

OXFORD

Standards for the Management of **OPEN FRACTURES**



BAPRAS
British Association of Plastic
Reconstructive and Aesthetic Surgeons



British Orthopaedic
Association



Setting up an effective orthoplastic service

Summary

1. NICE defined an Orthoplastic Centre as: “A hospital with a dedicated, combined service for orthopaedic and plastic surgery in which consultants from both specialties work simultaneously to treat open fractures as part of regular, scheduled, combined orthopaedic and plastic surgery operating lists. Consultants are supported by combined review clinics and specialist nursing teams.”

The BAPRAS/BOA group recommend that for clarity this narrative description of an Orthoplastic Service by NICE is broken into its component parts as follows:

- A Combined service of Orthopaedic and Plastic Surgery Consultants
- Sufficient combined operating lists with consultants from both specialties to meet the standards for timely management of open fractures.
- Scheduled, combined review clinics for severe open fractures
- Specialist nursing teams able to care for both fractures and flaps

In addition, an effective orthoplastic service will also:

- Submit data on each patient to the national trauma database (TARN)
 - Hold regular clinical audit meetings with both orthopaedic and plastic surgeons present
2. The most cost-effective treatment strategy, if it can be achieved, is wound excision, definitive fixation and definitive soft tissue reconstruction as a combined surgical procedure within 24 hours of injury
 3. There are several models in evolution throughout the UK, but the development of the orthoplastic unit is least challenging in hospitals with co-location of Trauma Orthopaedic Surgery and Plastic Surgery departments

4. It is vital to establish an adequately resourced service by engaging with specialised (NHS England or equivalent) and non-specialised commissioners (Clinical Commissioning Groups) to support the service and ensure that the treating centres are appropriately reimbursed for delivering optimal care

NICE Recommendations relevant to open fractures

Introduction

In 2016 the National Institute for Clinical and Care Excellence (NICE) published a suite of five Trauma related guidelines including the Guideline on Complex Fractures NG37. A significant component of this guideline related specifically to open fractures, each of the relevant recommendations is discussed. Following the publication of the complete Trauma Suite of guidelines there was further work by NICE resulting in the formulation of just five Quality Standard Statements; one of these was specific to open fractures.

Quality Standards- QS166

Statement 3- People with open fractures of long bones, the hindfoot or midfoot have fixation and definitive soft tissue cover within 72 hours of injury if this cannot be performed at the same time as debridement.

Extracts from NICE recommendations Complex Fractures NG37 2016

1.1 Pre-hospital settings

Initial management of open fractures before debridement

- 1.1.8 Do not irrigate open fractures of the long bones, hindfoot or midfoot in pre-hospital settings.
- 1.1.9 Consider a saline-soaked dressing covered with an occlusive layer for open fractures in pre-hospital settings.
- 1.1.10 In the pre-hospital setting, consider administering prophylactic intravenous antibiotics as soon as possible and preferably within 1 hour of injury to people with open fractures without delaying transport to hospital.

Splinting long bone fractures of the leg in pre-hospital setting

- 1.1.11 In the pre-hospital setting, consider the following for people with suspected long bone fractures of the legs:
- a traction splint or adjacent leg as a splint if the suspected fracture is above the knee
 - a vacuum splint for all other suspected long bone fractures.

Destination for people with suspected fractures

- 1.1.12 Transport people with suspected open fractures:
- directly to a major trauma centre or specialist centre that can provide orthopaedic care if a long bone, hindfoot or midfoot are involved, or
 - to the nearest trauma unit or emergency department if the suspected fracture is in the hand, wrist or toes, unless there are pre-hospital triage indications for direct transport to a major trauma centre.

1.2 Hospital settings

Vascular injury

- 1.2.1 Use hard signs (lack of palpable pulse, continued blood loss, or expanding haematoma) to diagnose vascular injury.
- 1.2.2 Do not rely on capillary return or Doppler signal to exclude vascular injury.
- 1.2.3 Perform immediate surgical exploration if hard signs of vascular injury persist after any necessary restoration of limb alignment and joint reduction.
- 1.2.4 In people with a devascularised limb following long bone fracture, use a vascular shunt as the first surgical intervention before skeletal stabilization and definitive vascular reconstruction.
- 1.2.5 Do not delay revascularization for angiography in people with complex fractures.

