Why Should I Refer to a Wound Management Center?

Evidence Based Wound Healing
Pretest
Question # 1

The practice of evidence based medicine should drive us to do the right thing for the right reason at the right time in the right manner for the right patient every time.

A. True
B. False
Pretest
Question # 2

- It is an absolute ESSENTIAL in wound management to ensure adequate blood supply to the wounded anatomic region.

A. True
B. False
Surgical removal of all non-viable tissue within a wound is **ESSENTIAL** in wound management to maximize the opportunity for early wound closure.

A. True

B. False
Level III Evidence is the highest form of medical evidence and is supported by meta-analysis of multiple randomized clinical trials (RCTs) or at least two RCTs supporting the application of the guideline. An alternative pathway would be multiple laboratory or animal experiments with at least two significant clinical series supporting the laboratory results.

A. True
B. False
Aggressive, Evidence Based Wound Management
What is Evidence-Based Medicine?

“An approach to health care practice in which the clinician is aware of the evidence in support of his/her clinical practice, and the strength of that evidence.”

Evidence Based Medicine Working Group at McMaster University, Hamilton, Ontario, Canada
What is Evidence-Based Medicine?

“The conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients.”

What's New

The National Guideline Clearinghouse™ (NGC) Web site is updated weekly with new content.

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See the What's New Archive to view a complete archive of weekly updates.

See the NGC Guideline Index to view a complete list of all guidelines included in NGC, organized alphabetically by guideline developer.

See the Guidelines In Progress page to view a list of all guidelines that are actively in the NGC work queue, organized alphabetically by guideline developer.

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Cochrane Manual
Archie (IMS)

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Newsroom & Our growth
Newcomers' Guide
Evidence Aid - Resources for healthcare emergencies
Cochrane Reviews on ISII

From the newsroom

Issue 3, 2006 of The Cochrane Library is now online!

Featured reviews address pre-eclampsia, smoking cessation, acupuncture for chronic neck pain, and many more topics. Browse and search the abstracts here on cochrane.org, or log in to The Cochrane Library for full text access.

Published: 2006.07.19
Professional societies...

- Wound Healing Society [www.woundheal.org](http://www.woundheal.org)
  - Pressure ulcers
  - Venous leg ulcers
  - Arterial insufficiency ulcers
  - Diabetic foot ulcers
Professional societies...

- Wound Ostomy Continence Nurses Society (WOCN)
  
  www.wocn.org
  
  - Pressure ulcers
  - Venous leg ulcers
  - Arterial insufficiency ulcers
  - Diabetic foot ulcers
Forms of Evidence

The levels of evidence selected for the review may predetermine the outcome of the assessment.

### Quantitative
- Systematic reviews and meta-analyses
- Randomized, controlled double blind trials
- Randomized, controlled trials
- Non-randomized trials
- Cohort studies

### Qualitative
- Case-controlled studies
- Case series and registries
- Surveys
- Qualitative, descriptive, studies...case reports
- Professional consensus
- Animal research, in vitro research

[Image of a pyramid with Quantitative at the top and Qualitative at the bottom, indicating a hierarchy of evidence types.]

- [Image of a square with Systematic reviews and meta-analyses written inside it.]
- [Image of a square with Randomized, controlled double blind trials written inside it.]
- [Image of a square with Randomized, controlled trials written inside it.]
- [Image of a square with Non-randomized trials written inside it.]
- [Image of a square with Cohort studies written inside it.]
- [Image of a square with Case-controlled studies written inside it.]
- [Image of a square with Case series and registries written inside it.]
- [Image of a square with Surveys written inside it.]
- [Image of a square with Qualitative, descriptive, studies...case reports written inside it.]
- [Image of a square with Professional consensus written inside it.]
- [Image of a square with Animal research, in vitro research written inside it.]
Levels of Evidence

- **Level I:** Meta-analysis of multiple randomized clinical trials (RCTs) or at least two RCTs supporting the application of the guideline. An alternative pathway would be multiple laboratory or animal experiments with at least two significant clinical series supporting the laboratory results.

- **Level II:** Less than Level I, but at least one RCT and at least significant clinical series or expert opinion papers with literature reviews supporting the application/intervention. Experimental evidence that is quite convincing, but not yet supported by adequate human experience, is also included.

