

6. ORTHOPEDIC INJURIES
A. Open Fractures

OBJECTIVE: To define the initial management of open fractures based on the Gustilo and Anderson classification of open fractures.

Guidelines: This system uses the amount of energy, the extent of soft-tissue injury and the extent of contamination for determination of fracture severity. Progression from grade I to IIIC implies a higher degree of energy involved in the injury, higher soft tissue and bone damage and higher potential for complications. It is important to recognize that grade IIIC fracture implies vascular injury.

Grade	Description
I	Open fracture, clean wound, wound < 1 cm in length
II	Open fracture, wound > 1 cm in length without extensive soft tissue damage, flaps, or avulsions.
III	Open fracture with extensive soft tissue laceration, damage, or loss or an open segmental fracture. Also includes open fractures from farm injuries, fractures requiring vascular repair, or fractures that had been open for 8 hours before treatment.
III A.	Grade III fracture with adequate periosteal coverage of the fractured bone despite extensive soft tissue laceration or damage.
III B.	Grade III fracture with extensive soft tissue loss, periosteal stripping, and bone damage. Usually associated with massive contamination. These will often need a further soft-tissue coverage procedure such as free or rotational flap.
III C.	Grade III fracture associated with an arterial injury requiring repair, regardless of the degree of soft-tissue injury.

Saving the patient's life must take precedence over saving the patient's limb. Life over limb. Once the patient is stabilized, the fracture will be evaluated, and a Neurovascular assessment of the extremity should be performed. All gross contamination should be removed using sterile saline, and the wound covered with sterile dressings soaked in saline. The extremity should be imaged with AP and lateral images, including the proximal and distal joints to the fracture site.

For grade I and II Gustilo open fractures:

- Cefazolin 2 grams IV immediately in the trauma resuscitation area (Level 1)
 - Must be given within 6 hours
- Continue Cefazolin q8h
- Duration of antibiotics for Grade I and II will be 24 hours after the wound is closed

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A. Open Fractures

For contaminated and grade III wounds:

- Ceftriaxone 2 g every 24 hrs.
- Vancomycin 15-20 mg/kg (typical dose 1 g).
- Duration of Antibiotic therapy with Grade III open fractures will be 24 - 72 hours after soft tissue closure (Level 2).

Special Situations:

- Open fracture wounds contaminated by soil, freshwater, and seawater will require adjustments to antibiotic therapy ([See table below](#)).
- [Adult renal dosing adjustments can be found in table below.](#)
- Immobilization of the extremity should be followed by debridement and washout in the OR.
- For Grade III C injuries, with a pulseless distal extremity or an ABI less than 0.90, the patient should initially undergo a CTA of the extremity and/or intraoperative angiogram if limb salvage is planned.
- Tetanus prophylaxis should be included as indicated, but it is not needed if the patient has a history of tetanus immunization and is under 50 years old.
- For patients at risk for MRSA, vancomycin should be added to all regimens.
- For patients > 120 kg, cefazolin dosing consists of 3 g IV every 8 hrs.
- For further guidance, please call Antimicrobial Stewardship via Tiger Text or consult infectious diseases.

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Preventive antibiotic regimens for patients with open fractures in adult patients:

	<u>Absence</u> of potential <u>soil</u> or <u>water</u> contamination	Presence of soil contamination (Absence of water contamination)	Presence of water Contamination
<u>Gustilo – Anderson Fracture Type I or II</u>			
Preferred Regiment	Cefazolin 2 g IV q8h	Levofloxacin 750 mg IV q12 PLUS Metronidazole 500 mg IV q8h	No modification needed
Alternateregiment with beta lactam hypersensitivity	Vancomycin 15-20 mg/kg q12h OR Clindamycin 900 mg IV q8h	Clindamycin 900 mg IV q8h	No modification needed
<u>Gustilo – Anderson Fracture Type III</u>			
Preferred Regiment	Ceftriaxone 2 g IV q24h PLUS Vancomycin 15-20 mg/kg once	Ceftriaxone 2 g IV q24h PLUS Metronidazole 500 mg IV q8h PLUS Vancomycin 15-20 mg/kg once	<u>Freshwater contamination:</u> Piperacillin – tazobactam 4.5 g q6h
			<u>Salt water contamination:</u> Piperacillin – tazobactam 4.5 g q6h PLUS Doxycycline PO/IV 100 mg q12h
Alternateregiment with beta lactam hypersensitivity	Vancomycin 15-20 mg/kg PLUS Clindamycin 900 mg IV q8h OR Levofloxacin 750 mg IV q12h	Levofloxacin 750 mg IV q12h PLUS Metronidazole 500 mg IV q8h PLUS Vancomycin 15-20 mg/kg once	<u>Fresh or Salt water contamination:</u> Levofloxacin 750 mg IV q12h PLUS Metronidazole 500 mg IV q8h PLUS Vancomycin 15-20 mg/kg once