Whole-body CT of multiple injuries Whole-body CT of multiple injuries

- 1.2.8 Use whole-body CT (consisting of a vertex-to-toes scanogram followed by CT from vertex to mid-thigh) in adults (16 or over) with blunt major trauma and suspected multiple injuries. Patients should not be repositioned during whole-body CT.
- 1.2.9 Use clinical findings and the scanogram to direct CT of the limbs in adults (16 or over) with limb trauma.

Management of open fractures before debridement

- 1.2.20 Do not irrigate open fractures of the long bones, hindfoot or midfoot in the emergency department before debridement.
- 1.2.21 Consider a saline-soaked dressing covered with an occlusive layer (if not already applied) for open fractures in the emergency department before debridement.
- 1.2.22 In the emergency department, administer prophylactic intravenous antibiotics immediately to people with open fractures if not already given.

Limb salvage in people with open fractures

- 1.2.23 Do not base the decision whether to perform limb salvage or amputation on an injury severity tool score.
- 1.2.24 Perform emergency amputation when:
 - A limb is the source of uncontrollable life-threatening bleeding, or
 - A limb is salvageable but attempted preservation would pose an unacceptable risk to the person's life, or
 - A limb is deemed unsalvageable after orthoplastic assessment.

Include the person and their family members or carers (as appropriate) in a full discussion of the options if this is possible.

- 1.2.25 Base the decision whether to perform limb salvage or delayed primary amputation on multidisciplinary assessment involving an orthopaedic surgeon, a plastic surgeon, a rehabilitation specialist and the person and their family members or carers (as appropriate).
- 1.2.26 When indicated, perform the delayed primary amputation within 72 hours of injury.

Debridement, staging of fixation and cover

- 1.2.27 Surgery to achieve debridement, fixation and cover of open fractures of the long bone, hindfoot or midfoot should be performed concurrently by consultants in orthopaedic and plastic surgery (a combined orthoplastic approach).
- 1.2.28 Perform debridement:
 - immediately for highly contaminated open fractures
 - within 12 hours of injury for high-energy open fractures (likely Gustilo-Anderson classification type IIIA or IIIB) that are not highly contaminated
 - within 24 hours of injury for all other open fractures.

1.2.29 Perform fixation and definitive soft tissue cover:

- At the same time as debridement if the next orthoplastic list allows this within the time of debridement.

1.2.30 When internal fixation is used, perform definitive soft tissue cover at the same time.

1.3 Documentation

Photographic documentation of open fracture wounds

1.3.4 All trusts receiving patients with open fractures must have information governance policies in place that enable staff to take and use photographs of open fracture wounds for clinical decision-making 24 hours a day. Protocols must also cover the handling and storage of photographic images of open fracture wounds.

1.3.5 Consider photographing open fracture wounds when they are first exposed for clinical care, before debridement and at other key stages of management.

1.3.6 Keep any photographs of open fracture wounds in the patient's records.

Documentation of neurovascular status

1.3.7 When assessing neurovascular status in a person with a limb injury, document for both limbs:

- Which nerves and nerve function have been assessed and when
- The findings, including:
 - Sensibility
 - Motor function using the Medical Research Council (MRC) grading system
- Which pulses have been assessed and when
- How circulation has been assessed when pulses are not accessible.

Document and time each repeated assessment.

1.5 Training and skills

These recommendations are for ambulance and hospital trust boards, medical directors and senior managers within trauma networks.

- 1.5.1 Ensure that each healthcare professional within the trauma service has the training and skills to deliver, safely and effectively, the interventions they are required to give, in line with the NICE guidelines on non-complex fractures, complex fractures, major trauma, major trauma services and spinal injury assessment.
- 1.5.2 Enable each healthcare professional who delivers care to people with fractures to have up-to-date training in the interventions they are required to give.



