

When The Best is Not Enough



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Goals



“ The primary goal of wound care is not the technical repair of the wound; it is providing optimal conditions for the natural reparative processes of the wound to proceed”

Wound Care Today



- **6.7 Million patients are suffering from non-healing advanced wounds**
- **Where are advanced wounds treated?**
 - **40% Hospital outpatient wound centers**
 - **20% Hospital inpatient**
 - **5% Long term care facilities**
 - **35% Stand alone offices**

Wound Evaluation



- It is important to recognize the intrinsic and extrinsic factors that may impede wound healing or promote infection
 - Mechanism of injury
 - Time of injury or length wound present
 - Environment in which wound occurred (contaminants or foreign bodies)
 - Patient's systemic medical conditions

Factors Affecting Wound Healing



- Remember the mnemonic:
“DIDN’T HEAL”

“Didn’t heal”



- **D=Diabetes: The debilitating triad:**

- **diminishing sensation**
- **decreased arterial flow & angiogenesis**
- **Increased plantar pressure**

*Endothelial progenitor cells (EPCs) play a big role in neovascularization after injury

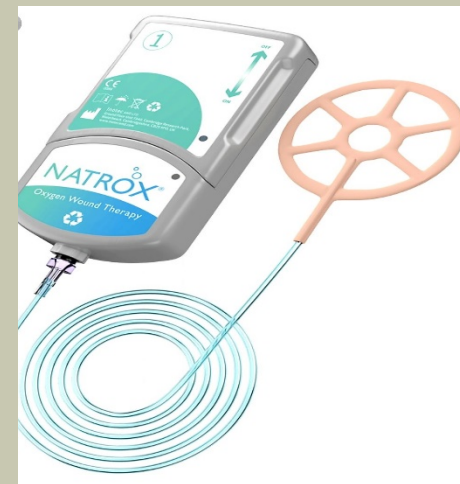
*Cells are released from the bone marrow to the circulation in response to ischemia

*This process is impaired in diabetics

“Didn’t heal”



- Hyperoxia has been shown to activate these dormant EPCs
- Reversal of the low levels of EPCs in circulation
 - Gallagher KA, et al. *J. Clin. Invest* 2007;117:1249-1259
- HBO?
 - Effective
 - Expensive
 - Narrow coverage
- Topical oxygen therapy?
 - Continuous oxygen therapy
 - Ease of use
 - Safety
 - Lower cost



“Didn’t Heal”



- **I=Infection: Increase bacterial contamination inhibits wound healing and causes collagen lysis.**
 - Culture in cases of **acute bacterial** processes or abscess formation
 - What about:
 - ✦ Excessive protease activity
 - ✦ Biofilm

Didn't Heal



- **Protease activity**
 - Collagen matrices have long been used to treat chronic wounds
 - Serves as a sacrificial substrate for matrix metalloproteinases (MMPs) and elastase
 - Collagen matrices are supportive of the extracellular matrix and helpful in protecting tissue collagen deposition

Didn't Heal



Protease Activity

- Antimicrobial collagen matrices have entered into the wound care market
- One example is a collagen coated with the antimicrobial polyhexamethylene biguanide (PHMB)
- PHMB is an extensively studied topical antimicrobial that is effective in binding to bacterial walls and causing disruption in biosynthesis

Didn't Heal



Biofilm

- **Identifying and managing biofilm**
 - ✦ recently become two of the most important aspects of wound care.
- **Over 90% of chronic wounds contain biofilm**
- **The US Centers for Disease Control and Prevention and the National Institutes of Health have estimated that between 65-80% of infections are caused from biofilms**

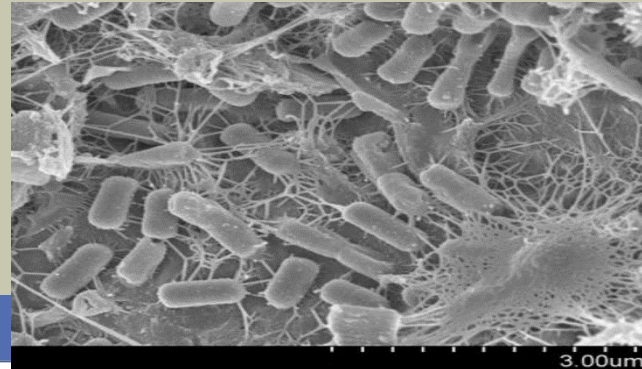
Didn't Heal



Biofilm

Generally it is believed that biofilms develop in stages.

