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Open Extremity Fractures

Guideline Statement: To provide a systematic approach to the care of patients presenting with open fractures of the upper and lower extremities

Scope: Emergency Department Attendings, Emergency Department Residents, Orthopedic Attendings, Orthopedic Residents, Trauma Attendings, Trauma Residents

Introduction: An open fracture, in which the fracture fragments communicate with the external environment through a break in the skin, increases the risk of infection, soft tissue complications, and fracture nonunion. Prompt delivery of antibiotics, thorough surgical debridement, careful soft tissue handling and management, and thoughtful application of skeletal stabilization will optimize the healing environment and minimize adverse outcomes.

Initial Emergency Management

- A. Antibiotics within 60 minutes of injury: **HIGHEST PRIORITY**
- B. Realign limb with manipulation
 1. decrease compression on adjacent neurovascular structures
 2. decrease ongoing blood loss at fracture site
 3. reposition extruded bone within the soft-tissue envelope
 4. minimize barotrauma to chondral joint surfaces
- C. Manual removal of bulk gross contamination
- D. Saline irrigation of open fracture tissues
- E. Splints or traction as indicated

Classification

- A. Gustillo-Anderson

1. Classification describes injury severity and correlates with infection and nonunion rates
2. Initial classification may be later revised but helps guide initial antibiotic therapy
3. Definitive classification assigned after surgical debridement

I	Open fracture with a wound less than 1 cm long, low energy, without gross contamination or periosteal stripping
II	Open fracture with a wound 1-10 cm long, low energy, without gross contamination or extensive soft-tissue damage, flaps, or avulsions
III	A: Open fracture with a wound greater than 10 cm with adequate soft-tissue coverage, or any open fracture due to high-energy trauma or with gross contamination, regardless of the size of the wound B: Open Fracture with extensive soft-tissue injury or loss, with periosteal stripping and bone exposure that requires soft-tissue coverage in the form of muscle rotation or transfer C: Open fracture associated with arterial injury requiring repair

Timing and Duration of Antibiotics

A. Parenteral Antibiotics

1. Patients presenting with open fractures should receive antibiotics for infection prophylaxis as rapidly as possible, ideally within ONE HOUR of injury.
2. Where possible, in an effort to provide less time to antibiotic administration, antibiotic coverage may begin with EMS first responders at the scene of trauma when there is an obvious/suspected open fracture.
3. In the event that the fracture classification is not easily identified, it is appropriate to begin with a first-generation cephalosporin, and then later escalate coverage for a higher-grade of open fracture when graded intraoperatively.
4. Parenteral antibiotic coverage should continue for 48hrs after index debridement of open blunt-trauma fractures and for at least 24hrs after each subsequent return to the operating room for extremity open fractures (repeat debridement, definitive fixation, etc.)

B. Local Antibiotics

1. Especially when subsequent debridements are indicated (high-volume gross contamination, significant muscle loss, etc.), initial application of local antibiotics at the fracture site should be considered (topical antibiotics or bone-cement delivery devices)
2. Local topical antibiotic application should be considered at the time of wound closure

C. Tetanus vaccination

1. Tetanus booster if not received in last 10 years

Institutional Antibiotic Coverage Protocol

A. Open blunt mechanism fractures

1. Types I & II

- a. Cefazolin 2gm IV q8hr x 48hrs
- b. Anaphylaxis to beta lactams: Vancomycin 15mg/kg IV x1 then pharmacy to dose for 48hrs

2. Type III (A, B, C)

- a. No Gross Contamination

- i. Ceftriaxone 2gm IV q8hr x 48hrs
- ii. Anaphylaxis to beta lactams: Vancomycin 15mg/kg IV x 1 then pharmacy to dose for 48hrs PLUS Tobramycin 5mg/kg IV q24hr x 48hrs pharmacy to dose

- b. Fecal Contamination or Farm Related Injury

- i. Ceftriaxone 2gm IV q24hr x 48 hrs PLUS Metronidazole 500mg IV q8hr x 48 hrs
- ii. Anaphylaxis to beta lactams: Levofloxacin 750mg IV q24hr x 48hr PLUS Metronidazole 500 MG iv Q8HR x 48HRS

- c. Open Fracture with Standing Water Exposure

- i. Levofloxacin 750mg IV q24hr x 48hrs PLUS Metronidazole 500m IV q8hr x 48hrs

B. Open ballistic mechanism fractures

1. Low velocity projectiles (<2000 ft/sec)

- a. Nonoperative

- i. Cefazolin 2gm IV x 1 dose
- ii. Anaphylaxis to beta lactams: Vancomycin 15mg/kg x 1 dose