BRITISH ORTHOPAEDIC ASSOCIATION & BRITISH ASSOCIATION OF PLASTIC, RECONSTRUCTIVE & AESTHETIC SURGEONS



AUDIT STANDARDS for TRAUMA

OPEN FRACTURES

December 2017



Background and Justification

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

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

Standards for Practice Audit:

1. Patients with open fractures of long bones, hind foot or midfoot should be taken directly or transferred to a specialist centre that can provide Orthoplastic* care. Patients with hand, wrist, forefoot or digit injuries may be managed locally following similar principles.
2. Intravenous prophylactic antibiotics should be administered as soon as possible, ideally within 1 hour of injury.
3. There should be a readily accessible published network guideline for the use of antibiotics in open fractures.
4. The examination of the injured limb should include assessment and documentation of the vascular and neurological status. This should be repeated systematically, particularly after reduction manoeuvres or the application of splints. Management of suspected compartment syndrome should follow BOAST guidelines.
5. The limb should be re-aligned and splinted.

6. Patients presenting with arterial injuries in association with their fracture should be treated in accordance with the BOAST for arterial injuries.
7. In patients where an initial “Trauma CT” is indicated there should be protocols to maximize the useful information and minimize delay:
 - The initial sequence should include a head to toes scanogram. This should be used with clinical correlation to direct further specific limb sequences during that initial CT examination.
 - There should be a local policy on the inclusion of angiography in any extremity CT related to open fractures.
8. Prior to formal debridement the wound should be handled only to remove gross contamination and to allow photography, then dressed with a saline-soaked gauze and covered with an occlusive film. ‘mini-washouts’ outside the operating theatre environment are not indicated.
9. All trauma networks must have information governance policies in place that enable staff to take, use and store photographs of open fracture wounds for clinical decision-making 24 hours a day.
10. Photographs of open fracture wounds should be taken when they are first exposed for clinical care, before debridement and at other key stages of management. These should be kept in the patient’s records.
11. The formation of the management plan for orthopaedic and coverage of open fractures and surgery for initial debridement should be undertaken concurrently by consultants in orthopaedic and plastic surgery (a combined orthoplastic approach).
12. Debridement should be performed using fasciotomy lines for wound extension where possible (see overleaf for recommended incisions for fasciotomies of the leg)
 - Immediately for highly contaminated wounds (agricultural, aquatic, sewage) or when there is an associated vascular compromise (compartments syndrome or arterial disruption producing ischaemia).
 - within 12 hours of injury for other solitary high energy open fractures.
 - within 24 hours of injury for all other low energy open fractures.
13. Once debridement is complete any further procedures carried out at the same sitting should be regarded as clean surgery; i.e. there should be fresh instruments and a re-prep and drape of the limb before proceeding.

14. Definitive soft tissue closure or coverage should be achieved within 72 hours of injury if it cannot be performed at the time of debridement.
15. Definitive internal stabilization should only be carried out when it can be immediately followed with definitive soft tissue cover.
16. When a decision whether to perform limb salvage or delayed primary amputation is indicated, this should be based on a multidisciplinary assessment involving an orthopaedic surgeon, a plastic surgeon, a rehabilitation specialist, the patient and their family or carers.
17. When indicated, a delayed primary amputation should be performed within 72 hours of injury.
18. Each trauma network should submit appropriate data to the TARN, monitor its performance against national standards and audit its outcomes.
19. All patients should receive information regarding expected functional recovery and rehabilitation, including advice about return to normal activities such as work and driving

***Orthoplastic unit** - A hospital with a dedicated, combined service for orthopaedic and plastic surgery in which consultants from both specialties work simultaneously to treat open fractures as part of regular, scheduled, combined orthopaedic and plastic surgery operating lists. The surgical service is supported by combined review clinics and specialist nursing teams (from NICE guidelines).

