

[HOSPITAL / HEALTH AUTHORITY NAME]

LIMB INJURY, FRACTURE, DISLOCATION, AND NEUROVASCULAR COMPROMISE PATHWAY

Protocol 34: Rapid Assessment, Analgesia, Neurovascular Protection, Reduction, Splinting, Open-Fracture Care, Compartment-Syndrome and Vascular Rescue, Transfer, and Safe Disposition

DRAFT FOR EMERGENCY MEDICINE, TRAUMA / ORTHOPAEDICS, PLASTIC / HAND SURGERY, VASCULAR SURGERY, ANAESTHESIA, RADIOLOGY, PAEDIATRICS, NURSING, EMS, PHARMACY, PHYSIOTHERAPY, OCCUPATIONAL THERAPY, AND TRANSFER SERVICES

STATUS: This is a draft clinical-governance document. It must be adapted to local orthopaedic, vascular, plastic / hand-surgery, radiology, theatre, anaesthesia, rehabilitation, blood-bank, pharmacy, paediatric, and transfer capabilities. Reduction techniques, sedation and regional-anaesthesia practices, antibiotic regimens, tetanus products, splint choices, vascular imaging, weightbearing instructions, and referral routes require local approval before implementation.

IMMEDIATE SAFETY RULE: A pulseless, pale, cold, deformed, or rapidly swelling limb is a time-critical emergency. Control catastrophic bleeding, urgently realign or reduce a grossly deformed dysvascular limb within clinician competence, release constricting dressings, reassess and document neurovascular status, and activate orthopaedic and vascular / plastic-surgery support. Do not delay limb-saving intervention for routine imaging, complete paperwork, or a perfect diagnosis.

Document control	Details
Document owner	Emergency Department / Medical Services Directorate / Nursing Services / Clinical Governance
Clinical leads	Emergency Medicine; Trauma and Orthopaedics; Vascular Surgery; Plastic / Hand Surgery; Anaesthesia / Critical Care; Radiology; Paediatrics; Rehabilitation
Applies to	Adults, children, pregnant patients, older adults, and vulnerable patients with acute traumatic limb injury, suspected fracture or dislocation, open wound, crush injury, amputation, or neurovascular compromise
Interfaces	Protocol 31 Major Trauma; Protocol 32 Head and Spinal Injury; Protocol 33 Thoracic, Abdominal and Pelvic Trauma; Protocol 49 Major Haemorrhage; Protocol 50 Procedural Sedation; local open-fracture, tetanus, antimicrobial, imaging, transfer, safeguarding, and rehabilitation policies
Version / status	Draft 1.0 for local multidisciplinary validation
Review cycle	After any serious incident, major guideline change, service change, or at least every 2 years
Required approval	Emergency Department; Orthopaedics; Vascular / Plastic / Hand Surgery; Anaesthesia; Radiology; Nursing; Pharmacy; Rehabilitation; Clinical Governance

1. Purpose

To provide a standardized emergency-department pathway for rapid recognition, stabilization, investigation, reduction, immobilization, specialist referral, transfer, observation, and disposition of limb injuries while preventing avoidable haemorrhage, ischaemia, nerve injury, compartment syndrome, infection, skin loss, loss of function, and amputation.

2. Scope

This protocol applies from pre-alert or first contact until discharge, observation, admission, operative treatment, specialist transfer, rehabilitation referral, or death. It covers closed and open fractures, joint dislocations, major soft-tissue injury, tendon and nerve injury, crush injury, traumatic amputation, suspected arterial injury, and acute compartment syndrome. It complements rather than replaces the major-trauma, sedation, analgesia, antimicrobial, tetanus, safeguarding, and specialty-specific pathways.

3. Core policy statements

- Assess and document distal arterial perfusion, motor function, and sensation before and after every reduction, splint, cast, procedure, transfer, and significant clinical change.
- Treat life-threatening haemorrhage first. Use direct pressure, wound packing, haemostatic dressing, or a tourniquet when required; never perform blind clamping within a wound.

- A pulseless deformed limb must be urgently realigned and splinted. Persistent dysvascularity, unequal pulses, hard signs of arterial injury, or recurrent loss of perfusion requires immediate consultant-led vascular and orthopaedic escalation.
- Acute compartment syndrome is a clinical and time-critical surgical emergency. Pain out of proportion, escalating analgesic need, pain with passive stretch, tense swelling, or progressive neurological change must trigger urgent review; normal pulses do not exclude it.
- Give adequate analgesia early. Pain treatment does not replace serial examination and must not be withheld solely to preserve diagnostic signs.
- Reduce dislocations and severely displaced fractures urgently when perfusion, nerve function, skin integrity, or soft tissue is threatened. Obtain pre-reduction imaging when safe, but not if it would delay rescue of a threatened limb or skin.
- For open fractures, give approved IV antibiotics immediately, ideally within 1 hour of injury; photograph once when appropriate, remove only gross contamination, cover with saline-moistened sterile gauze and an occlusive layer, align and splint, and avoid emergency-department “mini-washouts” of long-bone, hindfoot, or midfoot wounds.
- Never assume that a small wound is unrelated to the fracture. Any wound near a fracture is open until proven otherwise.
- Remove rings, watches, bracelets, footwear, and constricting items early when swelling is expected, while preserving forensic evidence where relevant.
- Use the lowest-radiation imaging that answers the clinical question, but do not under-image high-risk injury. Image the joint above and below when the injury pattern or examination warrants it.
- Every discharge requires an explicit diagnosis or working diagnosis, immobilization and skin-care instructions, weightbearing or activity status, analgesia plan, follow-up ownership, and written return precautions.
- Every missed vascular injury, delayed fasciotomy, delayed open-fracture antibiotic, reduction complication, pressure injury from immobilization, unplanned return, unexpected surgery, or functional loss must be reviewed through clinical governance.