6. ORTHOPEDIC INJURIES

A. Open Fractures

Renal Adjustments for Cefazolin, Levofloxacin, and Piperacillin/tazobactam

Cefazolin IV	> 50	2gm	Q8 Hours	Given the 3gm dose after HD prior to weekend (i.e Mon-2gm, Wed-2gm, Fri-3gm)
	10-50	2gm	Q12 Hours	
	< 10	2gm	Q24 Hours	
	Hemodialysis	2gm, 2gm, 3gm	TIW after HD	
	CAPD	500mg	Q12 Hours	
	CRRT	2gm	Q12 Hours	
Levofloxacin IV/PO (750mg dose)	≥ 50	750mg	Q24 Hours	Supplemental doses are not required following dialysis
	20-49	750mg	Q48 Hours	
	10-19	750mg load, then 500mg	Q48 Hours	
	Hemodialysis	750mg load, then 500mg	Q48 Hours	
	CAPD	750mg load, then 500mg	Q48 Hours	
	CRRT	500mg	Q24 Hours	
Piperacillin/ tazobactam IV	>40	3.375gm-4.5gm	Q6 Hours	Use 4.5gm dosing for treatment of Pseudomonas or other nosocomial infections. Add 0.75gm after HD, if next dose at 10pm.
	20-40	2.25gm-3.375gm	Q6 Hours	
	<20	2.25gm	Q6- Q8 Hours	
	Hemodialysis	2.25gm	Q8- Q12 Hours	
	CAPD	2.25gm	Q8- Q12 Hours	
	CRRT	2.25gm-3.375gm	Q6 Hours	
No renal adjustments required for ceftriaxone, clindamycin, metronidazole and doxycycline				

Risk Factors for methicillin-resistant *Staphylococcus aureus* (MRSA) infection

Health care-associated risk factors include:
- Recent hospitalization - Residence in a long term care facility - Recent surgery - Hemodialysis
Additional risk factors for MRSA infection include:
- HIV infection - Injection drug use - Prior antibiotic use
Factors associated with MRSA outbreaks include:
- Incarceration - Military service - Sharing sport equipment - Sharing needles, razors, or other sharp objects

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A. Open Fractures

Orthopedic Surgery Response Criteria < 30 minutes:

- Hemodynamically unstable, secondary to pelvic fracture
- Suspected extremity compartment syndrome
- Fractures/dislocations with risk of avascular necrosis (e.g. femoral head or talus)
- Vascular compromise related to a fracture or dislocation
- Trauma surgeon discretion

References

1. Gustilo RB and Anderson JT. Prevention of infection in the treatment of 1025 open fractures of long bones: retrospective and prospective analyses. J Bone Joint Surg Am. 58:453–458, 1976.
2. Gustilo RB et al. Problems in the management of grade III (severe) open fractures: a new classification of grade III open fractures. J Trauma. 24:742–746, 1984.
3. Luchette FA et al. EAST Practice Management Guidelines Workgroup: practice management guidelines for prophylactic antibiotic use in open fractures. Eastern Association for the Surgery of Trauma, 2000.
4. Hoff WS et al. East practice management guidelines workgroup: Update to practice management guidelines for prophylactic antibiotic use in open fractures. J Trauma 70(3): 751-754, 2011.
5. Hand, T; Hand, Elizabeth O.; Welborn, A; Zelle, BA, Gram-Negative Antibiotic Coverage in Gustilo-Anderson Type-III Open Fractures, The Journal of Bone and Joint Surgery: 2020; 102(16):p 1468-147
6. Carver DC, et al. Role of Systemic and Local Antibiotics in the Treatment of Open Fractures. Orthop Clin Am. 2017 Apr;48(2): 137-153.
7. Chang Y, Bhandari M, Zhu KL, et al. Antibiotic Prophylaxis in the Management of Open Fractures: A Systematic Survey of Current Practice and Recommendations. JBJS Rev. 2019;7(2):e1
8. Hauser CJ, Adams CA Jr, Eachempati SR. Surgical infection society guideline: prophylactic antibiotic use in open fractures: an evidence-based guideline. Surg Infect (Larchmt). 2006;7(4):379-405

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