Evidence Base:

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

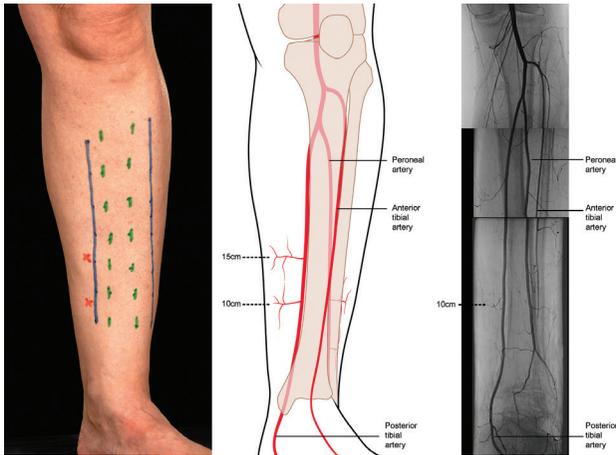


Figure showing recommended incisions for wound debridement and fasciotomies in the leg. The medical incision alone is usually sufficient for debridement and preserves the perforators arising from the posterior tibial vessels, which form the basis of local fasciocutaneous flaps. It also provides access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

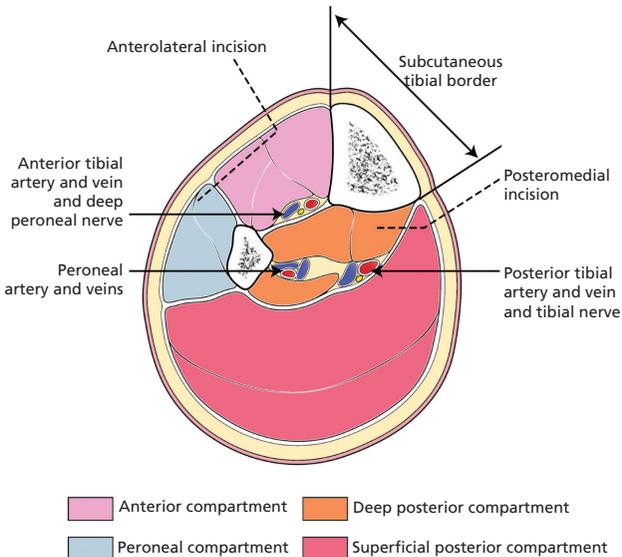


Figure showing cross section through leg showing incisions to decompress all four compartments

Chapter Summaries

1. Pre-hospital, antibiotics and accident and emergency

- Antibiotics should be administered intravenously as soon as an open fracture is identified, ideally within one hour of the injury without delaying transfer to hospital.
- Splinting is a highly effective form of analgesia and should be performed prehospital.
- Clinical examination of the neurological and vascular status must be thorough, performed repeatedly and documented, particularly after an intervention has taken place.
- Transport people with suspected open fractures directly to a major trauma centre or specialist centre that can provide orthopaedic care if a long bone, hindfoot or midfoot are involved, or to the nearest trauma unit or emergency department if the suspected fracture is in the hand, wrist or toes, unless there are pre hospital triage indications for direct transport to a major trauma centre.
- For isolated open fractures, orthogonal views on radiographs should be obtained. In patients where an initial “Trauma CT” is indicated there should be protocols to maximize the useful information and minimize delay; the initial sequence should include a head to toes scanogram. This should be used with clinical correlation to direct further specific limb sequences during that initial CT examination.
- There should be a local policy on the inclusion of angiography in any extremity CT related to open fractures
- Irrigation of the wound should not be performed prehospital or in the emergency department. It should be reserved until after surgical excision of the wound in the operating theatre.
- Once wounds are identified they should be photographed and then covered with a saline soaked gauze and occlusive dressing.

2. Timing of wound excision

- Highly contaminated lower limb fractures should undergo immediate wound excision.
- Wound excision should be performed jointly by consultant orthopaedic and plastic surgeons

- High-energy lower limb fractures (likely Gustilo-Anderson Type IIIA and IIIB), which are not highly contaminated, should undergo wound excision within 12 hours of injury and all other lower limb fractures should be excised within 24 hours of injury. The consultant orthopaedic surgical team are best placed to determine the timing for individual patients based on clinical assessment.