- **Level III:** Suggestive data of proof-of-principle, but lacking sufficient evidence such as meta-analysis, RCT, or multiple clinical series.
Clinical Evidence should drive us to...

- Do the right thing...
  - For the right reason...
  - At the right time...
  - In the right manner...
  - For the right patient.

Every time...
The Nine Essentials of Wound Healing

1. Adequate Perfusion
2. Non-Viable Tissue
3. Inflammation or Infection
4. Edema
5. Wound Microenvironment
6. Tissue Growth Optimized
7. Off-Loading
8. Pain Control
9. Host Factors
Adequate Perfusion
DFU...Enhance Perfusion and Oxygenation

- Patients with ischemia should be considered for a revascularization procedure.
- In patients with Wagner grade III or greater diabetic foot ulcers, hyperbaric oxygen treatment should be considered as an adjunctive therapy.
  - Tissue hypoxia with responsiveness to in chamber oxygen challenge as currently measured by transcutaneous oximetry (PtcO²) is useful in predicting outcome. (diabetic ischemic ulcers—Level I)
The Nine Essentials of Wound Healing

If you can’t get water to the garden......the garden won’t grow!!!!!
The Nine Essentials of Wound Healing

1. Adequate Perfusion
2. Non-Viable Tissue
3. Inflammation or Infection
4. Edema
5. Wound Microenvironment
6. Tissue Growth Optimized
7. Off-Loading
8. Pain Control
9. Host Factors
Nonviable Tissue
DFU...Remove Nonviable Tissue

- Maintain dry stable eschar on non infected, ischemic, neuropathic wounds until revascularized.
- Remove all necrotic or devitalized tissue by surgical, enzymatic, mechanical, biological, or autolytic debridement. (Level II)
- The best available evidence on diabetic foot ulcer debridement suggests that callous, undermining of the ulcer edges or margination of keratinocytes at the ulcer edge, and the presence of necrosis should always be addressed by sharp surgical debridement if perfusion status permits. (Level I)
Debridement performance index and its correlation with complete closure of diabetic foot ulcers

LUIANA J. SAAP, MD; VINCENT FALANGA, MD, FACP

In recent years there has been wider acceptance of aggressive surgical debridement as a means to accelerate closure of diabetic foot ulcers. In a clinical trial by Streed et al., involving the use of a topically applied growth factor, thorough surgical debridement of surrounding callus, necrotic ulcer bed, and undermined ulcer’s edges was associated with a greater incidence of healing and effectiveness of the therapeutic agent. However, at present there is no established way to judge the adequate extent of debridement and its performance. Here we describe a scoring system to assess whether debridement has been performed adequately. Our scoring system consists of the following three categories: debridement of a) callus, b) ulcer’s edge undermining, and c) wound bed necrotic tissue. We assigned a score of 0-2 to each of these categories using the following criteria: 0 — debridement needed but not done, 1 — debridement needed and done, and 2 — debridement not needed. These three scores are then added to give a total ranging from 0 to 6, with the highest number being the optimal score. This system, the Debridement Performance Index, evaluates both the adequacy of debridement and whether the ulcer has been or is being properly debridged. To initiate the validation of this scoring system and determine its predictive value for wound closure, we applied it to 145 patients with diabetic foot ulcers who had been treated in a clinical trial involving either standard therapy (n = 56) or the application of a bioengineered skin construct (n = 89). We blindly evaluated sequential digital photographs of each diabetic foot ulcer and applied the Debridement Performance Index score at day 5 before initiation of either treatment. We found that the lower the baseline Debridement Performance Index, the lower the incidence of ultimate wound closure by week 12 (P = 0.0279). Patients with a Debridement Performance Index between 3 and 6 were 2.4 times more likely to heal than those with a score of 0-2. After controlling for treatment type, the Debridement Performance Index was found to be an independent predictor of wound closure (odds ratio = 4.95, 95% confidence interval = 1.0-26.0). In conclusion, this novel scoring system, for debridement performance, appears to be a very promising tool as a predictive tool for determining outcomes in clinical trials and, more likely, in clinical practice. (WOUND REP REG 2002;10:354-359)

Diabetes affects 17 million persons or 6.2% of the population in the United States. About 60-70% of patients with diabetes will develop mild to severe foot neuropathy, and 0.5% of subjects with diabetes will develop foot-related problems such as ulcers and infections. These complications increase the risk of amputation in diabetics to between 15 and 40 times that of the general population. About 56,000 diabetic patients lose a foot or a leg each year.

