Debridement: Is there a limit?

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Faculty Disclosure

- Advisory board for Acelity
- Advisory board for Cardinal Health
- Past President of Wound Healing Society
- Plastic Surgeon with career emphasis on difficult wounds and reconstruction
- No conflicts of interest related to this presentation
Objectives

- Describe the rationale for surgical debridement of chronic wounds
- Discuss the benefits of surgical wound debridement
- List 3 biomarkers that could be used to determine the efficacy of wound debridement
- Describe currently available tools to determine the margins of debridement

Basic Principles of Wound Bed Preparation

- Debride Necrotic Tissue
- Achieve Bacterial Balance
- Maintain Moisture Balance
- Optimize tissue perfusion
What is Debridement?

- **French:** To remove a constraint
- **Removal of foreign or unhealthy material**
- **Removal of Necrotic Tissue**
  - Skin
  - Fat
  - Muscle/Tendon
- **Removal of Slough**
  - Fibrin
  - Proteinaceous Material
  - Neutrophils
  - Bacteria

Why Do Wounds Need Debridement?

- **Treat or prevent infection**
  - Decrease bacterial burden
  - Reduce Inflammation
- **Address Chronic (Hostile) Wound Environment**
  - Remove senescent cells
  - Altered signaling
    - Elevated cytokines
    - Inflammatory Mediators
    - Lack of growth factor receptors

Brem et al. Mol Med 13(1-2) 30-33.
Debridement Promotes Wound Healing

Ladder of Debridement

- Simple:
  - Autolytic
  - Enzymatic
  - Mechanical
  - Biological/ultrasonic
  - Hydrosurgery
  - Curettage
  - Surgical

- Complex:

What is that yellow stuff?

Mature fibrin; Traps critical growth factors needed for healing

Increased MMPs

Chronic Ulcer with Yellow Slough

Chronic Inflammation
Fibrinogen, Fibrin and Fibronectin

Fibrinogen and Fibrin are Anti-Adhesive for Keratinocytes

Fibronectin Promotes Cell Attachment, Spreading and Migration

No Fibronectin  With Fibronectin

Fibroblasts

Endothelial Cells


Fibronectin in Chronic Wound Fluids and Tissue

Fibronectin reappears (stable) as ulcer heals

Fibronectin is degraded in non-healing ulcer

Surgical Strategy

• Operative Debridement and Irrigation
  – Debride to viable tissue
    • Scalpel, Curette, Hydrosurgery
  – Pulse lavage
  – Tissue Biopsy
    • Culture
      – Aerobes, Anaerobes
      – Fungal, Atypical mycobacteria
    • Pathology
      – Wound edge with intact skin
      – Debrided tissue

• Dressing
  – Antimicrobial, antibiofilm
  – Edema reducing
  – Extracellular matrix

Debridement Decision parameters

– Pain
– Patient’s environment
– Patient’s choice and consent
– Biological age and comorbidities
– Quality of life
– Skill of the caregiver
– Resources of the caregiver
– Regulations
– Guidelines

EWMA, J Wound Care, 2013; 22(1)
Easy Decisions

- Massive burden of necrotic tissue
  - +/- purulence
- Lack of access to wound bed

Rapid Removal of Necrotic Tissue

- Presentation
- Clinic Debridement
- Operative Debridement
- 4 weeks of NPWT
Limited Access to Wound Bed

Wide Undermining
Cannot Access Necrotic Tissue

Basic Principles:
Wound Bed Preparation + Surgical Approach

- Debride necrotic tissue
- Irrigate
- Post-debridement, Post-lavage tissue biopsy
- Culture guided antibiotics

5 months
2 operations
Small Skin Opening, Large Wound

Surgical Approach: Adapt to Patient

- Improve access to wound bed
- Debride necrotic tissue
- Post-debridement, post-lavage bone biopsy
- Culture guided antibiotics for osteomyelitis

NPWT
Debridement considerations

- Patient comfort, positioning
- Bedside debridement
  - Lighting
  - Bleeding
  - Vital structures
  - Tools
- Operative debridement
  - Lighting
  - Bleeding
  - Necrotic tissue
    - Extent
    - Location
  - Suspected Osteomyelitis

Ideal Patient

- New wound
  - Known event
- Patient factors
  - Nutrition
  - Off-loading
  - Few co-morbid illnesses, medically optimized
  - Support structure
- Early, Aggressive Approach
DTPI and Unstageable: When and If?

- Bariatric Surgical Patient
  - Surgical complication
- Acute wound
  - Exact event unknown
    - Probable hypotension
    - Multiple operations, ICU, poor nutrition
  - Appears to have demarcated
- Sensate, mobile
- Goals of care:
  - Reduce pain
  - Prevent infection
  - Rapid healing

Initial Debridement

- Nutrition marginal
- Impaired mobility
- Pain
- Wound characteristics
  - Patchy bleeding
  - Gluteal muscle involved
    - Necrotic fibers
  - No bone exposed
  - No purulence
- Apparent excellent prognosis!