3. Wound excision

- Assessment of tissue viability is difficult after open trauma and wound excision should be performed by consultant plastic and orthopaedic surgeons as a combined procedure.
- Immediate surgical exploration is indicated in the presence of gross wound contamination, compartment syndrome, devascularised limb or multiple injuries.
- Wound extensions along fasciotomy lines are used to facilitate wound excision and allow inspection of deeper structures.
- Wound excision should be systematic to ensure all devitalized soft tissue and bone is removed whilst preserving the neurovascular bundles. Repeat wound excision may be required in the presence of tissue of doubtful viability.
- Low-pressure lavage with a high volume of tepid 0.9% saline completes the wound excision.
- The injury is classified at the end of the final wound excision.
- Closure of an open fracture wound should be a combined decision between orthopaedic and plastic consultants.
- Definitive fracture fixation after wound excision should be undertaken as a distinctly separate operative procedure with re-prepping of the limb and opening of fixation instruments and implants at the time of stabilization.

4. Degloving injuries

- Degloving of the limb occurs in the plane superficial to the deep fascia and the extent of injury is often underestimated.
- Thrombosis of the subcutaneous veins usually indicates the need to excise the overlying skin.
- Circumferentially degloved skin is not viable.
- In severe injuries, multiplanar degloving can occur with variable involvement of individual muscles, which may be stripped from the bone. Under these circumstances, a second look is usually necessary.

- It may be appropriate to offer patients with severe multiplanar degloving over a wide zone primary amputation within 72 hours of the injury.
- Large collections (greater than 50ml) associated with Morel-Lavallée lesions may be best treated by surgical evacuation rather than aspiration.

5. **Temporary dressings**

- Consider a saline-soaked dressing covered with an occlusive layer for open fractures in pre-hospital settings and in the emergency department.
- Following initial wound excision, if the wound cannot be closed primarily, use a simple non-adherent dressing.
- When internal fixation is used, perform definitive soft tissue cover at the same time
- Prolonged application of negative pressure wound therapy (NPWT) should not be used to downgrade the requirements for definitive soft tissue reconstruction, which should be performed within 72 hours of injury.

6. **Skeletal stabilization**

- Spanning external fixation is recommended when definitive stabilization and immediate wound cover is not carried out at the time of primary wound excision.
- Spanning external fixation must be stable to prevent fracture site displacement and pain during patient transfer or movement.
- Fracture patterns, the quantity of bone loss and degree of contamination at injury will determine the most appropriate form of definitive skeletal stabilization.
- Internal fixation is safe if there is minimal contamination at the time of injury.
- If internal fixation is used at any time for stabilization, it is mandatory for definitive soft tissue cover to be achieved simultaneously.
- If exchange from spanning external fixation to internal fixation is planned, it is to be done as early as possible (within 3 days).
- Modern multiplanar and circular fixators are used if there is significant contamination, bone loss or multilevel fractures of the tibia.

7. **Timing of soft tissue reconstruction**

- Early definitive soft tissue cover is associated with better outcomes, including reduced deep infection rates.
- Definitive soft tissue cover should be performed either at the same time as wound excision or within 72 hours of injury.

- Free flap reconstruction is best performed on scheduled lists by experienced, dedicated senior surgical teams following adequate preparation of the patient, including necessary imaging for concurrent fracture reconstruction such as computer tomography scans of comminuted fractures. This should be undertaken in a specialist centre offering the full spectrum of orthoplastic services.
- If internal fixation is used, definitive soft tissue cover should be performed at the same time.