Debridement has always been considered part of standard care in the care of diabetic foot ulcers. However, perhaps because of lack of proof, this fundamental principle was not uniformly applied. It was not until

The Nine Essentials of Wound Healing

Wounds Won’t Heal in a SEWER!!
The Nine Essentials of Wound Healing

1. Adequate Perfusion
2. Non-Viable Tissue
3. Inflammation or Infection
4. Edema
5. Wound Microenvironment
6. Tissue Growth Optimized
7. Off-Loading
8. Pain Control
9. Host Factors
Inflammation/Infection
Tissue biopsy is considered the gold standard to confirm diagnosis of infection. Properly performed swab cultures have been demonstrated to be a reasonable alternative in clinical practice. (Level II)

Obtain anaerobic cultures in clinically infected deep diabetic foot or pressure ulcers. (Level II) Consider anaerobic cultures in recalcitrant or progressive, heavily exudative venous leg ulcers. (Level III)

Blood cultures should be performed for patients with severe or progressing infection, in patients with infection in the setting of significant immune compromise, or in patients who are systemically ill. (Level III)
DFU…Resolve Infection, Maintain Microbial Balance

- If osteomyelitis is suspected by observation of necrotic or infected bone or probing to bone in the planter DFU patient, appropriate diagnostic measures should be undertaken including serial x-rays, MRI, CT, and radionucleotide scans. (Level II) As a noninvasive technology, magnetic resonance imaging (MRI) has demonstrated the highest sensitivity and specificity for diagnosing osteomyelitis in patients with diabetes and foot ulcers. Osteomyelitis is best treated by removal of the infected bone, followed by 2–4 weeks of antibiotics. However, when this is not practical, osteomyelitis underlying a diabetic ulcer can be effectively treated with prolonged antibiotic therapy. (Level II)
The Nine Essentials of Wound Healing

Wounds With Bugs Don’t Heal!!
The Nine Essentials of Wound Healing

1. Adequate Perfusion
2. Non-Viable Tissue
3. Inflammation or Infection
4. Edema
5. Wound Microenvironment
6. Tissue Growth Optimized
7. Off-Loading
8. Pain Control
9. Host Factors
Edema
Effects of Edema on Wound Healing

- Inhibits formation of collagen
- Creates protein rich environment
  - Promotes infection
- Inhibits blood flow
- Inhibits production of MMPs
The Nine Essentials of Wound Healing

Wounds Don’t Heal in a Swamp!!
The Nine Essentials of Wound Healing

1. Adequate Perfusion
2. Non-Viable Tissue
3. Inflammation or Infection
4. Edema
5. Wound Microenvironment
6. Tissue Growth Optimized
7. Off-Loading
8. Pain Control
9. Host Factors
Too wet??  Too Dry??
Too Wet
Too Dry
Perfect!!
The Nine Essentials of Wound Healing

Wounds Don’t Heal Unless

The Environment Supports Healing
The Nine Essentials of Wound Healing

1. Adequate Perfusion
2. Non-Viable Tissue
3. Inflammation or Infection
4. Edema
5. Wound Microenvironment
6. Tissue Growth Optimized
7. Off-Loading
8. Pain Control
9. Host Factors
Tissue Growth

04/24/2009

06/07/2009
Patients who fail to show a reduction in ulcer size by 30% or more after four weeks of therapy should be reevaluated and other treatments should be considered. (Level II)

- **Platelet-derived growth factor** (PDGF, Becaplermin) is effective in treating diabetic neurotrophic foot ulcers. (Level I)

- The role of topically applied **autologous platelet gel** products, is undefined at this time.
DFU...Enhancing Tissue Growth

• Temporary epidermal/dermal cellular replacement with bioengineered tissue grafts can accelerate the closure of wounds. However, adequate arterial inflow and a wound surface free of active infection and microbial colonization is necessary. (Level I).

