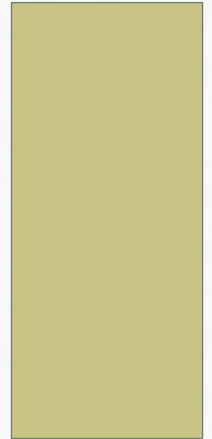




INFECTION AFTER FRACTURE FIXATION

ANTE KALSTAD, ST OLAVS HOSPITAL,
NORWAY



INCIDENCE

5% of all osteosynthesis

0.5 – 2% closed fractures

10 – 30% open fractures



The NEW ENGLAND
JOURNAL of MEDICINE

HOME	ARTICLES & MULTIMEDIA ▾	ISSUES ▾	SPECIALTIES & TOPICS ▾	FOR AUTHORS ▾
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REVIEW ARTICLE
CURRENT CONCEPTS

Treatment of Infections Associated with Surgical Implants
Rabih O. Darouiche, M.D.
N Engl J Med 2004; 350:1422-1429 | April 1, 2004 | DOI: 10.1056/NEJMra035415

Rabih, N Engl J Med, 2004

McGraw, JBJS, 1988

Obrebskey, J.Orth.Trauma, 2003

Perren, JBJS, 2002

CLASSIFICATION, IAFF

- There's been plenty of attempts
- No consensus yet

CLASSIFICATION

- Early (0-2 weeks)
- Delayed (2-10 weeks)
- Late (>10 weeks)

Willeneger and Roth classification

RISKS

- Fracture related
- Patient related
- Procedure related

FRACTURE RELATED

Open fractures x 10-20



Rabih, N Engl J Med, 2004

McGraw, JBJS, 1988

Obremskey, J.Orth.Trauma, 2003

Perren, JBJS, 2002

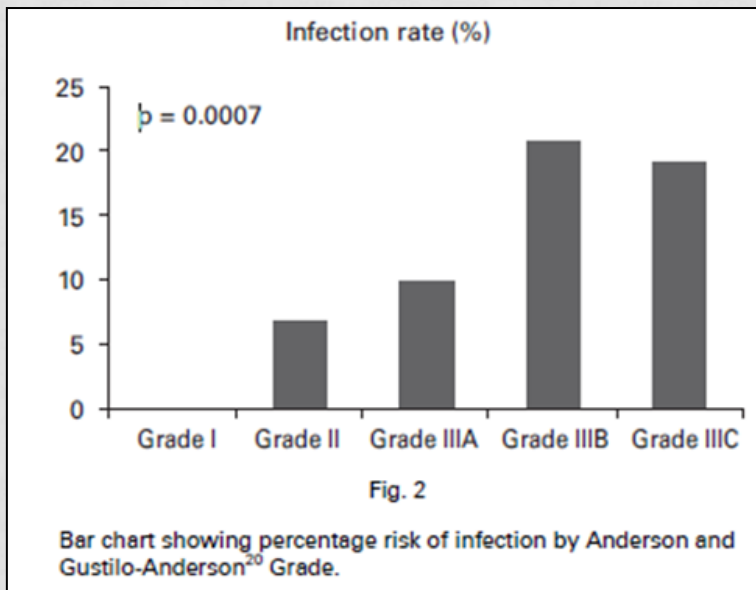
FRACTURE RELATED

Open fractures x 10-20

➤ Gustilo-Andersen



HULL, JBJ, 2014



■ TRAUMA

Delayed debridement of severe open fractures is associated with a higher rate of deep infection

FRACTURE RELATED

Open fractures x 10-20

- Gustilo-Andersen
- Contamination x 3



Table II. Results of adjusted analysis using multivariable logistic regression.

Variable	Odds increase of infection (95% CI)
Time to debridement	1.033 (1.01 to 1.057) per hour of delay
Gross contamination	3.12 (1.36 to 7.36)
Tibial fracture vs non-tibial fracture	2.44 (1.26 to 4.73)
Low grade fracture vs high grade fracture	1.99 (1.004 to 3.954)

HULL, JBJ, 2014

■ TRAUMA

Delayed debridement of severe open fractures is associated with a higher rate of deep infection

FRACTURE RELATED

Open fractures x 10-20

- Gustilo-Andersen
- Contamination x 3
- Tibia fractures x 2.5



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HULL, JBJ, 2014

■ TRAUMA

Delayed debridement of severe open fractures is associated with a higher rate of deep infection

PATIENT RELATED

- Obesity
- Smoking
- Low hematocrit
- Diabetes mellitus
- Earlier infection in the same region