8. **Soft tissue reconstruction**

- All open fractures must be covered with well-vascularized soft tissue 72 hours of the injury to achieve infection-free bony union.
- If internal fixation is used, definitive soft tissue coverage should be achieved at the same time.
- Dressings, including negative pressure wound therapy, can temporize for cover following wound excision but should not be used as a substitute for definitive flap coverage.
- The medical fasciotomy incision is used to raise local fasciocutaneous flaps or to access the posterior tibial vessels for microsurgical anastomosis in free flap reconstruction.
- Local fasciocutaneous flaps are usually best reserved for patients with relatively low energy injuries and a limited zone of injury.
- Experimental data suggest that coverage with muscle leads to improved healing of fractures. However, there is currently little clinical evidence to support the use of one form of soft tissue cover over another for open fractures of the lower limb. When choosing a flap, careful consideration should be given to donor site morbidity.

9. **Bone loss**

- Bone loss in relation to open fractures may arise directly from extrusion of fragments at the time of injury or after surgical excision (debridement).
- Safe and effective management requires expertise of both plastic and orthopaedic specialists in reconstruction. These cases are particularly challenging and should be managed in units with relevant expertise and experience.
- The options for reconstruction will depend on the shape and size of the defect, the location within the bone, the condition of the local soft tissue and the patient's general physical and mental health.
- Bone defects can be reconstructed through autogenous bone grafts (with or without augmentation), vascularized free-transfer of bone (usually

the fibula) or by distraction osteogenesis (according to the methods described by Ilizarov).

10. Vascular injuries

- Resuscitation and management of life-threatening injuries must take priority over any extremity problems
- Haemorrhage from the extremities must be controlled by direct pressure or tourniquet.
- Use hard signs (lack of palpable pulses, continued blood loss or expanding haematoma) to diagnose vascular injury. The pink pulseless limb must be assumed to have an arterial injury until proven otherwise.
- Devascularised limbs are a clinical emergency. If following fracture and joint reduction the limb remains devascularised, immediate surgical exploration is essential.
- Revascularisation must take place as soon as possible and definitely within 3-4 hours as both muscle and neural tissue are especially susceptible to hypoxia.
- Preoperative angiography is not necessary and wastes valuable time. The site of vascular injury can usually be ascertained from the mechanism of injury, fracture location and configuration and by clinical examination. In a patient with multi-level trauma to the same limb or polytrauma who is undergoing a CT scan, CT angiography may be helpful.
- The use of vascular shunts revascularises the limb rapidly, minimizing ischaemia time. Systemic anticoagulation is not necessary.
- Once circulation is restored and an adequate reperfusion interval observed, re-evaluate the potential for limb salvage
- If salvage is deemed appropriate, perform skeletal fixation followed by definitive vascular repair followed by definitive soft tissue cover as required.
- Access incisions for vascular repair must take into account the potential need for compartment decompression and definitive skeletal and soft tissue reconstruction.
- Peripheral nerves that have been transected should be repaired immediately when possible. Crushed or contused nerves should be documented and followed up for evidence of recovery.
- In patients with a single patent artery (usually posterior tibial) free flaps can be anastomosed end to side if required for soft tissue reconstruction.

11. Compartment syndrome

- Compartment syndrome is a surgical emergency and must be diagnosed and treated promptly.
- The accurate diagnosis of the condition relies on the collation of clinical features and intracompartmental pressure measurements. Serial assessments can help establish the diagnosis when there is uncertainty.
- Unrelenting pain out of proportion to the injury, paraesthesia or paresis of nerves within the affected compartments and passive stretch exacerbation of pain are important clinical features.
- The threshold for diagnosis in adults when using compartment pressure measurements is a perfusion pressure (diastolic blood pressure – intracompartmental pressure) of less than 30mm Hg for two consecutive hours.
- Decompression in the leg is performed using the two-incision technique. The posteromedial incision is 12-15mm posterior to the posteromedial border and the anterior incision 2cm lateral to the crest of the tibia. All four compartments are to be released adequately to enable extrusion of enlarged muscle.
- All non-viable muscle is excised and fasciotomy wounds covered immediately with meshed split skin grafts or within 72 hours at the latest.