• Extracellular dermal matrix replacement therapy appears to be promising for mixed ulcers and may have a role as an adjunctive agent but further study is required. (Level III)
The Nine Essentials of Wound Healing

Tissue Growth is OUR Business
The Nine Essentials of Wound Healing

1. Adequate Perfusion
2. Non-Viable Tissue
3. Inflammation or Infection
4. Edema
5. Wound Microenvironment
6. Tissue Growth Optimized
7. Off-Loading
8. Pain Control
9. Host Factors
Off Loading
Ensure adequate offloading of pressure through wound closure. Acceptable methods of therapeutic offloading include, in decreasing order of effectiveness (Level I):

- **Total contact casting (TCC) and variants (TCC-EZ™, Med-Efficiency):**
- Removable orthotic walkers (CROW) affixed to prevent removal (Armstrong “instant TCC”)
- Post operative shoes, half shoes, felt and foam dressings with crutch walking or use of walker in Wagner grade I ulcers
DFU…Offloading

- Utilize assistive devices (e.g., walker, quad cane, crutches, referral to physical therapy for gait training) to provide support, balance, and offloading of the affected site.

- Protective footwear should be prescribed in any patient at risk for amputation (significant arterial insufficiency, significant neuropathy, previous amputation, previous ulcer formation, pre-ulcerative callus, foot deformity, evidence of callus formation). (Level II)

- Achilles tendon lengthening may improve healing of diabetic forefoot wounds. (Level II)
The Nine Essentials of Wound Healing

Wounds Don’t Heal Under Pressure!!
The Nine Essentials of Wound Healing

1. Adequate Perfusion
2. Non-Viable Tissue
3. Inflammation or Infection
4. Edema
5. Wound Microenvironment
6. Tissue Growth Optimized
7. Off-Loading
8. Pain Control
9. Host Factors
The Nine Essentials of Wound Healing

Controlled Pain = Better Compliance
The Nine Essentials of Wound Healing

1. Adequate Perfusion
2. Non-Viable Tissue
3. Inflammation or Infection
4. Edema
5. Wound Microenvironment
6. Tissue Growth Optimized
7. Off-Loading
8. Pain Control
9. Host Factors
Host Factors
The Nine Essentials of Wound Healing

Wounds Don’t Heal Without Building Blocks!!
The Nine Essentials of Wound Healing

Let’s Go Back To Tissue Growth is OUR Business
Apligraf® Clinical Trials

Evidence-based
Bioactive Wound Healing
# Apligraf®: Evidenced-Based Bioactive Wound Healing

- Two of the largest wound healing clinical trials ever conducted
- Only bioactive wound healing product approved for two major indications (venous leg ulcers and diabetic foot ulcers)
- Extensive phase IV trial data
- >80,000 Clinical Applications in the United States, 6 years in routine clinical use
- Numerous peer-reviewed publications
Apligraf®

FDA Approved for the Treatment of Venous and Diabetic Neuropathic Ulcers
Venous Leg Ulcer Trial

A Multicenter, Randomized, Parallel-Group, Controlled Clinical Trial of Apligraf® in the Treatment of Venous Leg Ulcers

Study objectives

- Compare efficacy of Apligraf plus compression therapy vs standard compression (active control)
- Evaluate
  - Apligraf efficacy over a 6-month period
  - Apligraf safety over a 12-month period

## Venous Leg Ulcer Trial
### Patient Randomization

<table>
<thead>
<tr>
<th>Apligraf® Treatment Arm</th>
<th>Active Control Arm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Apligraf and Compression Therapy</strong></td>
<td>Compression Therapy Alone</td>
</tr>
<tr>
<td>Nonadherent primary dressing</td>
<td>Nonadherent primary dressing</td>
</tr>
<tr>
<td>Secondary-gauze pressure bolster</td>
<td>Secondary-gauze pressure bolster</td>
</tr>
<tr>
<td></td>
<td>Zinc oxide–impregnated paste bandage (Unna’s boot)</td>
</tr>
<tr>
<td></td>
<td>Self-adherent elastic bandage</td>
</tr>
</tbody>
</table>

Efficacy of Apligraf® in the Treatment of Venous Leg Ulcers

All Patients Achieving 100% Closure

By 24 weeks $P=.022$.