4. Definitions and severity framework

Term	Operational definition
Neurovascular compromise	Any new or worsening abnormality of pulse, arterial waveform, limb temperature or colour, capillary refill, motor function, sensation, or severe pain suggesting arterial, nerve, or compartment pathology.
Hard signs of arterial injury	Absent or markedly reduced pulse after alignment, active or pulsatile bleeding, expanding haematoma, bruit / thrill, distal ischaemia, or uncontrolled blood loss.
Open fracture	A fracture communicating with a skin or mucosal wound, regardless of wound size or apparent contamination.
Threatened skin / soft tissue	Skin blanching, tenting, puckering, necrosis risk, open dislocation, severe swelling, degloving, or pressure from a displaced bone or joint.
Acute compartment syndrome	Raised pressure within a closed myofascial compartment causing threatened tissue perfusion and requiring urgent decompression when diagnosed.
Dislocation	Complete loss of normal joint congruity. Subluxation is partial loss of congruity and may be equally urgent when neurovascular or skin compromise exists.
Crush injury	Compression causing muscle, nerve, vascular, bone, or soft-tissue damage with risk of compartment syndrome, hyperkalaemia, rhabdomyolysis, shock, and renal injury.
Traumatic amputation	Complete or partial separation of a limb or digit, including near-amputation with only a soft-tissue bridge.
Stable injury for discharge	No unresolved neurovascular or skin threat; pain controlled; immobilization safe; definitive imaging reviewed; follow-up and mobility plan reliable; and patient can return if deterioration occurs.

Priority category	Typical findings	Minimum response
Immediate limb / life threat	Uncontrolled bleeding; pulseless, pale, cold or paralysed limb; expanding haematoma; open fracture with haemorrhage; acute compartment syndrome; traumatic amputation; open dislocation; severe crush with shock or hyperkalaemia	Resuscitation bay; senior ED, orthopaedic and vascular / plastic input now; haemorrhage control; urgent alignment / reduction if indicated; antibiotics / tetanus; theatre or transfer activation without delay.

Priority category	Typical findings	Minimum response
Urgent threatened tissue / function	Skin tenting, progressive neurological deficit, severe deformity, irreducible dislocation, high-energy fracture, escalating pain or swelling, tendon rupture, major hand injury	Immediate analgesia, complete neurovascular assessment, imaging if it does not delay rescue, urgent reduction / splinting, senior specialty review and monitored disposition.
Potentially unstable injury	Closed fracture or dislocation with intact perfusion but significant displacement, unreliable examination, high-risk mechanism, anticoagulation, frailty, or inability to mobilize	Prompt imaging, analgesia, immobilization, serial examination, definitive specialty plan and admission / observation / transfer as required.
Low-risk injury	Minor mechanism, no red flags, normal neurovascular examination, stable imaging or reliable clinical rule, controlled pain and safe function	Appropriate imaging or clinical-rule pathway, support / splint as indicated, written advice, follow-up and return precautions.

5. Roles and accountability

Role	Minimum responsibility
Senior ED clinician	Lead initial assessment; identify life- and limb-threatening injury; authorize immediate reduction / haemorrhage control; coordinate analgesia, sedation, imaging, consultation, transfer, and disposition.
Orthopaedic clinician	Advise reduction, fixation, open-fracture, compartment-syndrome, weightbearing, admission, and operative strategy; provide time-critical review.
Vascular / plastic / hand surgeon	Assess suspected arterial injury, devascularized limb, major soft-tissue loss, degloving, tendon / nerve injury, amputation, and replantation candidacy.
Anaesthesia / sedation clinician	Provide regional anaesthesia, procedural sedation, airway and haemodynamic support, theatre readiness, and monitoring consistent with Protocol 50.
Nurse	Triage; analgesia; remove constricting items; wound cover; serial pain, skin and neurovascular observations; splint / cast safety; preparation for procedures and transfer.
Radiology / radiographer	Obtain and promptly report appropriate imaging; escalate critical findings; support CT angiography and image transfer.
Pharmacy	Maintain analgesia, sedation, antibiotic, tetanus, reversal and local-anaesthetic monographs and readiness.
Physiotherapy / occupational therapy	Assess mobility, walking aids, upper-limb function, safe transfer, activities of daily living, and discharge equipment.
EMS / transfer team	Protect limb alignment, monitor distal perfusion and pain, maintain warming and haemorrhage control, transport with complete documentation and images.
All clinicians	Document time-stamped findings, interventions and response; escalate deterioration; use closed-loop communication; and confirm ownership of pending results and follow-up.

6. Pre-alert, preparation, and triage

- Receive ATMIST / MIST: age, mechanism, energy, entrapment / crush time, wounds or amputation, haemorrhage-control devices, deformity, pain, neurovascular findings and trend, analgesia, anticoagulants, comorbidities, tetanus status, and estimated arrival.
- Activate orthopaedics, vascular / plastic / hand surgery, anaesthesia, blood bank, operating theatre, radiology, paediatrics, and transfer services according to physiology and limb threat.
- Prepare haemorrhage-control supplies, appropriate splints, reduction and procedural-sedation equipment, ultrasound, Doppler, compartment-pressure equipment, open-fracture pack, antibiotics, tetanus products, warming, and transport equipment.
- Triage as highest acuity for uncontrolled bleeding, traumatic amputation, gross deformity with absent or unequal pulse, open fracture with major contamination or tissue loss, escalating pain / swelling, suspected compartment syndrome, open dislocation, or crush injury with systemic compromise.

- For isolated apparently minor injury, screen for safeguarding, non-accidental injury, occupational or interpersonal violence, intoxication, self-harm, and inability to comply with immobilization or follow-up.

7. First 10 minutes: parallel action

1. Control life-threatening bleeding with direct pressure, packing, haemostatic dressing, or tourniquet. Record tourniquet site and time.
2. Complete ABCDE and expose the entire injured limb while preventing hypothermia and preserving dignity.
3. Remove rings, watches, bracelets, constricting clothing and footwear when safe. Do not delay if removal requires specialist cutting equipment.
4. Record baseline pain, limb position, wounds, colour, temperature, swelling, pulses compared with the opposite limb, Doppler waveform if needed, capillary refill, motor function and sensation by named nerve distribution.
5. Give early multimodal analgesia. Use age-appropriate regional block or procedural sedation by trained clinicians where indicated and safe.
6. If the limb is pulseless and deformed, urgently realign or reduce within competence, apply a splint, and repeat the complete neurovascular examination. Escalate persistent dysvascularity immediately.
7. For suspected open fracture, give approved IV antibiotic immediately, cover the wound, review tetanus, photograph once if policy permits, and align / splint. Do not repeatedly expose or wash the wound.
8. Release or split circumferential dressings / casts when compartment syndrome or swelling is suspected. Reassess within 30 minutes and obtain immediate senior orthopaedic review.
9. Obtain targeted imaging only when it does not delay treatment of haemorrhage, ischaemia, compartment syndrome, or threatened skin.
10. Decide and document the immediate route: bedside reduction and observation, urgent theatre, CT angiography, specialty admission, or emergency transfer.