12. Amputation

- Primary amputation is associated with similar long-term outcomes to limb salvage and should be considered a reconstructive procedure.
- The decision to amputate or salvage a limb is based on a careful multidisciplinary analysis of both injury and patient variables and should not be based on an injury severity score tool. The decision to amputate after trauma must involve an orthopaedic surgeon, a plastic surgeon, a rehabilitation specialist and the patient and their family members or carers whenever possible. Operative photographs illustrating the extent of limb injury should be obtained and stored in the patient's file.
- Immediate amputation is indicated:
 - a) When a limb is the source of uncontrollable life-threatening bleeding or as part of damage control in cases of severe limb trauma in unstable poly-traumatised patients
 - b) an avascular limb with a warm ischaemia time greater than 4 to 6 hours
 - c) extensive crush injuries, particularly involving both the tibia and the ipsilateral foot.

- Positive neurological findings at presentation including absent plantar sensation and lack of motor function are not absolute indicators for amputation but may warrant direct nerve visualization.
- When indicated, a delayed primary amputation should be performed within 72 hours of the injury.
- Maximising residual limb length is imperative for mobility. A through the knee level should be considered in preference to above knee and soft tissue reconstructive techniques should be used where there is sufficient bone but inadequate soft tissues to achieve a more distal amputation level.
- Vigilant follow-up with emphasis on the whole patient including pain management, psychological health and active rehabilitation is essential to maximize good functional outcomes. Revision surgery can dramatically improve prosthetic use, limb function and quality of life and regular orthoplastic review should continue for at least two years.

13. Infection

- Infection is the commonest major complication after open trauma and a high level of clinical suspicion is key for early diagnosis.
- A multidisciplinary approach is mandatory, including orthopaedic and plastic surgeons, microbiology and infectious disease consultants and radiologists.
- Evaluation of the local and systemic host factors is essential before commencing treatment.
- Diagnostic work up commences ideally after stopping antibiotics in stable patients and includes blood cultures if febrile, X-rays for implant loosening and bone changes, ultrasound guided aspiration and/or deep tissue sampling. Microbiological diagnosis may be difficult using traditional techniques and culture-negative cases should be treated proactively by dedicated MDT.
- Cornerstones of effective treatment are the prompt removal of sessile bacteria within the biofilm by aggressive wound excision and the elimination of planktonic bacteria by targeted, culture-specific antimicrobial chemotherapy.
- Removal of internal fixation devices is usually required except in early infection due to low virulent organisms. Treatment by implant retention and antibiotic suppression should be part of clear MDT plan and failure of treatment demands re-evaluation.

14. Open fractures in children

- The initial management of a child's open fracture is the same as recommended for adults. There is no evidence children have greater resistance to infection once the barrier of soft tissue cover of the fracture has been compromised by injury.
- The soft tissues of children do not have a greater regenerative potential and soft tissue reconstruction techniques involve the same strategies as in adults.
- Fracture fixation will need to consider the presence of physes. Flexible intramedullary nails, Kirschner wires, plates introduced by minimally invasive methods and external fixators have their indications.
- Bone loss in very young children (under 6 years) may be managed expectantly if the defect is small as spontaneous periosteal bone formation may occur. In older children, bone replacement by autografts or bone regeneration methods is required.
- The skeletal injuries in children older than 12 years behave as in adults and have higher complication rates. Delayed or nonunions will require a more active treatment strategy.

15. Open fragility fractures

The management of open fragility fractures should follow the established principles as for any open fracture of the lower limb with the following additional considerations:

- From admission, elderly patients should have orthogeriatric assessment promptly, which is then continued throughout their hospital stay and coordinated with related services (e.g. falls prevention, rehabilitation, bone health, mental health, primary care and social services).
- Consider the use of regional anaesthetic techniques
- Consider the use of angle-stable fixation devices to enhance skeletal fixation in osteoporotic bone.
- In patients who are frail or whose soft tissues place them at unacceptably high risk of flap failure, or those for whom a lengthy soft tissue reconstruction procedure may be unsafe, alternative surgical strategies should be considered.

16. Outcome measures

- UK funding bodies expect patient-reported outcome measures are reported in studies.