...but, not fully demarcated
Serial Surgical Debridement

- Nutrition improving
- Mobility poor
- Bone exposed, cortex intact
- Tunneling along gluteal muscle

Rapid healing after Operative Excision of all Necrotic Tissue

6 weeks after operative debridement  3 months after operative debridement
Compare to Presence of Osteomyelitis

• 41 y/o s/p GBP with neuropathy due to spinal stenosis

• Fell on black ice in March. Noted some drainage in August and sought medical care

• Exam under anesthesia by colorectal surgeon referred to me for further care

• Appearance 7 months after initial injury

Operative Debridement

• Chronic wound
• Coccygeal fracture with osteomyelitis
• Surgical debridement with ostectomy
• Culture guided antibiotics x 12 weeks per ID
• Persistently elevated inflammatory markers
Clinical Course, Osteomyelitis

1 month after presentation
Some bone still exposed – episodic debridement in clinic

4 months after debridement

Pelvic Osteomyelitis

• A neglected disease with little evidence to guide treatment

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (±SD)</th>
<th>Compatible With Infection (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WBC count (mean, SD), k/μL</td>
<td>13 (7)</td>
<td></td>
</tr>
<tr>
<td>ESR (mean, standard deviation), mm/h</td>
<td>78 (33)</td>
<td></td>
</tr>
<tr>
<td>CRP (mean, standard deviation), mg/dL</td>
<td>116 (83)</td>
<td></td>
</tr>
<tr>
<td>Diagnostic work-up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pelvic x-ray</td>
<td>89 (41%)</td>
<td>62%</td>
</tr>
<tr>
<td>CT scan</td>
<td>81 (37%)</td>
<td>83%</td>
</tr>
<tr>
<td>MRI</td>
<td>40 (18%)</td>
<td>86%</td>
</tr>
<tr>
<td>Bone scan</td>
<td>19 (9%)</td>
<td>79%</td>
</tr>
<tr>
<td>Any culture</td>
<td>113 (51%)</td>
<td></td>
</tr>
<tr>
<td>Wound culture</td>
<td>64 (29%)</td>
<td></td>
</tr>
<tr>
<td>Deep tissue culture</td>
<td>26 (12%)</td>
<td></td>
</tr>
<tr>
<td>Bone culture</td>
<td>23 (11%)</td>
<td></td>
</tr>
</tbody>
</table>

Which of these pressure injuries has osteomyelitis?

What is Osteomyelitis?

- An infection of the bone and bone marrow
  - Classification
    - Acute
      - Necrotic bony spicules, inflammatory exudate adhere to bony spicules
    - Chronic
      - Lymphocytes, histiocytes, plasma cells
      - Fibroblastic proliferation around bony spicules
      - +/- new bone formation
  - Long Bone
- Associated with pressure ulcer
How Does Osteomyelitis Occur?

- Hematogenous seeding
- Contiguous spread
- Direct inoculation

- Healthy bone is resistant to infection
- Bone injured or devitalized by trauma, inflammation or vascular insufficiency is more susceptible
- Pressure ulcers: contiguous spread to bone damaged by decreased vascularity due to pressure

Diagnosis of Foot Osteomyelitis

- Bone biopsy for culture
- Positive probe to the bone:
  - PPV = 89% (JAMA (1995) 273:721–723)
- Imaging studies
  - Baseline foot X-ray (Sens=60%, Spec=50%)
  - Triple phase Tc-MDP bone scan (Sens=100%, Spec=56%)
  - Dual isotope: In-111 leukocyte (Sens=93%, Spec=83%)
  - MRI (Sens=70%, Spec=100%)
    - Deep abscess, septic joint, osteo, tendon rupture
Diagnosis of Osteomyelitis in the Foot

Bone Biopsy

Probe to Bone

Imaging of Osteomyelitis in the Foot
Diagnosis of Pelvic Osteomyelitis

- Fever and presence of a wound
- WBC, ESR, pelvic X-ray: Sens 89%, Spec 88%
- Bone Scan
  - Technetium
  - Indium
- CT Scan
- MRI
- Bone biopsy

Pelvic Imaging Studies

- Pelvic X-ray
  - Periosteal reaction, heterotopic new bone, cortical destruction
  - Chronic: sclerotic bone, periosteal reaction
  - Findings persist after successful treatment
  - Sens 18%, Spec 100%

**Bone Scan**

- $^{99}$Tc: increased areas of bone turnover
  - Sens 64%, Spec 57%

- Indium:
  - WBC go to active infection
    - Bone marrow activity may lead to inaccurate interpretation
  - Sens 100%, Spec 75% or 50%


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**CT scan**

- Extent of deep soft tissue injury
  - Sens 11%, Spec 90%

MRI

- Decreased T1 weighted, increased T2 weighted signal intensity in marrow
- Better than CT for bony changes
  - Sens 98%, Spec 89%


Can a Wound Culture Guide Therapy?

