Approach to Infection in Chronic Wounds

Randall Cook, MD, FACS, UHM
Defining Infection – Quantity?

Contaminated
- Surface bacteria
- Non-proliferating
- No delay in healing

Colonization
- Surface Bacteria
- Proliferating
- Competes for wounds resources
- Healing delayed or halted

Infection
- Proliferating ($10^6$ colonies/gm)
- Invades and damages tissues
- Delays or arrests healing
Defining Infection – Quality?

Infection = \[(\text{Micro-burden}) \times \text{(Virulence)}\] / \[(\text{Host Resistance})\]
Biofilm vs Planktonic Phenotype
What is Biofilm?

A structured community of bacterial cells enclosed in a self-produced polymeric matrix and adherent to an inert or living surface.

Architecture of Mature Biofilm

Microcolonies

Water Channel

Microcolonies
Biofilms Don’t Play Fair

• Difficult to culture
• Tolerant of biocides
• Tolerant of antibiotics
• Capable of regenerating

Mechanisms of Biofilm Tolerance

Biofilm phenotype highly adapted for survival in the harshest of environments.
Significance of Biofilm in Chronic Wounds

• Bacterial diversity in chronic wounds is not predicted by routine cultures

• *P. aeruginosa* is detected in majority of chronic wounds and might be responsible for prolonged inflammation

• Anaerobes present in substantial numbers and also might incite chronic inflammation by affecting the redox potential of the tissue

• Multiple resistance mechanisms might cause immune response that damages the host more than the biofilm

2. Costerton, Stewart, Greenberg, Science 284, 1999
Management Strategies

Remove or disrupt the biofilm

- Frequent aggressive debridement
- Only method with demonstrated effectiveness

Other suggested methods remain unproven
- Cell signaling interruption
- Adherence blockers
- Enzymatic disruption of extracellular matrix
- Targeted topical antimicrobials
Surgical Debridement: Effect on Outcomes

Debridement Frequency vs. Time to Heal

- Weekly: 92% healed in <= 31 days, 1% healed in >= 98 days
- Q 2 Weeks: 50% healed in <= 31 days, 16% healed in >= 98 days
- Q 3 to 4 weeks: 28% healed in <= 31 days, 32% healed in >= 98 days

Wilcox JR, et al JAMA Dermatol. 2013 Sep;149(9):1050-8
Topical Antimicrobials

- No evidence of bacterial spread into peri-wound
  - No erythema > 1 cm beyond wound margin
  - No tenderness, odor, crepitance, excessive drainage
- No signs/symptoms of systemic sepsis
- No evidence of beta hemolytic streptococcus
- Cultures show < $10^5$ CFU/gm of tissue
Biocides

- Be selective – toxic to keratinocytes and fibroblasts
- Discontinue when microbial balance restored
- Best against biofilm:
  - Cadexomer iodine
  - Ionic silver
  - Methylene blue
- New additions
  - Honey
  - Super oxidized H₂O
Are systemic antibiotics necessary?

- Sepsis, osteomyelitis, cellulitis, lymphangitis, abscess formation
- Not required if the only sign of infection is mild inflammation with no evidence of infection extending more than 1 cm beyond wound margin
Methods of Diagnosis

• Cultures from swab – Notoriously unreliable
• Tissue Biopsy – Reliable but inconvenient
• Curettage from edge of wound
  ✓ Easy to obtain
  ✓ Accuracy equivalent to biopsy

Kandula S et al, Advances in Wound Care Vol 1, pp 281-286; 2010
Yearbook of the WHS
Methods of Diagnosis

- Traditional C&S fails to identify all species
- Molecular methods – not ready for prime time
  - Doesn’t distinguish live vs nonviable organisms
  - Questions remain regarding sensitivity/specificity
  - Relevance of biofilm remains unclear

Kandula S et al, Advances in Wound Care Vol 1, pp 281-286; 2010 Yearbook of the WHS
Diagnosing and Monitoring Osteomyelitis

• History
  • Ulcer fails to heal despite appropriate care
  • Extrusion on boney fragments from ulcer

• Physical Exam
  • Visible bone or extruding boney fragments
  • Probe to bone
Diagnosing and Monitoring Osteomyelitis

- **Bone Biopsy**
  - Highly reliable when appropriately obtained
  - High incidence of technical error
- **Plain Radiographs**
  - Highly accurate if characteristic changes are seen
  - 4-6 weeks before reliable signs are visible
- **Magnetic Resonance Imaging (MRI)**
  - Most useful of all imaging studies for DFO
  - Will not always distinguish infection from inflammation
- **Inflammatory markers**
  - ESR -
  - CRP -
Summary

• Diagnosis of infection is a clinical process
• Treat the clinical situation & adjust appropriately
• Biofilm is present in virtually all chronic wounds
• Mechanical debridement will disrupt the biofilm and is known to benefit chronic wounds
• All other methods remain unproven