8. Primary limb assessment and immediate treatment

8.1 Haemorrhage, perfusion, and ischaemia

- Control external haemorrhage by direct pressure and packing. Apply a tourniquet as distally as practical when bleeding is life-threatening or cannot be controlled; do not cover the tourniquet and record time clearly.
- Do not blindly clamp vessels or probe wounds. Preserve impaled objects and stabilize them in place.
- Compare pulses with the contralateral limb. An absent pulse, unequal pulse after alignment, active bleeding, expanding haematoma, bruit / thrill, or distal ischaemia requires consultant-led arterial-injury care.
- A normal capillary refill or audible Doppler signal does not by itself exclude arterial injury. Consider ankle-brachial or arterial pressure index only when it will not delay CTA or surgery and local expertise exists.
- A grossly deformed pulseless limb should be urgently realigned and splinted. If perfusion returns, maintain close observation and obtain urgent specialist advice; if it does not, proceed to emergency vascular imaging / intervention pathway.
- Warm the patient and limb, correct shock and hypoxia, and avoid excessive elevation of a clearly ischaemic limb. Document ischaemia onset, changes after intervention, and transfer delays.

8.2 Analgesia, anxiolysis, and safe handling

- Assess pain using an age- and cognition-appropriate scale and reassess after every intervention.
- Use multimodal analgesia: paracetamol, carefully selected NSAID when not contraindicated, titrated opioid for severe pain, and local / regional anaesthesia where trained and governed. Use opioids cautiously in frail older adults.
- For children with displaced femoral fracture, consider a femoral or fascia-iliaca block by a trained clinician. For distal radius reduction, use an approved anaesthesia / sedation technique; nitrous oxide alone is insufficient for a painful manipulation.
- Procedural sedation requires dedicated monitoring, airway rescue capability, consent, time-out, recovery criteria, and documentation under Protocol 50.
- Regional anaesthesia in a limb at risk of compartment syndrome requires joint surgeon-anaesthetist decision making, documented consent, and a defined serial-monitoring responsibility.
- Handle the limb gently, supporting above and below the injury. Avoid repeated examination manoeuvres that worsen pain, bleeding or tissue damage.

8.3 Neurovascular and soft-tissue examination

Domain	Minimum assessment and documentation
Perfusion	Pulse presence, symmetry and quality; Doppler signal / waveform if used; colour; temperature; capillary refill; bleeding; haematoma; distal oxygen saturation if useful; time of examination.
Motor	Document active movement and strength in relevant named nerves where possible: radial / posterior interosseous, median / anterior interosseous, ulnar, femoral, sciatic, common peroneal, tibial, and digital motor function.

Domain	Minimum assessment and documentation
Sensation	Test light touch in named nerve territories and compare sides. Record pre-existing neuropathy, altered consciousness, sedation or pain limiting reliability.
Skin / wound	Location, size, depth, contamination, bone / tendon exposure, degloving, skin tenting, blisters, pressure areas, puncture wounds and possible fracture communication. Photograph only under approved policy.
Compartment risk	Pain severity and trend, pain with passive stretch, tense swelling, increasing analgesic need, paraesthesia, weakness, and reliability of examination.
Function	Range of movement only when safe; tendon integrity; ability to bear weight or use limb; dominance; occupation; mobility baseline and aids.
After intervention	Repeat and time-stamp the complete examination after reduction, splint / cast, block / sedation, imaging transfer, and every deterioration. Name the clinician performing it.

9. Focused history and examination

Domain	Key questions / findings
Mechanism	Blunt, twisting, axial load, crush, fall, high-speed impact, penetrating, machinery, firearm / blast, sports, bite, thermal / chemical, traction, or repetitive stress; position at injury; energy and contamination.
Timing and course	Exact injury time, entrapment / tourniquet time, delay to presentation, pain and swelling trend, transient pulselessness, reduction attempts, weightbearing after injury, and treatments already given.
Symptoms	Pain, numbness, weakness, coldness, loss of function, instability, locking, bleeding, wound contamination, fever, or symptoms suggesting associated head, spine, chest, abdominal or pelvic injury.
Risks	Anticoagulants / antiplatelets, diabetes, vascular disease, neuropathy, renal disease, immunosuppression, haemoglobinopathy, osteoporosis, steroid use, prior fracture / surgery / prosthesis, allergies, tetanus status, pregnancy.
Social / function	Dominant hand, occupation, sport, home stairs, baseline mobility and cognition, caregiver support, transport, ability to use crutches / walker, and follow-up reliability.
Examination	Inspect from joint above to joint below; palpate selectively; assess axis, rotation and length; test adjacent joints, tendons and ligaments only when safe; look for non-contiguous injuries.
Safeguarding	Consistency of history, delay in seeking care, injury pattern, developmental stage, domestic or interpersonal violence, occupational safety, self-harm, and vulnerable-adult concerns.

10. Bedside tests, laboratory studies, and imaging

IMAGING RULE: Treat haemorrhage, dysvascularity, compartment syndrome, open dislocation, and threatened skin before routine imaging. Pre-reduction radiographs are desirable when the limb is perfused and skin is safe; they must not delay rescue of a threatened limb. Post-reduction imaging and neurovascular documentation are mandatory unless immediate theatre supersedes them.

Test / modality	Use and limitations
Plain radiographs	Use appropriate orthogonal views and include adjacent joints when clinically indicated. Obtain post-reduction films. Review for alignment, fracture-dislocation, growth plate, prosthesis, foreign body, and subtle associated injury.