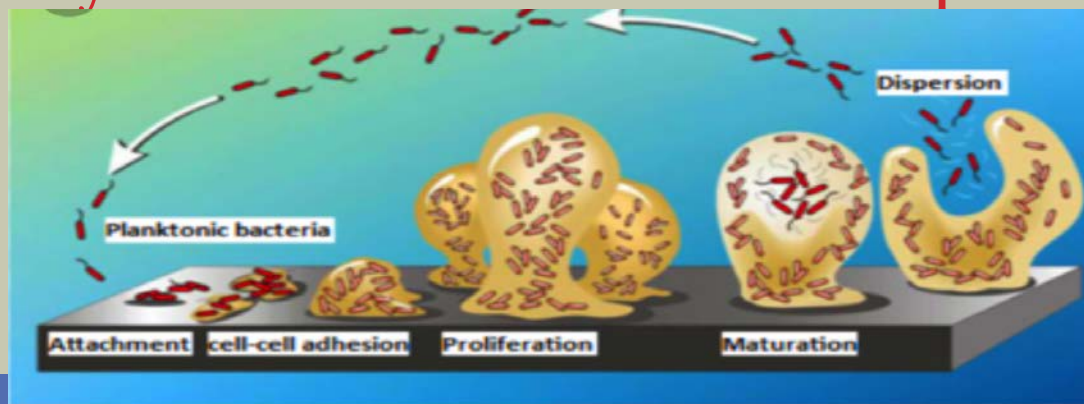
- The initial stage is composed of small communities of bacteria that begin to attach to the wound surface.
- These polymicrobial colonies com
 - ✦ composed of bacteria, fungi, as well as other microorganisms



Didn't Heal



- **Biofilm**
 - Are able to share information and gene-expression
 - ✦ mechanism called quorum sensing.
 - Biofilm colonies will begin to secrete a protective glycocalyx
 - ✦ also adheres to the wound surface.
 - This process typically occurs in two to four days.
 - This extra polymeric substance is difficult to penetrate with systemically administered antibiotics and topical therapies



Didn't Heal

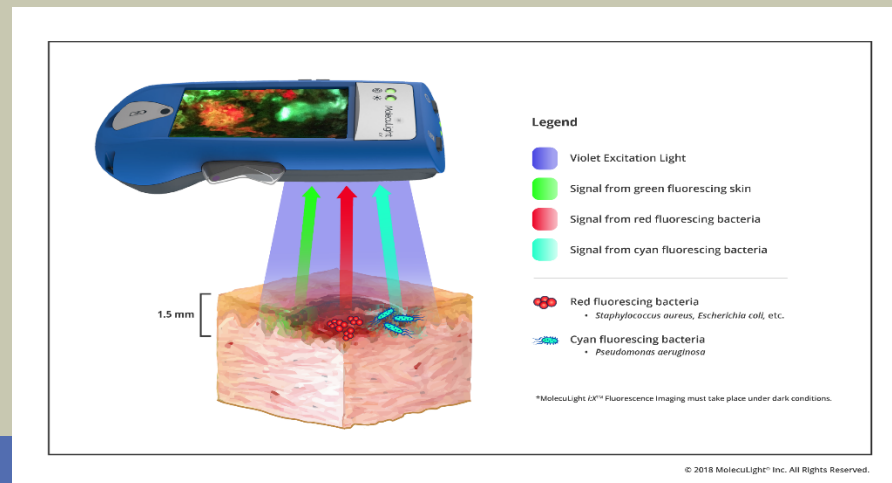


- **Emerging technologies to detect bacteria & treat biofilm**
 - Revolutionary research in the management and treatment of biofilms is ongoing.
 - Advanced therapies are entering into the market to help manage chronic wounds and address biofilm formation.
 - Monitor the most recent literature to ensure patients are receiving the most updated care available

