Evidence-Based Guideline for the Management of Open Fractures

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Introduction

Open fractures are orthopedic emergencies that require prompt evaluation and treatment to minimize infection, optimize bone healing, and restore function. These injuries involve a break in the bone with direct communication to the external environment, increasing the risk of infection and nonunion (Gustilo et al., 1984). The management of open fractures has evolved based on evidence from clinical studies and historical data.

Pathophysiology

Open fractures result from high- or low-energy trauma that disrupts the integrity of the soft tissues and bone. The exposed bone is at risk for contamination from bacteria, dirt, and debris. The primary pathophysiological concerns include:

- o Microbial contamination: Staphylococcus aureus is the most common organism; polymicrobial infections can occur in severe cases (Gustilo et al., 1984).
- o Compromised blood supply: Soft tissue damage and periosteal stripping impair perfusion, increasing the risk of infection and nonunion (Patel et al., 2019).
- o Inflammatory response: The release of proinflammatory cytokines and immune cell activation contribute to local and systemic inflammatory responses (Pollak et al., 2010).

Gustilo-Anderson Classification

The Gustilo-Anderson classification is widely used to categorize open fractures based on the severity of soft tissue damage, contamination, and fracture pattern (Gustilo & Anderson, 1976; Gustilo et al., 1984).

Type	Description	Infection Rate	Mortality & Morbidity
I	Clean wound <1 cm, minimal soft tissue damage, simple fracture	0-2% (Patzakis et al., 2000)	Low morbidity, <1% mortality
II	Wound >1 cm, moderate soft tissue damage, no extensive contamination or crush injury	2-10% (Merritt et al., 2018)	Morbidity varies, <1% mortality
IIIA	High-energy injury, extensive soft tissue damage but adequate coverage	4-10% (Gustilo et al., 1984)	Increased morbidity, <5% mortality

| IIIB | Extensive soft tissue loss, periosteal stripping, requires flap coverage | 10-50% (Pollak et al., 2010) | High morbidity, 10-25% mortality |
| IIIC | Open fracture with vascular injury requiring repair | 25-50% (Brumback & Jones, 1994) | High morbidity, amputation rate >50%, mortality up to 25% |

Antibiotic Prophylaxis

Early antibiotic administration significantly reduces infection risk. The choice of antibiotics depends on fracture severity (Merritt et al., 2018; Hauser et al., 2018).

Gustilo-Anderson Type	Antibiotic Recommendations	Duration
I	Cefazolin 2g IV q8h	24 hours
II	Cefazolin 2g IV q8h	24-48 hours
III	Cefazolin 2g IV q8h + Gentamicin 5 mg/kg IV q24h	72 hours or until soft tissue closure
IIIB & IIIC	Cefazolin + Gentamicin ± Metronidazole (if fecal or soil contamination)	72 hours or until closure

 *Penicillin allergy: Use Clindamycin instead of Cefazolin.

Farm injuries: Add Penicillin G for Clostridium perfringens coverage (Patzakis et al., 2000).

Surgical Management

Urgent Irrigation and Debridement

o   Time to OR: Ideally within 6 hours, but delayed interventions up to 12-24 hours have not shown increased infection rates when antibiotics are initiated promptly (Schmidt et al., 2020).

Irrigation:

o   Type I & II: 3L–6L of normal saline
o   Type III: 9L–12L with pulsatile lavage for heavy contamination (Bach et al., 2017).
o   Debridement: All devitalized tissue and foreign debris should be removed; repeat debridement at 24-48 hours if needed (Pollak et al., 2010).

Fracture Stabilization

- o Type I & II: Immediate primary fixation with internal fixation is appropriate in stable fractures (Merritt et al., 2018
- o Type IIIA: External or internal fixation depending on wound severity.
- o Type IIIB & IIIC: External fixation preferred initially; consider staged fixation after soft tissue reconstruction (Brumback & Jones, 1994).

Outcomes and Prognosis

Infection Rates and Complications

- o Overall infection rates:
- o Type I: 0-2%
- o Type II: 2-10%
- o Type IIIA: 4-10%
- o Type IIIB: 10-50%
- o Type IIIC: 25-50%

Nonunion and amputation rates:

- o Type III fractures have nonunion rates up to 30% (Gustilo et al., 1984).
- o Amputation rates in Type IIIC fractures approach 50-70% when vascular repair is unsuccessful (Brumback & Jones, 1994).

Mortality rates:

- o Type I & II: <1%
- o Type IIIA: <5%
- o Type IIIB: 10-25%
- o Type IIIC: 25-50%

Special Considerations

- o Soft tissue coverage: Type IIIB and IIIC fractures require collaboration with plastic surgery for flap coverage within 7 days for optimal outcomes (Pollak et al., 2010).
- o Tetanus prophylaxis: Administer tetanus toxoid if vaccination status is unknown, and tetanus immunoglobulin if the wound is heavily contaminated (CDC, 2020).
- o Negative pressure wound therapy (NPWT): May be used in Type III injuries before definitive closure (Hauser et al., 2018).

Conclusion

Open fractures require timely intervention, aggressive infection prevention, and appropriate stabilization. Early antibiotics, prompt surgical debridement, and fracture stabilization significantly improve outcomes. Type IIIB and IIIC fractures pose the highest risks for infection, nonunion, and amputation, necessitating a multidisciplinary approach.

Version Control Record			
Version	Date	Author/Reviewer	Description of Changes
1	10/21/2024	Paul Wisniewski, D.O.	Initial review and update to reflect latest evidence/practice

References

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