- Core outcomes for patients with open fractures of the lower limb include:
 - quality-of-life
 - return to life roles
 - walking, gait and mobility
 - pain and discomfort
- Following a consensus process with patients, healthcare professionals and research methodologists the EuroQol-Five Dimensions-5L and the Lower Extremity Functional Scale are recommend to be used in future studies as a minimum.

17. Patient experience of open fracture and psychological support

- Psychological difficulties following open fracture are common and should receive attention alongside the physical effects of injury to help improve long term functioning.
- Patients require support from teams to express strong emotions, manage their pain, adjust to their wounds, live with limited mobility and reimagine their future lives.
- Drawing on Cognitive Behavioural Therapy(CBT) and eliciting a patient's thoughts, feelings, behavioural choices and physiological reactions may help validate patient experience and provide information for mental health referral where indicated.
- Common post traumatic symptoms will often alleviate over time, but their elevation can be predictive of later Posttraumatic Stress Disorder. Patients experiencing acute stress will benefit from regular orientation to their surroundings and help to focus on daily life.
- A patient's distress about change in appearance is linked to their subjective perception rather than objective clinical assessment. Patients may require: support to look at and touch scars and flaps, help with anxiety, which may be indicated by excessive checking or avoidance of their wound, and opportunities to discuss their concerns. Neutral descriptors should be used where possible (e.g. change in appearance rather than deformity).
- Patients should be referred to a trained mental health clinician for evidence-based treatment where their psychological difficulties are negatively impacting on their functioning and recovery.

18. Rehabilitation

- Rehabilitation in Major Trauma Centres(MTCs) should be delivered by a Multi-Disciplinary Team (MDT) led by a consultant in rehabilitation medicine.

- Patients with an isolated open tibial fracture should be assessed by a member of the MDT and provided with a Rehabilitation Prescription (RP) within two calendar days of admission.
- Patients requiring inpatient Rehabilitation Prescription (usually for injuries other than their open tibial fracture) should be assessed by the inpatient unit within ten days.
- The weight-bearing status of the limb and permissible range of movement of joints (with respect to both bony stability and soft-tissue reconstruction) must be recorded in the clinical notes and RP immediately after definitive surgical treatment. Unrestricted rehabilitation should be the goal of surgery and achieved as early as possible.
- The patient's recovery after severe open tibial fracture should be assessed twelve months after injury using the EQ-5D tool.
- A member of the Rehabilitation MDT should have the ability to screen patients for post-Traumatic Stress Disorder (PTSD); ideally the team should include a clinical psychologist.
- Referral to a specialist pain medicine service should be considered if pain symptoms are becoming chronic, are not related to a treatable cause, and are persisting despite treatment by the surgical team and GP.
- A patient undergoing delayed amputation should have a peri-operative pain-control plan in place prior to surgery.
- A patient undergoing delayed amputation should be assessed by a prosthetist or a consultant in rehabilitation medicine prior to surgery.
- Surgeons should consider referring patients with poorly functioning but reconstructed lower limbs for dynamic orthotics.
- Patients with a high transfemoral amputation who do not tolerate standard prosthetic sockets should be referred to a specialist centre with experience in osseointegration.

19. Blast injuries and mass casualties

- Blast and ballistic mechanism of injury result in wounds that have different characteristics than those usually seen by Orthoplastic Teams
- Wound severity is proportional to the energy transferred and degree of contamination.
- The amount of tissue damage may be significantly greater than the size of the obvious wound and is likely to evolve over time.

- There is a greater likelihood of a systemic response than from other injury mechanisms and particular emphasis must be placed on general supportive care.
- Perform initial wound surgery as early feasible in the damage control process.
- Repeated wound excision is often required in contrast to other mechanisms of injury.
- Do not primarily close blast or complex ballistic wounds.
- The decision to use complex reconstruction early should be made more cautiously than with other mechanisms.
- In Mass Casualty Incidents there might be difficulty in timely access to Orthoplastic Services and standard treatment pathways may need to be modified to provide a more population based approach.
- There are evidence preservation and forensic implications when dealing with these wounds.