Wound Care for PCP: Assessment & Management
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Alejandro Perez, MD, FSVM, RPVI
Vascular Medicine
Providence Heart and Vascular Institute
Regional Medical Director of Providence Wound Care and Hyperbaric Programs

Disclosures

None
Objectives

- Understand common impediments to wound healing
- Vascular Testing to optimize wound healing
- Adjunctive treatments in wound care

Types of Wounds - Major

- Venous
- Arterial
- Diabetic
- Pressure
- Neuropathic
- Surgical
- Trauma
- Malignant
Factors to address in all wounds

- Moisture balance
- Infection control
- Offloading requirements
- Removal of necrotic tissue
- Circulation

Phases of Wound Healing

- Hemostasis: within 5-10 minutes
- Inflammation: completed within 3 days
- Epithelialization: within 2 days of surgery
- Fibroplasia: collagen production up to 6 wks
- Maturation- 80% strength at 6 wks but 180 days for normal skin appearance

Front Biosci. 2004;9:283.
Phases of Wound Healing

Moisture balance

- Myth: “Let air get to it”
- Proven: Moist wound healing
Moist Wound Healing

• Total of 70 wounds (1.5x 1.5x 0.8 cm)- Porcine model
• Repithelialization 12 days after wounding:
  – 0 % of dry (p= 0.0046)
  – 20 % of moist/hydrocolloid (p= 0.027)
  – 86 % of saline-treated wounds


Dressing Selection - A Primer
Dressing types

Transparent film- polyurethane

Advantages:
- Impermeable to bacteria
- Retains moisture
- Allows for wound visualization
- Helps with autolytic debridement

Disadvantages:
- Can retain excess moisture
- Can worsen infected wounds

Dressing types

Gauze

- Advantage: inexpensive
- Disadvantage: Must be remoistened or will dry on ulceration
Dressing Type

Hydrogel- water or glycerin based gel/gauze/sheet dressing

Advantages:
- Reduces pain
- Rehydrates
- Helps with autolytic debridement
- Can be used on infected and deep wounds

Disadvantages:
- May cause maceration
- Difficult to secure

Dressing Type

Alginate: Derived from seaweed; ropes/pads
- Absorbs 20x its weight
- Forms a gel
- Facilitates autolytic debridement
- Can be used for heavy exudate

Disadvantages:
- May dehydrate
- Requires secondary dressing
Dressing Type

Foam: Pads/sheets
• Absorbs exudate
• Good for fragile skin

Disadvantage:
• Not good for dry wounds

Dressing Type

Hydrocolloid: composed gelatin/pectin (wafers, pastes, powders)
• Absorbs mild-moderate exudate

Disadvantages:
• Not for heavy exudate
• Not for packing
Silver dressings

- For infected or heavily colonized wounds
- Should be limited to 2-4 weeks

Infection control

- Wounds should be kept clean
- Superficial swabs not recommended unless after wound cleaning and debridement
- Deep cultures help to better target antibiotic therapy
- Imaging/bone biopsy helps with diagnosis of osteomyelitis
Diabetic Foot infections

- Aerobic Gram (+) cocci (Staph Aur) predominant
- Chronic wound or recent antibiotics indicate possible Gram (−) rods
- Foot ischemia or gangrene may indicate obligate anaerobe involvement


Offloading

- Critical in treating and prevention of recurrence for
  - Diabetic ulcers
  - Neuropathic ulcers
  - Pressure ulcers
Support Surfaces

- Overlays - filled: water, air, gel, or foam
- Pressure relief mattresses - water, air, gel, foam layers
- Air-fluidized beds - silicone-coated beads in pressurized air
- Low-air loss beds - interconnected air-filled pillows that lose air through cushions

Diabetic offloading

- Total contact casting
- Offloading shoes
Diabetic Offloading

Peak Plantar Pressures
A Barefoot, B flat cushioned insole, C custom-made insole

Off-loading the diabetic foot for ulcer prevention and healing.
Cavanagh PR, Bus SA. J Vasc Surg. 2010;52(3 Suppl):37S
Debridement

- Sharp
- Autolytic (body’s own enzymes)
- Mechanical: hydrotherapy, laser, medical maggots, ultrasound
- Enzymatic (collagenase)
- Osmotic

Debridement

- Collagenase (clostridium histolyticum)
- Papain (from papaya)
- Bromolain (from pineapple)
- Leptospermum honey
Edema control

- Compression stocking
- Multilayer wrap
- Unna boot (if ambulatory)

Wound Closure

- Primary- sutures, staples
- Delayed primary
- Negative pressure
Wound Coverage

• Skin Grafts: Split and Full thickness
• Biologic (skin substitutes):
  – Cell based
  – Acellular matrices

Vascular Assessment

• History:
  – prior revascularization
  – other arterial diseases
  – claudication
  – smoking, diabetes
• Exam:
  – decreased hair
  – cool feet
  – nonpalpable pedal pulses
Risk Factors for Symptomatic PAD

Vascular Testing: Ankle-Brachial Index

Resting ABI ≤0.9 is most commonly used as the hemodynamic definition of PAD.
95% sensitive
99% specific

Fowkes FG. The measurement of atherosclerotic peripheral arterial disease in epidemiologic surveys. Int J Epidemiol. 1988;17:248-254
**ABI**

**Right ABI = ratio of**
- Higher of the right ankle systolic pressures (posterior tibial or dorsalis pedis)
- Higher arm systolic pressure (left or right arm)

**Left ABI = ratio of**
- Higher of the left ankle systolic pressures (posterior tibial or dorsalis pedis)
- Higher arm systolic pressure (left or right arm)