Efficacy of Apligraf® In Patients With Venous Leg Ulcers >1 Year’s Duration

Control (n=48)  Apligraf (n=72)

<table>
<thead>
<tr>
<th>Time</th>
<th>Control</th>
<th>Apligraf</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Weeks</td>
<td>6</td>
<td>10</td>
<td>.008</td>
</tr>
<tr>
<td>8 Weeks</td>
<td>10</td>
<td>32</td>
<td>.001</td>
</tr>
<tr>
<td>12 Weeks</td>
<td>13</td>
<td>40</td>
<td>.002</td>
</tr>
<tr>
<td>24 Weeks</td>
<td>19</td>
<td>47</td>
<td></td>
</tr>
</tbody>
</table>

Progression of Healing in a Venous Ulcer After Extensive Debridement and Apligraf Treatment
Apligraf® Venous Leg Ulcer Pivotal Trial

Summary

- Compared to standard compression therapy in ulcers with duration >1 year, Apligraf therapy was:
  - At 8 weeks: Three times more effective (32% vs 10%) for frequency of complete closure*
  - At 6 months: More than twice as effective for frequency of complete closure†
  - At all times: Superior to active control for time to complete wound closure‡

*Fisher’s exact test, \( P=0.008 \).
†Logistic regression: odds ratio = 2.01, \( P=0.0021 \).
‡Cox proportional hazards regression analysis: risk ratio = 1.66, \( P=0.0075 \).

Apligraf® Evidence-based Healing: Multiple Clinical Trials in Venous Leg Ulcers

<table>
<thead>
<tr>
<th>Journal</th>
<th>Year</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archives Dermatology</td>
<td>1998</td>
<td>134:293-300</td>
</tr>
<tr>
<td>Wound Rep Regen</td>
<td>1999</td>
<td>7:201-207</td>
</tr>
<tr>
<td>Ostomy Wound Management</td>
<td>1999</td>
<td>45:34-43</td>
</tr>
<tr>
<td>Journal Vasc Nursing</td>
<td>1998</td>
<td>16:11-15</td>
</tr>
<tr>
<td>Archives Dermatology</td>
<td>2002</td>
<td>138:1079-1081</td>
</tr>
<tr>
<td>Journal of Wound Care</td>
<td>2002</td>
<td>11:182-183</td>
</tr>
<tr>
<td>Dermatologic Surg</td>
<td>2001</td>
<td>27:915-919</td>
</tr>
</tbody>
</table>
**Diabetic Foot Ulcer Study Design**

A prospective, randomized, controlled study comparing Apligraf® plus conventional therapy (debridement, saline dressings, and total off-loading) to conventional therapy alone.

| Patient Demographics | 208 patients enrolled with diabetic foot ulcers  
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>67 with type 1 diabetes; 139 with type 2 diabetes; 2 not specified</td>
</tr>
<tr>
<td></td>
<td>Study excluded patients who exhibited rapid healing (≥30% closure: from day -7 to day 0)</td>
</tr>
<tr>
<td><strong>Ulcer Characteristics</strong></td>
<td>All patients had ulcers on the plantar surface of the foot</td>
</tr>
<tr>
<td></td>
<td>Mean ulcer size 2.97 cm² and 2.83 cm² in the Apligraf and Control group, respectively</td>
</tr>
<tr>
<td></td>
<td>Mean duration: 12 months in the Apligraf group and 11 months in the Control group</td>
</tr>
<tr>
<td><strong>Off-Loading</strong></td>
<td>All patients used either crutches or a wheelchair for the first 6 weeks, followed by customized pressure-relieving footwear for at least 4 weeks postclosure</td>
</tr>
</tbody>
</table>

Efficacy of Apligraf® in Diabetic Foot Ulcers

Incidence % of Complete Wound Closure Over Time (N=208)

By 12 weeks $P=0.0026$.
Proven to Promote Rapid Closure of Diabetic Foot Ulcers

Apligraf®
(n=112)

Median Time to 100% Wound Closure

Conventional Therapy (n=96)

$P = .0026$

Apligraf®
Lower Incidence of Osteomyelitis

Incidence of Osteomyelitis at the Study Ulcer Site

- Conventional therapy alone (debridement, saline dressings, total off-loading) [n=96] - P<.05
- Apligraf (n=112) - 2.7%