Ortega, Trauma-Orth., 2014

Trauma-Orthopaedics

Posttraumatic orthopaedic wound infections:
a current review of the literature

Gil R. Ortega and Ashleigh A. Ortega

PROCEDURE RELATED

- Handwash technique
- Sterile technique
- Preperation of operative field
- Traffic in the operating room
- Length of surgery
- Blood loss > 1L
- Surgeon unfamiliar with procedure

Harrop, J Am Acad Ortop., 2012

Ortega, Trauma-Ort. 2014

Contributing Factors to Surgical Site Infections

James S. Harrop, John C. Styliaras,
Yinn Cher Ooi, Kristen E. Radcliff,
Alexander R. Vaccaro,
and Chengyuan Wu

J Am Acad Orthop Surg February 2012 ;
20:94-101.;

Trauma-Orthopaedics

Posttraumatic orthopaedic wound infections:
a current review of the literature

Gil R. Ortega and Ashleigh A. Ortega

PROCEDURE RELATED

Open fractures – time to revision

TIME IS OF THE ESSENCE

“This relationship shows a linear increase of 3% per hour of delay.”

Hull, 2014

Table II. Results of adjusted analysis using multivariable logistic regression.

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■ TRAUMA

Delayed debridement of severe open fractures is associated with a higher rate of deep infection

Procedure related

Open fractures – time to revision

TIME IS OF THE ESSENCE?

“no evidence of an association between delayed debridement and infection in the treatment of open long-bone fractures”

Schenker, 2012

Review 16 studies, 3539 patients

Does timing to operative debridement affect infectious complications in open long-bone fractures? A systematic review

ML Schenker, S Yannascoli, KD Baldwin, J Ahn, and S Mehta.

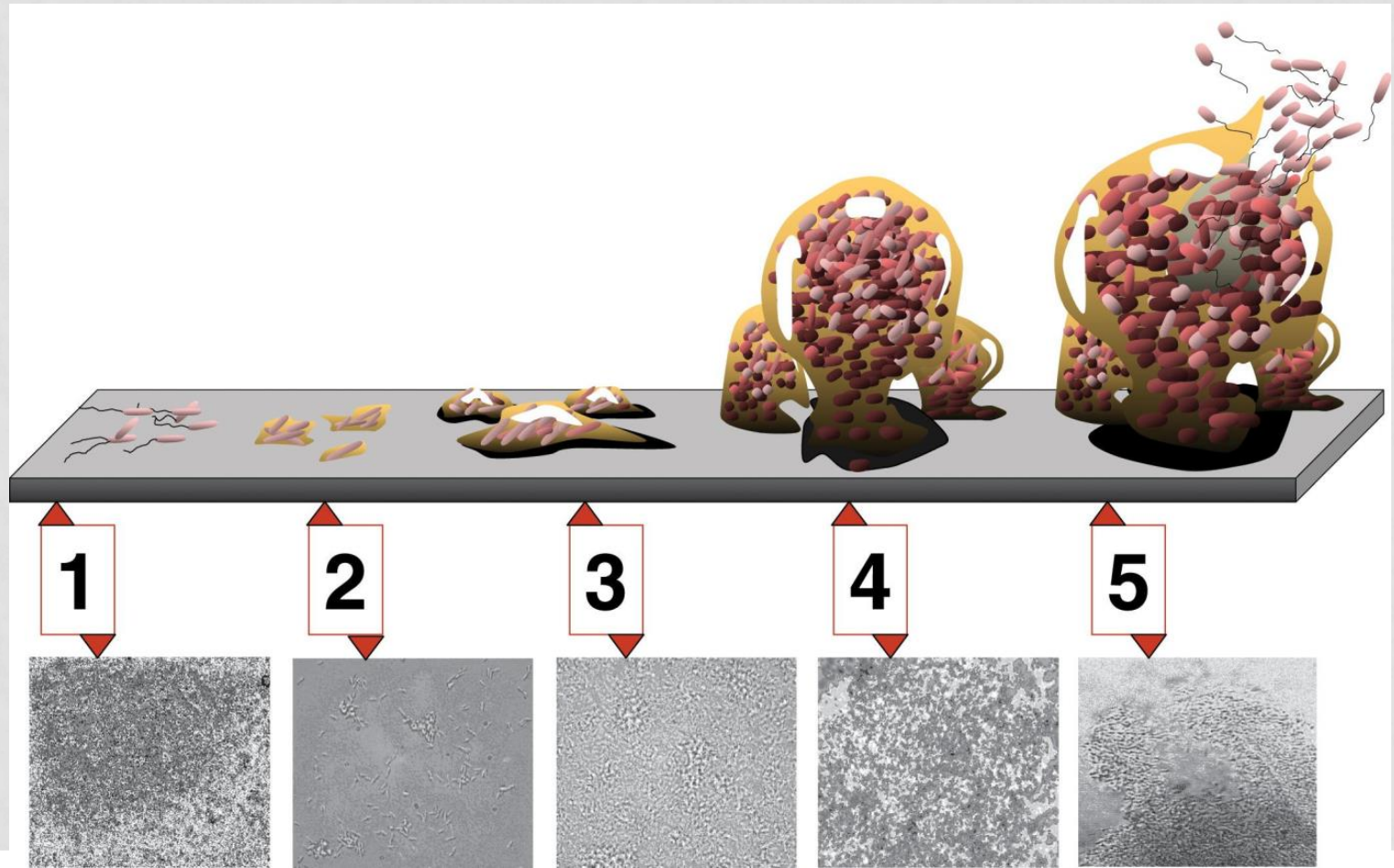
Review published: 2012.