Didn't Heal



- Emerging technologies to detect & treat biofilm
 - It is unlikely that biofilm can be seen with the naked eye since they are often less than 100 micron
 - A novel advancement in wound imaging using violet light may be able to detect the presence of bacteria and biofilm in chronic wounds



Didn't Heal

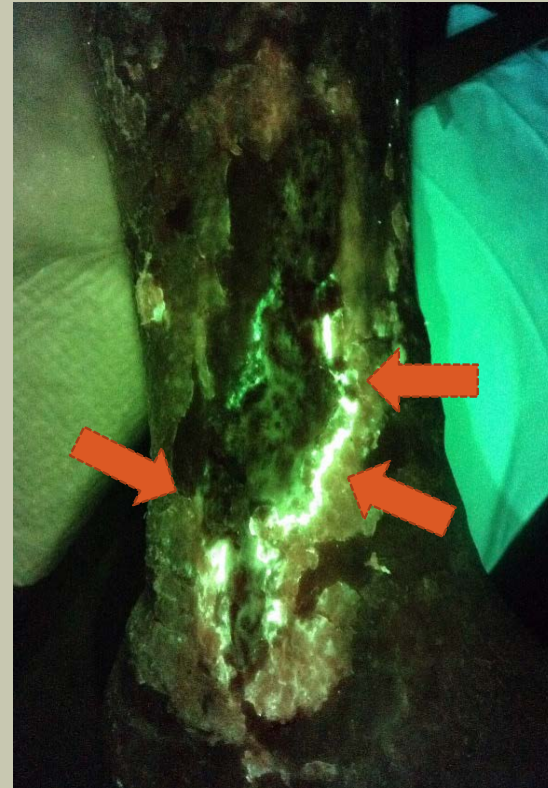


- **Emerging technologies to detect bacteria & treat biofilm**
 - **The camera instantly visualizes potentially harmful bacteria**
 - **The device emits a violet light (405 nm)**
 - ✦ **excites the wound tissues and bacteria**
 - **This results production of fluorescence signals**
 - ✦ **no need for additional contrast agents**
 - **The fluorescence signals (i.e. colors) produced are tissue specific**
 - **Collagen will fluoresce green, while clinically relevant bacteria producing metabolic by-products like porphyrins fluoresce red, and pyoverdine fluoresce cyan**

Didn't Heal



- Emerging technologies to detect bacteria & treat biofilm



“Didn’t Heal”



- **D=Drugs:** patients are on a variety of medications to treat their systemic conditions.
- Important to obtain a full medical history
 - including herbal supplements
- Steroids, anticoagulants, antiangiogenic drugs, antineoplastic drugs, colchicine, nicotine, vasoconstrictors and antimetabolites
 - impede proliferation of fibroblasts and collagen synthesis.
 - **Must weigh the risks/benefits of such medications.**
 -

“Didn’t Heal”



- **N=Nutrition:** Protein deficiencies are one of the most overlooked parameters in wound care.
 - Caloric needs during wound healing 30-35kcal/kg
 - Check patients albumin levels-marker of malnutrition
*should be 3.4-5.4g/dl.
 - Protein is essential for collagen synthesis, angiogenesis, fibroblast proliferation, and tissue remodeling
 - Recommend supplement
 - ✦ Juven or Ensure
 - Fluid intake is also important.
 - ✦ Fluids maintain skin turgor and promote tissue perfusion and oxygenation

“Didn’t Heal”



- **T=Tissue Viability: Must remove non-viable tissue from wounds to promote healing and decrease bioburden.**
 - A crucial component of wound care is debridement.
 - The goal is to remove of all necrotic, fibrous, and devitalized tissue from the wound.
 - Devitalized tissue in wounds produces a physical barrier to formation of new tissue
 - ✦ decreases healing rates.
 - Devitalized tissue makes bacterial colonization more likely.

Didn't Heal



- **Tissue Viability**

- **The presence of devitalized tissue increases concealed dead spaces and bacterial content**
- **Standard of care is that unhealthy tissue be sharply debrided to bleeding tissue to:**
 - ✦ (1) allow for visualization of the extent of the ulcer
 - ✦ (2) to detect underlying exposed structures, deep bacterial contamination or abscesses
 - ✦ (3) to assess the quality of the peri-wound tissue.