J Vasc Surg 2007;45 (1 Supp)S5-S67

**ABI**

- **ABI >1.4** Incompressible
- **ABI 1-1.4** Normal
- **ABI 0.91-0.99** Borderline
- **ABI 0.4-0.9** Mild- Moderate PAD
- **ABI <0.4** Severe PAD
Cardiovascular Events and ABI


ABI and mortality

TBI

- A pressure gradient of 20 to 30 mmHg normally exists between the ankle-toe
- Normal toe-brachial index is 0.7 to 0.8.
- An absolute toe pressure >30 mmHg is favorable for wound healing.\(^1\)
- Toe pressures >45 to 55 mmHg may be required for healing if diabetes present.\(^2\)

\(^1\) J Vasc Surg. 1996;24(2):258

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Pulse Volume Recordings (PVR)

![Pulse Volume Recordings](medscape.com)
Vascular Testing

- Segmental Pressures and PVRs

Natural History of PAD – 5 years

Hirsch et al. J Am Coll Cardiol 2006;47:12
Natural History of PAD – 5 years

Critical limb ischemia 1–3%

1-year outcomes

- Alive with two limbs 45%
- Amputation 30%
- Mortality 25%

Revascularization

- Acute Limb Ischemia
- Critical Limb Ischemia
  - Rest Pain
  - Ulcer
  - Gangrene

Hirsch et al. J Am Coll Cardiol 2006;47:12
Revascularization

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NO FLOW ≠ NO OPTIONS

Endovascular occlusion treatment

![Pre and Post images of vascular treatment](image_url)
Benefit of revascularization

- 564 patients with DM2 and CLI (ABI <70 mmHg); 4 year cohort study
- angioplasty (PTA): 74.5 %
- bypass grafting (BPG): 20.6 %
- amputations
  - 8.2 % PTA
  - 21.2% BPG
  - 59.2 % no intervention

Hyperbaric Oxygen Therapy:

Undersea and Hyperbaric Medical Society: Indications

- Severe anemia
- Intracranial abcess
- Necrotizing soft tissue infections
- Refractory osteomyelitis
- Compromised graft/flap
- Acute Thermal Burn Injury
- Idiopathic Sudden Sensorineural Hearing Loss
HBO Therapy- Wound Healing

- Patient breathes 100% oxygen intermittently while inside a treatment chamber at a pressure higher than sea level pressure (i.e., >1 atmosphere absolute).
- Therapy for nonhealing wounds generally consists of daily sessions of 1.5 to 2 hours for 20 to 40 days.

Hyperbaric oxygen therapy

- 1928, “Steel ball hospital” built in Cleveland, OH
- 6 stories high and 64 feet in diameter
- The AMA and Cleveland Medical Society forced Dr. Orville Cunningham to close in 1930
HBO chambers

Monoplace  Multiplace

HBO Mechanisms for Healing

DFU Wagner Classification

- Grade 0 – No ulcer in a high-risk foot
- Grade 1 – Superficial ulcer involving the full skin thickness but not underlying tissues
- Grade 2 – Deep ulcer penetrating to ligaments and muscle, but no bone involvement or abscess formation

O'Neal, LW, Wagner, FW. The Diabetic Foot, Mosby, St Louis 1983. p.274

DFU Wagner Classification

- Grade 3 – Deep ulcer with cellulitis or abscess formation, often with osteomyelitis
- Grade 4 – Localized gangrene
- Grade 5 – Extensive gangrene involving the whole foot

O'Neal, LW, Wagner, FW. The Diabetic Foot, Mosby, St Louis 1983. p.274
HBO for diabetic foot ulcers

- Approved for use in ulcers with Wagner Classification ≥ 3 that have not shown progression to healing over 4 weeks of wound care

Transcutaneous oxygen monitoring

- TCOM- Platinum oxygen electrodes placed on the chest wall and legs or feet
- Values <25-40 mmHg associated with poor healing of wound and amputation flaps
- The lower the value the greater the degree of healing impairment

TCOM

Low TCOM indicates tissue hypoxia

HBO in DFU

- Systematic Review
- 13 trials
- RR of healing 2.33 (95% CI, 1.5-3.6)
- RR of major amputations 0.29 (95% CI, 0.19-0.44)

HBO controversies

Lack of Effectiveness of Hyperbaric Oxygen Therapy for the Treatment of Diabetic Foot Ulcer and the Prevention of Amputation

A cohort study

Objective — Hyperbaric oxygen (HBO) is a device that is used to treat burn patients. The study goal was to compare the effectiveness of HBO with other conventional therapies administered in a wound care network for the treatment of diabetic foot ulcers and prevention of lower extremity amputations.

Research Design and Methods — This was a longitudinal observational cohort study. To address treatment selection bias, we used propensity scores to determine the "propensity" that an individual was selected to receive HBO.

Results — We studied 2,239 individuals with diabetes, adequate lower limb arterial perfusion, and two or more ulcers through the devices, representing 372,400 person-days of wound care. The propensity score-adjusted models, individually receiving HBO were less likely have healing of ulcer area after 50 days (0.01: 95% confidence interval, 0.01–0.03) and more likely to have an amputation (5.27 [1.86–14.14]). Additional analyses, including the use of an instrumental variable, were conducted to assess the robustness of our results in univariate and multivariate analysis. HBO was found to improve the likelihood that a wound might heal or to reduce the likelihood of amputation in any of these analyses.

Conclusions — Use of HBO further improved the likelihood that wounds would heal and reduce the need for amputations. In a system of patients treated by Laceras for Woundcare and Wound Treatment Services, the usefulness of HBO in the treatment of diabetic foot ulcers needs to be determined.

Key Points

• Address obstacles to healing
• Confirm perfusion
• Consider adjunctive treatments when healing is stalled
Questions?