Test / modality	Use and limitations
Clinical rules	Ottawa ankle / foot rules for appropriate patients over 5 years and Ottawa knee rule for appropriate patients over 2 years may reduce unnecessary radiography; do not use when examination is unreliable or high-risk injury is suspected.
Ultrasound	Useful for effusion, tendon injury, foreign body, vascular flow, procedure guidance, and selected fractures, but operator dependent and not a substitute for CTA or formal imaging when limb threat exists.
CT	Use for complex articular, pelvic / acetabular, calcaneal, talar, tibial plateau / pilon, peri-prosthetic, occult, or surgical-planning injuries. Do not delay urgent reduction or vascular rescue.
CT angiography	Recommended when arterial injury remains suspected after alignment / splinting, or for soft signs / unequal pulses according to the local vascular pathway. Perform concurrently with trauma CT when appropriate.
MRI	Consider for occult scaphoid fracture, occult hip / stress injury, ligament / tendon or spinal-associated pathology when it changes care and is available; not a first-line test for an unstable limb threat.
Laboratory tests	Target to severity: FBC, group / crossmatch, coagulation, electrolytes, renal profile, glucose, CK, potassium, calcium, blood gas / lactate, pregnancy test, toxicology or infection tests. Routine labs are not required for every simple fracture.
Definitive report	A trained definitive report of ED radiographs should be available before discharge or a governed discrepancy process must ensure prompt review, patient recall, and documented ownership.

11. Fractures, alignment, and immobilization

- Align gross deformity with threatened perfusion, nerve function, skin, or severe pain within clinician competence. Use gentle longitudinal traction and correction of obvious angulation; stop if resistance, worsening pain, or neurovascular deterioration occurs.
- Immobilize the joint above and below long-bone fractures when practical, pad pressure points, leave room for swelling, and preserve access for repeated neurovascular checks.
- Choose splints rather than circumferential casts during the acute swelling phase unless a specialist directs otherwise. Bivalve or split a cast when swelling or compartment concern develops.
- After splint or cast application, document skin, pulse, motor and sensory findings, comfort, fit, and patient understanding. Recheck after mobility training and before transfer or discharge.
- Do not use traction splints when contraindicated by pelvic injury, knee / ankle injury, partial amputation, or local protocol. Confirm device competency and distal perfusion.
- For suspected scaphoid injury with negative initial radiographs, use the local early-MRI or immobilization and follow-up pathway. A negative radiograph does not exclude occult fracture.
- Provide precise activity and weightbearing instructions using locally approved terms: non-weightbearing, limited weightbearing with stated functional limits and duration, or unrestricted weightbearing.
- For low-risk injuries, avoid unnecessarily rigid or prolonged immobilization; follow injury-specific evidence and specialist guidance to reduce stiffness, thrombosis, pressure injury, and dependence.

12. Dislocations and urgent reduction

Situation	Required action
Any dislocation with absent pulse, ischaemia, progressive nerve deficit, threatened / tented skin, open wound, or severe unrelieved pain	Immediate senior-assisted reduction within competence, with analgesia / sedation as condition allows. Do not wait for routine imaging. Reassess and document neurovascular status and obtain post-reduction imaging; urgent specialty review remains mandatory.
Closed, perfused dislocation without tissue threat	Analgesia, baseline neurovascular examination and pre-reduction imaging when timely; use approved technique and sedation / block; confirm stable reduction, repeat examination, immobilize and obtain post-reduction imaging.
Irreducible or unstable dislocation	Stop repeated forceful attempts. Urgent orthopaedic / specialist review and theatre or transfer. Consider associated fracture, soft-tissue interposition, tendon entrapment, or buttonholing.

Situation	Required action
Native hip dislocation	Treat as an orthopaedic emergency; reduce as soon as safely possible under adequate anaesthesia / sedation. If closed reduction fails or expertise is unavailable, arrange immediate specialist transfer. Evaluate for associated femoral-head / acetabular injury and sciatic nerve deficit.
Knee dislocation or suspected spontaneously reduced knee dislocation	Assume possible popliteal arterial and multi-ligament injury. Reduce urgently if deformed, document pulses and nerve function, perform serial vascular assessment and CTA / vascular pathway when suspicion persists even if pulses return.
Elbow dislocation	Assess brachial artery and median / ulnar / radial nerves. Reduce urgently when perfusion or skin is threatened; check stability and associated fracture after reduction.
Shoulder dislocation	Confirm axillary nerve and distal pulse before and after reduction. Obtain pre-reduction imaging unless recurrent uncomplicated presentation or tissue threat is governed by local criteria. Do not repeatedly manipulate suspected fracture-dislocation.
Ankle / subtalar dislocation	Urgent reduction for skin tenting, neurovascular compromise or severe deformity; splint, repeat examination and image. Open injury, talar extrusion or irreducibility requires immediate specialist care.
Finger / thumb dislocation	Remove rings, assess tendon / collateral injury, reduce with appropriate block, image as indicated, and avoid forceful repeated attempts when fracture or volar-plate / tendon interposition is suspected.

13. Open fractures and major wounds

- Assume any wound near a fracture communicates with the fracture until specialist assessment proves otherwise. Do not use wound size alone to grade severity.
- Administer approved IV prophylactic antibiotic immediately if not already given, ideally within 1 hour of injury. Record drug, dose, route, and time. Broaden coverage according to contamination, water / farm exposure, bites, and local antimicrobial policy.
- Control bleeding, remove only gross surface contamination, photograph once under policy, cover with sterile saline-moistened gauze and an occlusive layer, align and splint. Minimize repeated dressing changes.
- Do not irrigate long-bone, hindfoot, or midfoot open fractures in the ED before operative wound excision, and do not perform "mini-washouts." Hand / fingertip wound care follows specialist and local pathways.
- Review tetanus immunization and administer vaccine and immunoglobulin according to wound risk and national / local policy.
- Document neurovascular status, wound location and dimensions, contamination, bone / tendon exposure, degloving, photographs, antibiotic and tetanus times, reduction, splint and referral.
- Open fractures of long bones, hindfoot or midfoot require early orthopaedic discussion and transfer to a capable centre when definitive combined care is unavailable. Highly contaminated or vascularly compromised injuries require immediate theatre / transfer.
- Do not base limb-salvage or amputation decisions solely on a numerical injury score. Use multidisciplinary consultant assessment, the patient's physiology, ischaemia, contamination, nerve / muscle injury, functional potential, rehabilitation, and informed preferences.