Apligraf®
Lower Frequency of Amputation

Frequency of Amputation/Resection of the Study Limb

<table>
<thead>
<tr>
<th>% of Patients</th>
<th>Conventional therapy alone (debridement, saline dressings, total off-loading) [n=96]</th>
<th>Apligraf (n=112)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15.6%</td>
<td>6.3%</td>
</tr>
</tbody>
</table>

P < .05

Diabetic Ulcer Healed With Apligraf®: Treatment Sequence
### Apligraf® Evidence-based Healing: Multiple Clinical Trials in Diabetic Foot Ulcers

- *Archives of Surgery*. 2000;235:627-634.
Only Apligraf is FDA-approved for both venous leg ulcers and diabetic foot ulcers

Closes more diabetic foot ulcers faster than conventional therapy alone

More than twice as effective as compression therapy alone in long-standing venous ulcers

Lower incidence of osteomyelitis at the study ulcer site and lower frequency of amputation of the study limb

Easy to incorporate into practice

Positive reimbursement in all settings

Well tolerated in over 80,000 patient applications
Selecting Patients for HBO

- By ability to reverse specific pathophysiology ... of wound healing failure
- By diagnosis
Benefits of Hyperbaric Oxygen

**Physiologic Effects:**
- Improved leukocyte function and bacterial killing
- Antibiotic potentiation
- Enhanced collagen synthesis and cross-linking

**Pharmacological Effects:**
- Direct antimicrobial effects, toxin synthesis suppression
- Blunting of systemic inflammatory responses
- Prevention of leukocyte activation and adhesion
- PDGF-BB receptor stimulation (multiple effects)
- VEGF release and angiogenesis
- Detoxification (CO, CN, H$_2$S)
Selecting Patients for HBO

- By ability to reverse specific pathophysiology of wound healing failure

- By diagnosis
## Emergency/Acute Indications

<table>
<thead>
<tr>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cerebral Arterial Air or Gas Embolism</td>
</tr>
<tr>
<td>Carbon Monoxide Poisoning</td>
</tr>
<tr>
<td>Cyanide Poisoning</td>
</tr>
<tr>
<td>Hydrogen Sulfide Poisoning</td>
</tr>
<tr>
<td>Clostridial Myositis &amp; Myonecrosis</td>
</tr>
<tr>
<td>Acute Traumatic Ischemia</td>
</tr>
<tr>
<td>- Crush Injury</td>
</tr>
<tr>
<td>- Compartment Syndrome</td>
</tr>
<tr>
<td>- Replantation Limb/Digits Etc.</td>
</tr>
</tbody>
</table>
Newly Approved Emergent Indications

- Central Retinal Artery/Vein Occlusion
- Actinomycosis
### Chronic/Elective Indications

<table>
<thead>
<tr>
<th>Problem Wounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Diabetic Foot Ulcers (Chronic; Wagner III)</td>
</tr>
<tr>
<td>- Arteriolar Insufficiency</td>
</tr>
<tr>
<td>- Etc.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chronic Refractory Osteomyelitis</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Delayed Radiation Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Soft Tissue</td>
</tr>
<tr>
<td>- Bony</td>
</tr>
</tbody>
</table>

| Meleny Ulcer (Invasive Group A Strep) |
Age associated differences in cellular Proliferation \textit{(in vitro)}…

(Buras and Buras, Harvard Medical School, MGH, Boston)
Decreased cellular proliferation with diabetes…

(Buras and Buras, Harvard Medical School, MGH, Boston)
HBO Dramatically Increases Old Adult Fibroblast Proliferation…

(Buras and Buras, Harvard Medical School, MGH, Boston)
HBO Dramatically Increases Diabetic Fibroblast Proliferation…

(Buras and Buras, Harvard Medical School, MGH, Boston)
PtcO$_2$ As A Predictor of Wound Healing in Diabetic Foot Wounds…

PtcO$_2$ < 30 mmHg indicated 39-fold increased risk of early healing failure.

Wound Healing Impairment with Decreasing PtCO₂

40 mmHg

TcPO2 Decreasing

Minimally Impaired

No Healing

Wound Healing Impairment

0 mmHg
What About Smoking?