BACTERIOLOGY

Microorganism	Frequency (%)
<i>Staphylococcus aureus</i>	30
Coagulase-negative staphylococci	22
Gram-negative bacilli	10
Anaerobes	5
Enterococci	3
Streptococci	1
Polymicrobial	27
Unknown	2

BIOFILM

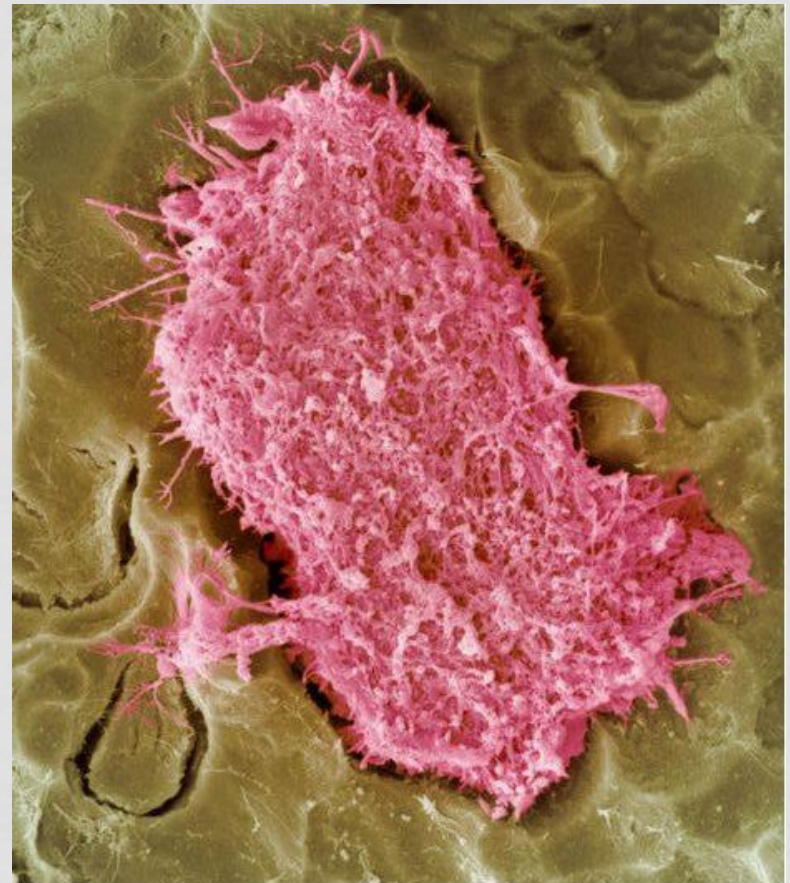
Biofilm leads to 10-1000 times increased resistance towards antibiotics



OSTEOCLASTAL ACTIVATION

Bacteria → Immune response → triggering of osteoclastal activation

- prevents remodelling
- osteolysis



DEFINITIVE DIAGNOSIS

Positive cultures

- ~~Bacterial swab~~
- Aspiration
- **Tissue culture**
- Sonication

Histopathology

PCR



Tissue cultures

- 5 samples
- Separate containers
- Inform the lab:
«infected implant»