14. Suspected arterial injury and the dysvascular limb

Finding / stage	Action
Uncontrolled haemorrhage	Direct pressure, packing or distal tourniquet; resuscitate and move to simultaneous surgical control. No blind clamping.
Pulseless deformed limb	Urgently realign and splint; repeat and record pulse, Doppler, colour, temperature, capillary refill, motor and sensation.
Persistent hard signs after alignment	Immediate consultant orthopaedic plus vascular / plastic-surgery management. Proceed to emergency revascularization / exploration pathway; imaging must not create avoidable delay.
Suspected arterial injury without hard signs	Consultant input; CTA recommended according to local pathway, ideally concurrent with trauma CT. Unequal pulses after alignment remain suspicious until excluded.

Finding / stage	Action
Confirmed devascularized limb	Emergency revascularization with no assumed “safe” ischaemic time. Begin transfer or theatre activation immediately; a temporary vascular shunt may be used by an appropriately trained team to restore flow before definitive repair and skeletal stabilization.
After reperfusion	Assess for compartment syndrome and consider fasciotomy; monitor perfusion, potassium, CK, acidosis, renal function and systemic reperfusion effects. Document any decision not to decompress.
Potential amputation	Where possible discuss honestly with the patient / family. Early amputation decision requires documented multidisciplinary consultant agreement and should not delay life-saving haemorrhage control.

15. Acute compartment syndrome

COMPARTMENT-SYNDROME RULE: Normal pulses, normal capillary refill, or an open fracture do not exclude acute compartment syndrome. A suspected case requires immediate release of constriction, senior orthopaedic review, hourly documented reassessment when diagnosis is uncertain, and immediate surgical decompression once diagnosed.

Assessment / stage	Minimum action
Who is at risk	High-energy tibial / forearm fractures, crush injury, reperfusion, vascular injury, tight cast / dressing, bleeding disorder / anticoagulation, burns, prolonged compression, paediatric supracondylar injury, or severe swelling after surgery.
Early clinical concern	Pain out of proportion or escalating despite treatment, pain with passive stretch, tense swelling, increasing analgesic requirement, anxiety / agitation in a child, paraesthesia, or progressive weakness.
Immediate bedside action	Remove or split all circumferential dressings / casts to skin, place limb approximately at heart level rather than high elevation, correct hypotension / hypoxia, provide analgesia, mark findings, and obtain immediate senior orthopaedic review. Re-evaluate within 30 minutes.
Reliable but equivocal examination	Document repeated examination at least hourly, including time, pain trend, passive stretch, compartments, motor / sensation, pulse, analgesia and interpretation. Escalate any progression.
Unreliable or incomplete examination	Consider repeated or continuous intracompartmental pressure monitoring in all suspected compartments with concurrent blood pressure and consultant interpretation.
Pressure interpretation	A diastolic blood pressure minus compartment pressure under 30 mmHg indicates increased risk; an absolute pressure over 40 mmHg warrants urgent consideration. Do not use a single number in isolation when clinical concern is high.
Diagnosis established	Immediate open decompression of all involved compartments as an emergency procedure. Do not delay for confirmatory imaging or prolonged observation.
Delayed presentation	High complication risk. Consultant-level multidisciplinary decision regarding fasciotomy versus non-operative management; include renal assessment, rhabdomyolysis treatment, infection risk, and frank communication with patient / family.

16. Traumatic amputation, degloving, crush injury, and rhabdomyolysis

Presentation	Immediate management
Complete or partial amputation	ABCDE, haemorrhage control, analgesia, antibiotics and tetanus, sterile wound cover, remove rings, document warm-ischaemia time, urgent replantation / limb-salvage discussion, and transfer without avoidable delay.

Presentation	Immediate management
Amputated part	Handle gently; do not scrub. Wrap in sterile gauze lightly moistened with saline, place in a sealed clean plastic bag, then place that bag in ice-water slurry. Do not place tissue directly on ice or immerse it in water. Label with patient identifiers and time; send with the patient.
Near-amputation	Do not sever remaining tissue. Align gently, protect from tension / torsion, cover, splint, maintain warmth, monitor perfusion, and obtain immediate specialist advice.
Degloving / major soft-tissue loss	Control haemorrhage, preserve viable tissue, photograph once, sterile moist cover, antibiotics / tetanus, avoid aggressive ED debridement, and involve plastic / orthopaedic / hand surgery early.
Crush injury / prolonged entrapment	Prepare for hyperkalaemia, acidosis, rhabdomyolysis, shock and compartment syndrome. Establish monitoring and IV access; check potassium, CK, renal function, calcium, phosphate, ECG, blood gas and urine; treat dangerous electrolyte abnormalities and follow Protocol 28.
Traumatic muscle ischaemia / reperfusion	Monitor closely for arrhythmia, hyperkalaemia, acidosis, myoglobinuria, AKI and systemic deterioration. Coordinate renal / critical-care support and urgent source control.
Replantation candidacy	Do not promise or exclude replantation in the ED. Provide the specialist with mechanism, level, contamination, tissue loss, warm / cold ischaemia, patient age, comorbidity, occupation, hand dominance and availability of the part.

17. Region-specific red flags and associated injuries

Region / pattern	Do not miss
Clavicle / shoulder	Open fracture, skin tenting, pneumothorax / vascular injury, axillary nerve injury, posterior dislocation, proximal humerus fracture-dislocation, brachial plexus injury.
Humerus / elbow	Brachial artery injury, radial nerve palsy, paediatric supracondylar fracture, compartment syndrome, open injury, Monteggia / Galeazzi pattern, elbow instability.
Forearm / wrist	Compartment syndrome, median / ulnar / radial nerve injury, DRUJ injury, perilunate dislocation, occult scaphoid fracture, open fracture, tendon entrapment.
Hand / digits	Ring entrapment, rotational deformity, flexor / extensor tendon injury, digital nerve / artery injury, bite / fight-bite, nail-bed injury with fracture, high-pressure injection, amputation.
Hip / femur	Occult hip fracture, native or prosthetic hip dislocation, femoral-neck fracture in younger adult, femoral-shaft haemorrhage, sciatic / femoral nerve injury, non-accidental injury in child.
Knee	Spontaneously reduced dislocation with popliteal artery injury, extensor-mechanism rupture, tibial plateau fracture, compartment syndrome, septic joint mimic.
Tibia / ankle	Compartment syndrome, open fracture, pilon / talar injury, skin tenting / fracture blister, posterior tibial / dorsalis pedis compromise, syndesmotic injury.
Foot	Lisfranc injury, talar neck fracture / dislocation, calcaneal fracture with spine injury, compartment syndrome, plantar puncture / foreign body, diabetic neuropathic injury.
Multiple or non-contiguous injuries	Perform secondary survey and image based on mechanism. A dramatic injury can distract from a second fracture, spine injury, head injury, or contralateral limb injury.