- b. Operative

- i. Cefazolin 2gm IV x 24hrs
- ii. Anaphylaxis to beta lactams: Vancomycin 15mg/kg x 1 then pharmacy to dose for 24hrs

2. High velocity projectiles (>2000 ft/sec)

- a. Ceftriaxone 2gm IV q24hr x 48hrs
- b. Anaphylaxis to beta lactams: Vancomycin 15mg/kg IV x 1 then

pharmacy to dose for 48hrs PLUS Tobramycin 5mg/kg IV q24hr x 48hrs pharmacy to dose

Timing and Method of Debridement

A. Timing:

1. Open fractures should undergo operative debridement within 24hrs of injury
2. When feasible, open highly contaminated fractures should be considered for debridement even more rapidly, and on day of injury

B. Method:

1. Sharp excisional debridement should be performed for all devitalized or grossly contaminated skin, subcutaneous tissue, fascia, muscle, irreparable but contaminated neurovascular structures, and bone.
2. Non-articular bone fragments without soft-tissue attachments should be discarded (unless retention would permit assessment of absolute length, alignment and rotation of bone).
3. Articular bone fragments should be preserved, even when stripped of soft-tissue/blood supply, to preserve chondral architecture.
4. Open fracture site cultures should be avoided because they do not yield results that help target antibiotic therapy to causative organisms when eventual deep infection occurs
5. No irrigating fluids have been shown to be superior to high volume, low pressure saline irrigation
6. Irrigation does not supplant thorough excisional debridement of all grossly contaminated or devascularized tissue

Wound Closure

- A. When thorough debridement can be performed at index surgery and concern is low for further myonecrosis, primary wound closure should be attempted whenever possible.
- B. Primary wound closure consistently yields superior results with regards to avoidance of deep infection and nonunion compared to flap coverage
- C. Even when wound is not primarily close-able, reasonable degree of tension should be maintained on skin margins (e.g. roman-lace vessel loop technique for vacuum assisted coverage), in an effort to promote eventual secondary skin closure and lessen need for flap coverage

Coverage

- A. Plastic surgical coverage (rotational, free flaps) of open fracture wounds should be undertaken within 7 days of injury, and ideally even sooner when possible
- B. When possible, coverage should be ideally performed in <48hrs after definitive fracture fixation
- C. Flaps with muscle coverage of bone have lower nonunion risks than fasciocutaneous

flaps, likely due to improved vascular environment for bone union

- D. Delays of coverage > 7 days from injury or >48hrs after definitive fixation (plate/rod implantation) have rapidly increasing rates of surgical deep infections and complications
- E. Use of vacuum assisted wound closure devices over open wounds does to delay/ extend the optimal window for definitive wound coverage

Damage control OR

- A. Damage control orthopaedic care should clearly be rendered when primary skin closure is not possible due to traumatic tissue loss
- B. Damage control orthopaedics should also be undertaken when patient resuscitation is not yet optimized (Lactate >4.0, hypothermia, hypo-coagulable state, hemodynamic instability, etc.)
- C. Goals of damage control orthopaedic care include:
 - 1. Thorough wound debridement and irrigation
 - 2. Provisional restoration of axial length of extremity long bones
 - 3. Minimization of movement of sharp skeletal fracture margins which may provoke ongoing blood loss or compromise adjacent neurovascular structures
 - 4. Improve ongoing clinical access and examination of limb to determine subsequent steps in patient care

Definitive fixation

- A. Early total care with fracture debridement, primary wound closure and definitive fracture fixation may be undertaken when significant initial gross contamination or tissue devascularization requiring second debridement is not identified.
 - 1. At the site of open extremity fractures, care should be taken to minimize surface implants (e.g. plates) directly under skin closure, ideally using intramedullary implants when able (e.g. intramedullary rod for tibial shaft, medial malleolar screws in lieu of plate, etc.)
- B. Following Damage Control orthopaedics, definitive extremity fracture stabilization should be performed when
 - 1. Patient hemodynamic stability is achieved
 - 2. Thorough wound debridement(s) verify no ongoing tissue necrosis (e.g. high velocity ballistic injuries, crush injuries) or gross contamination
 - 3. Further anesthetic events are unlikely to worsen cardiopulmonary status

References:

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Approval Signatures

Step Description	Approver	Date
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Applicability

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