- Organisms in soft tissue do not correlate with bone

<table>
<thead>
<tr>
<th></th>
<th>Isolated in bone</th>
<th>Not isolated in bone</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. aureus</em> in wound culture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed culture (wound)</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Pure culture (wound)</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Other organism(s) in wound culture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed culture (wound)</td>
<td>10</td>
<td>24</td>
</tr>
<tr>
<td>Pure culture (wound)</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>31</td>
</tr>
</tbody>
</table>

Bone Biopsy: What does it tell us?

- Culture: High false negative rate
  - Intraoperative
    - Evaluation of bone characteristics
      - Pinpoint bleeding
      - Cortex
      - Consistency
    - Pre vs post debridement
    - Access to large amount of bone
  - Jamshidi Needle
    - Can be done at bedside
    - Low yield from Jamshidi bone culture
- Histopathology
  - Definitive diagnosis
  - 73% sensitivity, 96% specificity


Organisms Involved in Pressure Ulcer Osteomyelitis

- S aureus
- Coag neg Staphylococcus spp.
- Diptheroids
  - Corynebacterium jeikeium
- Enterococcus spp
- Pseudomonas aeruginosa

75%

Why Treat Osteomyelitis?

- Reduce post-operative complications
  - Deep abscess
  - Sinus tract formation
- Reduce wound recurrence
- Cost
  - 1996 Incremental Cost (per pressure ulcer)
  - Pressure ulcer treatment: $2731
  - Associated with osteo: $59,000

Historical methods of Treatment

- 6 weeks of antibiotics
  - Empiric
  - Culture guided
- What is this based on?
  - Experimental osteomyelitis, Norden
    - J Infectious Disease 1971;124:565
- Surgical excision and flap coverage
  - Antibiotic therapy
Variability in Treatment of Pelvic Osteomyelitis

- Retrospective Observational Study
  220 patients with Pressure Ulcer and Pelvic Osteomyelitis

<table>
<thead>
<tr>
<th>Treatment</th>
<th>n (%)</th>
<th>Number of Readmissions (Median, Range)</th>
<th>Total Length of Hospital Stay (Median, Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antibiotics only</td>
<td>105 (47.7%)</td>
<td>1 (0–7)</td>
<td>7 (2–84)</td>
</tr>
<tr>
<td>Surgical Procedure only</td>
<td>7 (3.2%)</td>
<td>2 (0–5)</td>
<td></td>
</tr>
<tr>
<td>Combined medical-surgical approach</td>
<td>48 (21.8%)</td>
<td>0 (0–4)</td>
<td>8.5 (1–94)</td>
</tr>
<tr>
<td>None</td>
<td>60 (27.3%)</td>
<td>1 (0–9)</td>
<td></td>
</tr>
</tbody>
</table>


How Do We Treat Surgically?

- Debridement
  - Paint ulcer with methylene blue
  - Excise wound
  - Irrigate
- Send bone for pathology/microbiology
- Cover with muscle vs fasciocutaneous flap
- Antibiotic treatment guided for bone that remains, not what was taken out

How Should We Treat Medically?

- Pre-flap IV antibiotics
  - Empiric
  - Based on Culture from Jamshidi needle or operative debridement
  - How long prior to surgery?
- One post-operative algorithm
  - Culture negative, pathology negative: 5–7 days
  - Culture negative, pathology positive: 2 weeks
  - Culture positive, pathology positive: 6 weeks


Chronic Osteomyelitis
Occult Source

26 y/o male with spina bifida had chronic drainage from right ischial wound that was ‘healed’ for 2 years
Small skin opening, large problem

- Presented with drainage from scrotum.
- CT scan: ‘fluid collection’ from perineum to right thigh on CT scan.
- I&D via small incisions but persistent drainage.

Operative Debridement

9 days after I&D: 3 pieces of alginate at most distal aspect of track in thigh. Bone exposed in ischium, positive for osteomyelitis
Rapid Response

NPWT immediately after surgery
1 month post-debridement

2 months post-debridement

Chronic Tissue Response

5 months later, ischial wound still not healed.
Re-evaluate all potential modifiable risk factors for non-healing
Factors for Flap Reconstruction

- Reconstruction is ELECTIVE
- Ability to adhere to 6 weeks of convalescence (minimum)
  - Caregiver support
  - Psychosocial factors
  - Home vs Skilled Nursing Facility
  - Understanding that additional procedures may be required
- Medical optimization
  - Spasms
  - Contractures
  - Respiratory status
  - Nutrition
- Available support surfaces

Flap Reconstruction

10 days post-op
2 months post-op
(7 months after original I&D)
NPUAP/EPUAP Palliative Care Wound Guidelines

- Manage the pressure ulcer and periwound area on a regular basis. (Strength of Evidence = B/C.)