18. Special populations and presentations

Population / situation	Additional requirements
Children	Use age-adjusted physiology, analgesia, equipment and growth-plate interpretation. Watch for anxiety / increasing analgesic need as compartment signs. Address non-accidental injury, especially femoral fracture in a non-mobile child. Seek paediatric orthopaedic input for physeal, intra-articular, displaced, or neurovascular injuries.
Older adult / frailty	Minor mechanisms may cause major fracture. Screen for head injury, syncope, osteoporosis, delirium, pressure injury, dehydration, anticoagulation and unsafe mobility. Use opioids and NSAIDs cautiously; involve orthogeriatric / falls services as appropriate.
Pregnancy	Maternal stabilization first; use indicated imaging with shielding / dose optimization rather than withholding diagnosis. Consider thrombosis risk, medication safety and obstetric input for major trauma or late pregnancy.
Anticoagulated / bleeding disorder	Assess expanding haematoma, occult blood loss and compartment risk. Check relevant coagulation tests and reverse anticoagulation when life- or limb-threatening bleeding requires it under approved policy.
Diabetes / neuropathy / vascular disease	Examination and pain may be unreliable; lower threshold for vascular assessment, admission, infection review and specialist follow-up. Avoid pressure from casts / footwear and provide meticulous skin instructions.
Immunocompromised / sickle cell / renal disease	Consider infection, bone infarction, medication accumulation, electrolyte risk and impaired healing. Coordinate with relevant specialty.
Prosthesis / previous fixation	Suspect periprosthetic fracture, implant failure or dislocation; obtain prior imaging when possible and seek early specialist advice. Avoid repeated manipulation.
Intoxication / altered consciousness	Examination and consent may be unreliable. Treat urgent threats in the patient's best interests, use serial examination and consider compartment-pressure monitoring / admission when risk persists.
Violence / occupational injury	Preserve evidence, photograph under policy, document mechanism accurately, offer safeguarding / violence intervention, and complete statutory occupational reporting where required.

19. Reassessment and detection of deterioration

Reassessment element	Minimum standard / trigger
Frequency	Continuous monitoring for unstable or dysvascular injury. At-risk limbs require documented serial pain, skin and neurovascular checks at a frequency set by acuity; suspected compartment syndrome requires hourly assessment when diagnosis remains uncertain.
After every intervention	Repeat after analgesia, reduction, splint / cast, tourniquet change, block / sedation, imaging, transfer between areas, and mobilization.
Perfusion deterioration	New absent / weaker pulse, increasing coolness / pallor, delayed refill, recurrent deformity, increasing haematoma or bleeding -> immediate senior review, remove constriction, realign if indicated and activate vascular pathway.
Compartment deterioration	Increasing pain, pain with passive stretch, tense swelling, escalating opioid need, paraesthesia or weakness -> release circumferential material, reassess within 30 minutes and obtain urgent orthopaedic decision.
Skin / immobilization	Blanching, pressure pain, numbness, swelling beyond splint, wet / damaged cast, foul discharge, blistering or inability to move digits -> immediate splint / cast review.
Systemic deterioration	Hypotension, tachycardia, fever, hypoxia, confusion, oliguria, hyperkalaemia, acidosis or rising CK -> reassess for occult bleeding, sepsis, crush syndrome or reperfusion injury and escalate.

Reassessment element	Minimum standard / trigger
Documentation	Record exact time, examiner, findings, interpretation, action and response. "Neurovascularly intact" alone is insufficient for a high-risk limb.

20. Disposition, transfer, and discharge

Destination	Minimum criteria
Immediate theatre / intervention	Confirmed or strongly suspected compartment syndrome; persistent dysvascular limb / hard arterial signs; uncontrolled bleeding; open dislocation; open fracture requiring urgent debridement; irreducible threatened joint; major degloving / amputation; limb as source of life-threatening sepsis or haemorrhage.
Critical care / high dependency	Ongoing shock, ventilation or vasoactive support, severe crush / rhabdomyolysis, reperfusion risk, major transfusion, repeated neurovascular instability, or complex multi-system trauma.
Specialist transfer	Required vascular, orthoplastic, hand / microsurgical, paediatric, pelvic / acetabular, tumour, or complex trauma capability unavailable locally. Referral begins early; send images, reports, time-stamped neurovascular record, medication / antibiotic / tetanus times, tourniquet details and amputated part.
Admission / observation	Uncontrolled pain, unsafe mobility, unreliable examination, serial compartment / vascular monitoring, high-energy or unstable fracture, significant swelling, social vulnerability, anticoagulation concern, or uncertain definitive plan.
Discharge	Stable injury and immobilization; definitive imaging reviewed or governed follow-up; normal or accepted documented neurovascular status; pain controlled; safe mobility and home support; explicit weightbearing / activity plan; follow-up arranged; patient understands return precautions.
Return immediately for	Increasing pain despite medication, pain on passive movement, new numbness / weakness, pale / cold / blue digits, increasing swelling, bleeding, fever, foul discharge, tight / wet / broken cast, inability to move digits, chest pain / breathlessness, or any concern about the limb.

21. Documentation, governance, and audit

Indicator	Suggested measure
Neurovascular assessment	Percentage with named pulse, motor and sensory documentation before and after reduction / splint / cast; time to reassessment after deterioration.
Limb ischaemia	Time from arrival to alignment, consultant review, CTA when indicated, transfer / theatre, and start of revascularization.
Open fracture	Time from injury and arrival to first IV antibiotic; tetanus assessment; wound photograph / cover; orthoplastic referral and definitive transfer.
Compartment syndrome	Hourly chart use; time from first concerning sign to senior review, diagnosis and fasciotomy; delayed diagnosis and functional outcome.
Reduction safety	Consent / time-out, sedation monitoring, pre- and post-reduction neurovascular record, post-reduction imaging, complications and repeat attempts.
Immobilization	Cast / splint pressure injuries, unplanned returns, need for reapplication, discharge instruction completeness and weightbearing clarity.
Imaging	Definitive report before discharge or discrepancy closure; missed fractures / dislocations; time to CTA for suspected arterial injury.