2 hours pre .......................... 2 hours post

Pre Smoking Baseline

Post Smoking
Relative Contraindications

- Upper Respiratory Infections
- Chronic Sinusitis
- Emphysema w/CO₂ Retention
- High Fevers
- History of Seizure Disorder
- Pregnancy
# Oxygen Toxicity: Pulmonary & Cardiac

- **Bleomycin** *(Pulmonary)*
- **Anthracyclines** *(Cardiac & Pulmonary)*
  - Doxorubicin
  - Taxotere
  - Daunorubicin
  - Epirubicin
  - Idarubicin
  - Mixoxantrone

*UNQUALIFIED ABSOLUTE CONTRAINDICATION* to simultaneous administration with HBO. OK ≥1 year since last dose. Monitor pulmonary status closely.

**For the anthracyclines, a last dose interval ≥6 weeks appears to be sufficient to allow initiation of HBO.**
Chemotherapy and HBO Risks

- Oxygen Toxicity (Cardiac, Pulmonary and CNS)
  - Alkylating Agents
    - Plant Alkaloids
    - Anthracyclines (Unqualified Absolute Contraindication)

- Antineoplastic/Cytotoxic Agents
- Anti-tumor Antibiotics
- Cyto-skeletal disrupters (Taxanes)
- Epipodophyllotoxins
- Epothilones
- Peptide Antibiotics
- Platinum Based Agents
- Topoisomerase II Inhibitors
Chemotherapy and HBO Risks

Since there are no case series nor RCTs and very few case reports regarding chemotherapeutic agents and HBO, we can only extrapolate from information in the literature as it pertains to mechanism of action. In **OUR OPINION**, patients undergoing chemotherapy with the aforementioned agents should not be treated with HBO for at least **6 weeks or 5 half lives** (whichever is longer) after their last dose of that agent.
Chemotherapy and HBO Risks

- Probably Safe
  - Monoclonal antibodies
  - Nucleotide analogs and precursor analogs
  - Retinoids
Medication and HBO Risks
Amiodarone

1. Amiodarone has been associated with cases of acute pulmonary fibrosis in association with exposure to increased FiO2.

2. All cases reported (about 7 in the literature) have occurred in critically ill patients receiving the drug by intravenous administration which appears to lead to an increase in pulmonary uptake.

3. Animal models have demonstrated a similar occurrence.

4. All human cases have received Amidarone IV @ dosages > 200mg/day.
Our pulmonologist colleagues, with extensive HBO experience and some experience in treating patients receiving oral Amiodarone believe that it is probably safe at doses of ≤ 400mg/day (all cases of toxicity reported in the literature were in the dose range of ≥ 400mg/day).
Relative Contraindications (Continued)

- History of Surgery for Otosclerosis
  - PE tubes
- Viral Infections
  - Get worse
- Congenital Spherocytosis
  - Hemolysis in presence of increased $\text{paO}_2$
- History of Optic Neuritis
  - May be associated with blindness
Complications & Side Effects

- Barotrauma of the Ear
  - PE tubes
- CNS Oxygen Toxicity
- Pulmonary Oxygen Toxicity
- Visual Refractive Changes
Complications & Side Effects (Continued)

- Numb Fingers
- Dental Problems
  - Occult abcess
- Claustrophobia
### The Proof

Results of the Use of Evidence Based Clinical Practice Guidelines in a Wound Management Center

- Healing Percentage: 98.43%
- Median Days to Heal: 26
- Patient Satisfaction Rate: 98%
The practice of evidence based medicine should drive us to do the right thing for the right reason at the right time in the right manner for the right patient every time.

A. True
B. False
It is an absolute **ESSENTIAL** in wound management to ensure adequate blood supply to the wounded anatomic region.

A. True

B. False
Surgical removal of all non-viable tissue within a wound is **ESSENTIAL** in wound management to maximize the opportunity for early wound closure.

A. True
B. False
Level III Evidence is the highest form of medical evidence and is supported by meta-analysis of multiple randomized clinical trials (RCTs) or at least two RCTs supporting the application of the guideline. An alternative pathway would be multiple laboratory or animal experiments with at least two significant clinical series supporting the laboratory results.

A. True

B. False
That’s It!! Any Questions Bernie???