.
6. Repeat neurovascular examination after splinting.
7. Arrange appropriate x-rays.
8. Peripheral x-rays must not delay Trauma CT Scan.
9. In some cases it may be best to delay x-rays until the patient is in theatre and good quality traction x-rays can be obtained.

If emergency fracture fixation or wound management is likely, warn the theatre coordinator as early as possible so that the theatre staff can start preparations.

Contact Theatre coordinator on Ext 64668 or bleep 784 3201 or Theatre 7 (Trauma) on Ext 64235

Open fractures

1. Check tetanus status
2. Give IV antibiotics:
 - Grade I or II: Augmentin
 - Grade III: Augmentin + Gentamicin
 - Farm / aquatic (e.g. river Trent): add Metronidazole.

Definitive management

1. Discuss with consultant
2. Timing depends on other injuries, available theatres, surgeons, plastic surgery
3. Debridement, wound closure and definitive fracture fixation should be within 24h

4. Severely contaminated, farm and aquatic injuries remain a surgical emergency and must be debrided as quickly as possible.

Fracture surgery in polytrauma

Damage Control Surgery (DCS) involves rapid emergency surgery to save life and/or limb whilst avoiding time-consuming and potentially traumatic reconstruction.

The four key areas for DCS are:

1. Haemorrhage control – abdomen, thorax, exsanguinating limb injury
2. Decompression – cranium, cardiac tamponade, limb compartments
3. Decontamination / control of contamination – wounds and ruptured viscera
4. Fracture splintage – pelvic binder, skeletal traction femur, plaster casts, spanning external fixation.

The aim is to preserve physiology, do as little surgical trauma as possible and get the patient to ITU for continued resuscitation as quickly as possible.

All patients requiring care for areas 1-3 will be treated emergently (CEPOD 1).

Fracture care

For those patients not requiring surgery to control haemorrhage, decompress compartments or decontaminate ruptured viscera, the key decision in the first 12 hours is between Early Total Care (ETC) and Damage Control Orthopaedics (DCO) for their fractures.

Early Total Care is the definitive fixation of all long-bone fractures within 24 hours of injury once the patient is physiologically stable. The most important thing to remember is that the patient must be properly resuscitated before fracture surgery, and this is unlikely to be the case within the first 6-12 hours of admission. **Early Total Care does NOT mean Immediate Total Care.**

In general, if a patient is not fit enough for Early Total Care they are not fit enough for extensive surgery to revascularise an ischaemic limb from vascular injury and so amputation may be a life saving procedure.

The decision to undertake ETC or DCO should be based upon the patients physiological response to injury and resuscitation rather than any anatomical scoring system such as the Abbreviated Injury Score (AIS).

In each case you should review the terrible triad – Hypothermia, Coagulopathy and Acidosis.

Hypothermia:

- Patients must be actively kept warm during resuscitation.
- If the core temperature is $< 35^{\circ}$ do not perform ETC

Coagulopathy:

- Platelets < 120 or INR > 1.5 do not perform ETC

Acidosis:

- pH < 7.25 or Base excess < -5.0 do not perform ETC

Lactate Controlled Early Total Care

Venous or arterial lactate is a very useful guide and should be measured serially – all ABG analysers at QMC provide lactate levels. It seems to reflect the adequacy of resuscitation as it is one of the last indices to return to normal. The levels will guide decision making between ETC and DCO for fracture care in the first 12-24 hours.

Most polytrauma patients will have a raised lactate on admission. The important guide to fracture care is the identification of the trend in lactate levels during the resuscitation phase. During this time, fractures will require adequate splintage, which may be achieved with splints, plasters or skeletal traction.

We use the guidelines from Shock Trauma, Baltimore:

- Lactate < 2.0 -> ETC possible
- Lactate > 2.5 -> continued resuscitation
- Lactate 2.0 -2.5, trend up -> continued resuscitation
- Lactate 2.0 – 2.5, trend down -> ETC possible

Once a downward trend is established in patients initially above 2.5, then ETC can be considered but surgery should be delayed until the lactate is < 2.5 .

If the lactate remains elevated above 2.5 with NO evidence of a downward trend despite ongoing resuscitation during the first 12-24 hours, then external fixation of long-bones should be considered in the anticipation that internal fixation will be delayed for a number of days.

All of the above physiological measures should be continually monitored during surgery by frequently repeated blood gas analysis. The T+O consultant will have a prioritised plan for necessary surgery (often written on the white board in theatre). Planning of the surgery should include alternative surgical strategies and include time points when the patients physiological status is reviewed (eg following intramedullary nailing). If the indices deteriorate it may be agreed to

stop definitive fracture surgery, perform DCO and get the patient to ITU for further resuscitation. Remember – trauma is a team game and these decisions need to be made between all members of the trauma team ie. surgeons, anaesthetic team and critical care.

A suitable target haemoglobin concentration in this acute phase of resuscitation and surgery is 10 -11 g/dl as this allows for ‘undershoot’, and helps with lamination of blood flow and optimal platelet function.

Transfer to, and resuscitation in, ITU should be performed as a team with active input from the surgeons, anaesthetists and intensivists, all of whom have complementary skills in the early resuscitation of the multiply-injured patient. The patient should not simply be abandoned in ITU!

On occasions, critical care will have insufficient staff or beds to allow continued resuscitation on ITU. In this situation, the senior clinicians will need to decide the safest environment to continue resuscitation: this may be in the Emergency Department, theatre or the theatre recovery area. The patient must not be abandoned in any of these areas!

Tertiary Survey

All polytrauma patients should have a tertiary survey between 12 and 36 hours from admission. This involves a repeat of the head to toes examination, checking for bruising and tenderness and checking all joints for stability. Additional x-rays should be obtained where necessary and all available x-rays should be reviewed for missed injuries. At NUH a significant proportion of polytrauma patients will have at least one musculoskeletal injury and for these cases the T&O team will be responsible for the tertiary survey. In other cases it will be the responsibility of the admitting speciality team to perform this survey.

The tertiary survey must be documented in the medical records on the NUH Tertiary Survey document.

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