Indicator	Suggested measure
Patient-centred outcome	Pain control, mobility, follow-up attendance, return to function, infection, unplanned surgery, amputation, complaint or safeguarding concern.
Serious incident review	All delayed fasciotomies, missed vascular injury, avoidable amputation, delayed antibiotic, reduction-related injury, tourniquet event, pressure necrosis, transfer failure or death reviewed multidisciplinary.

22. Minimum equipment and readiness

- Adult and paediatric splints, vacuum splints, traction devices where used, sling / collar-and-cuff, cast-splitting tools, padding, stockinette, elastic bandage, ring cutters and heavy-duty cutting equipment.
- Direct-pressure and packing supplies, haemostatic dressings, tourniquets, blood-warming and major-haemorrhage access.
- Handheld Doppler, ultrasound, pulse oximetry, compartment-pressure monitor and consumables, and limb observation charts.
- Reduction, local / regional block and procedural-sedation equipment with monitoring, capnography, airway rescue, reversal agents and recovery area.
- Open-fracture pack: sterile saline-moistened gauze, occlusive film, cameras / secure image system, approved IV antibiotics, tetanus vaccine / immunoglobulin, labels and transfer packaging.
- Amputated-part kit with sterile gauze, sealed bags, rigid container, ice-water capability and identification labels.
- 24-hour referral contacts for orthopaedics, vascular, plastic / hand / microsurgery, anaesthesia, paediatrics, radiology, theatre, rehabilitation, blood bank and transport.
- Regular simulation for dysvascular limb, compartment syndrome, open fracture, traumatic amputation, paediatric supracondylar injury, knee dislocation and transfer.

23. References and evidence base

1. National Institute for Health and Care Excellence. Fractures (complex): assessment and management (NG37). 2016; updated recommendations and current online version.
2. National Institute for Health and Care Excellence. Fractures (non-complex): assessment and management (NG38). 2016; reviewed June 2025; current online version.
3. British Orthopaedic Association. BOAST: Diagnosis and management of arterial injuries associated with musculoskeletal trauma. June 2026.
4. British Orthopaedic Association. BOAST: Diagnosis and Management of Compartment Syndrome of the Extremities. Updated July 2025.
5. British Orthopaedic Association and British Association of Plastic, Reconstructive and Aesthetic Surgeons. BOAST: Open Fractures. 2017; current online standard.
6. American Academy of Orthopaedic Surgeons. Management of Acute Compartment Syndrome: Evidence-Based Clinical Practice Guideline. November 2025.
7. American Academy of Orthopaedic Surgeons / Major Extremity Trauma and Rehabilitation Consortium. Prevention of Surgical Site Infections After Major Extremity Trauma. 2022.
8. American College of Surgeons Trauma Quality Programs. Best Practices in the Management of Orthopaedic Trauma. Current online version.
9. British Society for Surgery of the Hand / GIRFT. Traumatic amputations of the digits, hand and wrist pathway. 2022; current online version.
10. British Orthopaedic Association. BOAST: Mobilisation and weightbearing after orthopaedic surgery / musculoskeletal injury. 2024.
11. Eastern Association for the Surgery of Trauma. Practice management resources for extremity vascular trauma, orthopaedic trauma, analgesia and rhabdomyolysis; current online collection.
12. Local approved policies: Major Trauma; Open Fracture Antibiotics; Tetanus; Procedural Sedation; Regional Anaesthesia; Anticoagulant Reversal; Imaging and CTA; Cast / Splint Care; Transfer; Safeguarding; Rehabilitation.

Annex 1. One-page ED workflow

Step	Action
TRIAGE	Highest acuity for uncontrolled bleeding, amputation, pulseless / cold / pale limb, severe deformity, open fracture / dislocation, threatened skin, progressive neurological deficit, compartment concern or crush syndrome.
ABCDE	Treat life threats; expose limb; prevent hypothermia; remove constricting items.

Step	Action
BLEEDING	Direct pressure / packing / haemostatic dressing / tourniquet; record time; no blind clamping.
BASELINE	Pain; pulse comparison; colour / temperature / refill; named motor and sensation; wounds / skin; compartment findings; time and examiner.
RESCUE	Pulseless deformed limb -> urgent realignment / reduction and splint; repeat assessment. Compartment concern -> release circumferential material, heart-level position, urgent orthopaedic review.
OPEN FRACTURE	IV antibiotic now; tetanus; photograph once; remove gross contamination only; saline-moist sterile / occlusive cover; align / splint; no mini-washout.
IMAGING	Pre-reduction if safe; do not delay limb rescue. Post-reduction radiograph and documentation. CTA when arterial injury remains suspected.
DECIDE	Theatre / emergency revascularization; specialist transfer; admission / observation; or safe discharge with weightbearing, follow-up and return precautions.
REASSESS	After every procedure / transfer and with any change. Document exact findings, interpretation and response.

Annex 2. Neurovascular assessment record

Time	Pulse / Doppler	Colour / temp / refill	Motor by nerve	Sensation by nerve	Pain / passive stretch	Action / examiner
___	___	___	___	___	___	___
___	___	___	___	___	___	___
___	___	___	___	___	___	___
___	___	___	___	___	___	___
___	___	___	___	___	___	___

Record before and after reduction, splint / cast, block / sedation, imaging transfer, and any clinical deterioration.
“Neurovascularly intact” alone is not an adequate entry for a high-risk limb.