- Debride the ulcer of devitalized tissue to control infection and odor, based on the individual’s overall quality of life (Martin et al., 1996; Pullen et al., 2002; WOCN, 2003). (Strength of Evidence = B.)

- Use conservative, non-surgical (autolytic, enzymatic) debridement of necrotic tissue as appropriate (AHCPR, 1994; WOCN, 2003; Hampton, 2006; Grocott, 2006). (Strength of Evidence = ?)

- Avoid sharp debridement with fragile tissue that bleeds easily. (Strength of Evidence = C.)

Standard vs Palliative Wound Care

<table>
<thead>
<tr>
<th>STANDARD WOUND CARE</th>
<th>ALVAREZ protocol</th>
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</thead>
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<tr>
<td>Debride Necrotic Tissue</td>
<td>Stabilize the wound</td>
</tr>
<tr>
<td>Achieve Bacterial Balance</td>
<td>Prevent further wounds</td>
</tr>
<tr>
<td>Maintain Moisture Balance</td>
<td>Eliminate odor</td>
</tr>
<tr>
<td>Optimize tissue perfusion</td>
<td>Control pain</td>
</tr>
</tbody>
</table>

Prevent or Treat Infection

Debridement
- Removes necrotic debris
- Prevents infection
- Eliminates odor
- Reduces exudate
- Avoid wet-to-dry gauze
  - Painful
  - Labor intensive
  - Impedes wound healing
- Combination approach
  - Enzymatic and sharp

ALVAREZ protocol
S tabilize the wound
P revent further wounds
E liminate odor
C ontrol pain
I nfection prophylaxis
A dvanced wound dressing
L essen dressing changes

Putting it all together: Patient #1

82 y/o presents to emergency room with fever, elevated white count and altered mental status.
Treatment intensity & prognosis

- Caregiver & family communication essential
- Consequences of decisions must be communicated
- Hard decisions
  - When to operate
  - How much to operate
  - Is amputation beneficial/desirable?

Putting it all together: Patient #2

- 84 y/o paraplegic due to spinal infarction, SNF resident
- Sacral pressure injury for at least 6 months
- Surgical debridement prior to presentation, down to bone but no bone cultures
  - Treated empirically with IV antibiotics
- Presented to wound clinic, admitted due to new onset of seizure activity
- Operative debridement at request of infectious disease specialist
  - Bone culture negative, pathology shows acute osteomyelitis
- Weight loss, no appetite, loss of strength, low albumin/prealbumin
- Son is very involved
Putting it all together: Patient #3

15 months

70 y/o quadriplegic with h/o COPD, resident of long-term care facility with excellent wound care. Developed sacral pressure injury during respiratory exacerbation

3 months

Putting it all together: Patient #3 (cont)

Debridement in clinic

Bilateral ischial pressure injuries were chronic but stable
Sent to Wound Center for worsening of right ischial wound
Pain with debridement despite topical analgesia

Returns for follow up with slough in the wound bed
Decision not to perform sharp debridement
Patient’s wishes
No evidence of infection
Putting it all together: Patient #4

82 y/o with history of CVA and expressive aphasia. Possible recent mental status changes; history limited by lack of caretaker. Wound care is extremely painful.

Patient unable to tolerate bedside debridement.
Wound tunnels >10cm.

Surgical excision
- facilitates wound care
- decreases pain
- prevents or reduces infection

Debridement and Palliative Wound Care

- Surgical approach may be palliative
  - Reduce bioburden
  - Decrease intensity of wound care
  - Provide temporary closure
  - Reduce pain
Putting it all together: Patient #5

85 y/o developed right heel blister after right hip arthroplasty. History of PAD, ABI=0.68, vascular surgeon states ‘not a candidate for revascularization’

Putting it all together: Patient #6

78 y/o diabetic had prolonged course after CABG. Right heel is not painful. Pulses are palpable. Eschar is dry
Putting it all together: Patient #6 (cont)

Treatment must be adjusted based on wound characteristics, patient functional status and medical status

Debridement: What is the Limit?

Putting it all together: Patient #6 (cont)

Topical therapy and need for debridement is based on the wound characteristics. Wound healing was promoted by prior debridement.

Debridement: Is there a limit?

- Surgical approach is currently inexact and results in either too much or too little tissue removal.
The Future: Using Science to guide debridement

Taverna et al, J. Proteome Res., 2015, 14 (2), pp 986–996

The Future: Using Science to guide debridement

Thank you! Questions?

This presentation is made possible by multiple contributions from the Wound Healing Society Education Committee