PROVISIONAL DIAGNOSIS

- Clinical findings
- X-ray
- Lab values
- Key information



KEY INFORMATION

1. Onset of symptoms (early-delayed-late)
2. Fracture healed or stable callus formed?
3. Osteosynthetic construct (stable implant?
Satisfactory reduction?)
4. Type of implant (plate, nail, ex.fix?)
5. Fracture localization (eg diaphyseal, articular)
6. Condition of soft tissue envelope
7. Local and systemic host physiology
8. History of infection at site of interest
9. Difficult to treat pathogen? (often not known at time of revision)

Treatment

CENTRAL AIMS WHEN TREATING IAFF

1. Fracture consolidation
2. Eradication of infection (or suppression)
3. Healing of the soft tissue envelope
4. Prevention of chronic osteomyelitis
5. Restoration of functionality

In contrast to PJI:

Fixation devices can be removed after healing
-thus removing biofilm

TWO WAYS TO ACHIEVE AIMS

- 1. Irrigation, debridement, and retention of the implant
 - Combined with antibiotic therapy
- 2. Debridement, implant removal or exchange (one or multiple stages)
 - Combined with antibiotic therapy
- In rare cases (compromised hosts) healing can't be achieved
 - Salvage procedures (amputation, establishing continuous fistula)

REMOVE HARDWARE?

Clin Orthop Relat Res (2008) 466:466–472
DOI 10.1007/s11999-007-0053-y

ORIGINAL ARTICLE

Acute Infections After Fracture Repair Management With Hardware in Place

**Eric Rightmire MD, David Zurakowski PhD,
Mark Vrahas MD**

Rightmire, 2008

Retrospective study

n = 69

Managed with hardware in place

68% healed with hardware in place

Conclusion: remove
hardware

REMOVE HARDWARE?

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A commentary by Michael J. Patzakis, MD, is available at www.jbjs.org/commentary and as supplemental material to the online version of this article.

Maintenance of Hardware After Early Postoperative Infection Following Fracture Internal Fixation

By Marshall Berkes, MD, William T. Obremskey, MD, MPH, Brian Scannell, MD, J. Kent Ellington, MD, Robert A. Hymes, MD, and Michael Bosse, MD, and the Southeast Fracture Consortium

Investigation performed at Vanderbilt University Medical Center, Nashville, Tennessee; Carolinas Medical Center, Charlotte, North Carolina; and Inova Fairfax Hospital, Fairfax, Virginia

Berkes, 2010

Retrospective study

n = 121

managed with hardware in place

71% healed with hardware in place

Conclusion: leave hardware until fracture has healed

REMOVE HARDWARE?



Is suppression possible?



YES:

- Debridement
- Antibiotics
- Potential removal when fracture has healed



NO:

- Debridement
- Remove hardware
- Re-stabilize fracture
- Antibiotics

Is suppression possible?



YES:

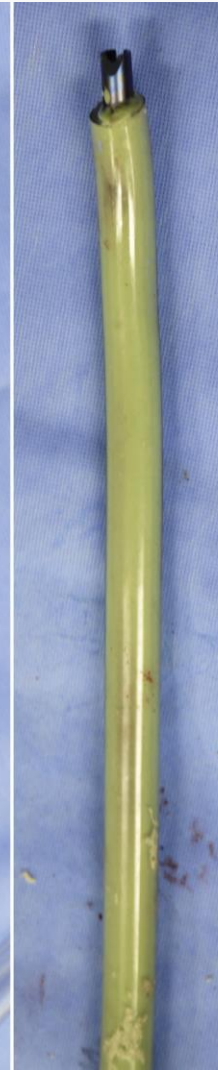
- Early infection
- Stable fixation
- Young patient



NO:

- Open fracture
- Unstable fixation
- Nail
- Late diagnosis
- Smoker

LOCAL ANTIBIOTICS?



ANTIBIOTICS

- Tailor according to resistance
- 2 weeks IV, then per oral
 - Use for 4-6 weeks after implant removal
- Metsemakers, et al; Injury, 2018

Review

Infection after fracture fixation: Current surgical and microbiological concepts

W.J. Metsemakers^{a,*}, R. Kuehl^b, T.F. Moriarty^c, R.G. Richards^c, M.H.J. Verhofstad^d,
O. Borens^e, S. Kates^f, M. Morgenstern^g

A FEW POINTS

- Do a good debridement
- Solid coverage
 - No closure under tension
 - May need a flap
- Get to know your infectious disease specialists



- 65 year old man
- Infected calcaneus fixation (extraarticular beak fracture 4 weeks earlier)
- revised x2











TAKE HOME MESSAGES

- Get cultures
- Retaining the hardware depends on several factors
- Must get good coverage
- Know the infectious disease specialists