Annex 3. Reduction and splint safety checklist

Check	Record
Indication and urgency	Diagnosis / suspected injury: ___ Tissue threat: perfusion / nerve / skin / pain / none
Consent / capacity	Consent obtained: Y / N / emergency best interests Interpreter / guardian: ___
Baseline	Pulse: ___ Motor: ___ Sensation: ___ Skin / wound: ___
Preparation	Time-out: ___ Monitoring: ___ IV access: ___ Airway rescue: ___ Assistant: ___
Analgesia / anaesthesia	Drug / block / sedation, dose and time: ___
Technique	Reduction / manipulation performed by: ___ Attempts: ___ Complication: ___
After reduction	Pulse: ___ Motor: ___ Sensation: ___ Skin: ___ Pain: ___
Immobilization	Device / position: ___ Padding / swelling allowance: ___ Recheck time: ___

Check	Record
Imaging / plan	Post-reduction imaging: ____ Specialist review: ____ Weightbearing / activity: ____
Disposition	Admission / transfer / discharge Follow-up: ____ Written precautions given: Y / N

Annex 4. Open-fracture emergency bundle

Bundle element	Record
Injury	Time: ____ Mechanism / contamination: ____ Wound location / size: ____
Neurovascular	Pre-alignment: ____ Post-alignment: ____ Compartment findings: ____
Haemorrhage	Pressure / packing / tourniquet: ____ Tourniquet time: ____
Antibiotic	Drug / dose / route: ____ Injury-to-antibiotic time: ____ Arrival-to-antibiotic time: ____
Tetanus	Immunization status: ____ Vaccine: ____ Immunoglobulin: ____
Wound handling	Gross contamination removed only: Y / N Photograph: ____ Saline-moist sterile + occlusive dressing: Y / N
Alignment / splint	Technique / device: ____ Post-splint NV exam: ____
Referral	Orthopaedic: ____ Plastic / hand: ____ Vascular: ____ Receiving centre / acceptance: ____
Transfer	NPO: ____ Analgesia: ____ Images / report sent: ____ Escort / monitoring: ____

Annex 5. Compartment-syndrome observation chart

Time	Pain score / trend	Analgesia and response	Passive stretch pain	Tension / swelling	Sensation / motor	Pulse / perfusion	Interpretation / action
____	____	____	____	____	____	____	____
____	____	____	____	____	____	____	____
____	____	____	____	____	____	____	____
____	____	____	____	____	____	____	____
____	____	____	____	____	____	____	____

Any progression, unreliable examination, or diagnostic uncertainty requires senior orthopaedic review. Release circumferential dressings to skin and re-evaluate within 30 minutes. Do not wait for pulselessness or paralysis.

Annex 6. Traumatic-amputation transfer checklist

Domain	Minimum handover
Patient / injury	Identity; injury time; mechanism; level; complete / partial; contamination; associated injuries; hand dominance / occupation.
Physiology / bleeding	Current and worst observations; tourniquet site and time; blood loss / transfusion; shock treatment.
Limb examination	Perfusion of residual / attached part; motor / sensation; wound / tissue loss; photographs; imaging.

Domain	Minimum handover
Treatment	Analgesia / block / sedation; antibiotic and tetanus; wound cover; splint; NPO; fluids / blood.
Amputated part	Available Y / N; wrapped in saline-moistened gauze, sealed bag, ice-water slurry; labelled; time cooled; sent with patient.
Specialist communication	Receiving surgeon and centre; acceptance time; replantation discussion; transfer priority and transport mode.
Documents	Notes, time-stamped NV chart, medication record, images / reports, consent / capacity, family contacts and safeguarding information.

Annex 7. Transfer and handover checklist

Domain	Minimum handover
Identity / mechanism	Patient identifiers; injury time; mechanism / energy; contamination; entrapment / tourniquet time; safeguarding.
Current status	ABCDE; pain; current and worst physiology; bleeding control; IV / IO access; blood products.
Limb status	Diagnosis / working diagnosis; wounds; pulse / Doppler; colour / temperature / refill; named motor / sensation; compartment findings and trend.
Interventions	Reduction / attempts; splint / cast; tourniquet; wound cover; antibiotic / tetanus; analgesia / block / sedation and response.
Investigations	Radiographs / CT / CTA / labs; reports; image transfer; pending results and owner.
Reason / destination	Required capability; receiving consultant and location; accepted time; urgency and anticipated procedure.
During transfer	Monitoring, oxygen, warming, limb position, analgesia, serial NV checks, equipment, escort competence and deterioration plan.

Annex 8. Audit tool

Audit field	Record
Arrival / senior review	Arrival: ____ Highest acuity: Y / N Senior ED: ____ Orthopaedic: ____
Baseline NV assessment	Pulse: ____ Motor: ____ Sensation: ____ Time / examiner: ____
Limb rescue	Bleeding control: ____ Alignment / reduction: ____ Perfusion restored: ____
Open fracture	Antibiotic: ____ Tetanus: ____ Dressing: ____ Referral: ____
Compartment syndrome	First concern: ____ Dressings released: ____ Senior review: ____ Fasciotomy: ____
Vascular injury	CTA: ____ Vascular acceptance: ____ Theatre / transfer: ____ Revascularization: ____
Reduction / immobilization	Sedation / block: ____ Post-NV: ____ Post-image: ____ Splint recheck: ____
Outcome	Discharge / admission / transfer / theatre: ____ Unplanned return / complication: ____
Governance	Delay / variance identified: ____ Incident review required: Y / N Learning action: ____

Annex 9. Local configuration checklist before approval

- ☐ Named 24/7 contacts for orthopaedics, vascular surgery, plastic / hand / microsurgery, anaesthesia, paediatrics, radiology, theatre, rehabilitation, blood bank and transfer.
- ☐ Approved competence framework and techniques for emergency realignment, common joint reduction, cast splitting, nerve / fascia-iliaca blocks, procedural sedation, Doppler and compartment-pressure measurement.
- ☐ Open-fracture antibiotic regimens by age, allergy, contamination and water / farm / bite exposure; tetanus vaccine and immunoglobulin access.
- ☐ CTA pathway, radiology reporting, image transfer and immediate vascular / orthoplastic transfer arrangements.
- ☐ Splint and cast formulary, swelling precautions, recheck frequency, weightbearing terminology, walking aids and rehabilitation access.
- ☐ Compartment-syndrome chart, pressure device, hourly monitoring responsibility and direct emergency-theatre activation.
- ☐ Traumatic-amputation / amputated-part kit and replantation-centre contact pathway.
- ☐ Paediatric supracondylar, physeal, non-accidental injury, older-adult falls, anticoagulation, pregnancy, safeguarding and forensic pathways.
- ☐ Discharge leaflets for cast / splint care, compartment warning signs, weightbearing / activity, analgesia and follow-up.
- ☐ Defined audit dashboard, simulation schedule, equipment checks, serious-incident review and protocol re-approval date.