Didn't Heal



- **Tissue Viability**

- **Traditional methods of debridement:**

- ✦ **Surgical** – scalpel, curette, etc., performed in the OR or clinic
 - ✦ **Autolytic** – covers a wound with an occlusive dressing, intrinsic enzymes digest fibrosis, infection risk
 - ✦ **Enzymatic** – collagenase, slow to act
 - ✦ **Maggot** – green blow fly larvae, discriminate for necrosis and fibrosis
 - ✦ **Hydro-surgical** – high pressure water, indiscriminate, bleeding risk

Didn't Heal



- **Tissue Viability**

- **Low Frequency Ultrasonic Debridement**

- ✦ Uses low-frequency ultrasound energy to remove unwanted, necrotic tissue

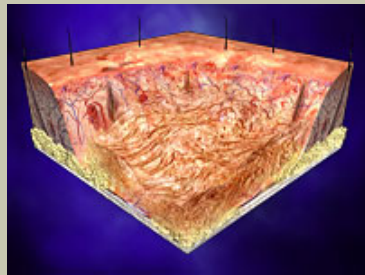
- **Microcavitation**

- ✦ Oscillations create vacuum bubbles
- ✦ Bubbles collapse and release mechanical energy
 - **Targets loose tissues, necrotic, slough and preserve the vital structures**

LFCU Mechanisms of Action



Preservation of Healthy Structures

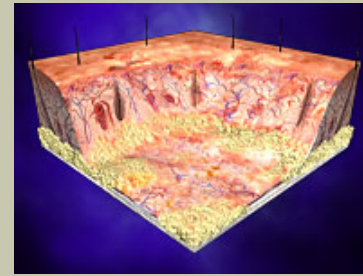


Sharp Debridement

Cutting is “Absolute”; Geometrically indiscriminate

More force, less control

May have excessive bleeding



Low Frequency Ultrasonic Debridement

Relies more on field effects;
Geometrically preservative

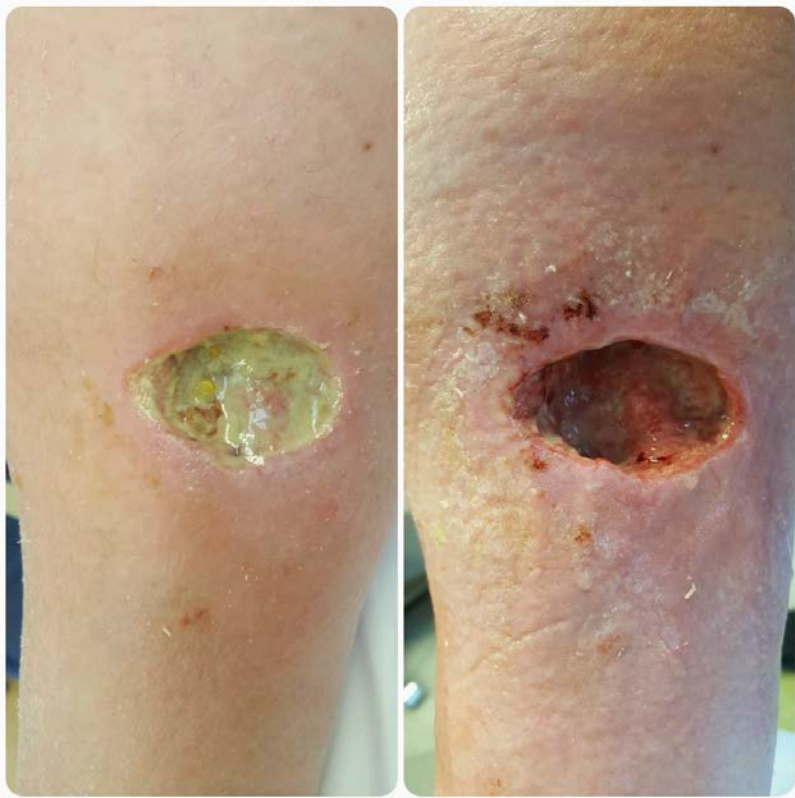
Ultrasound does the work: force low,
control high

Low bleeding, additional therapeutic
effects

Didn't Heal



Tissue Viability



“Didn’t Heal”

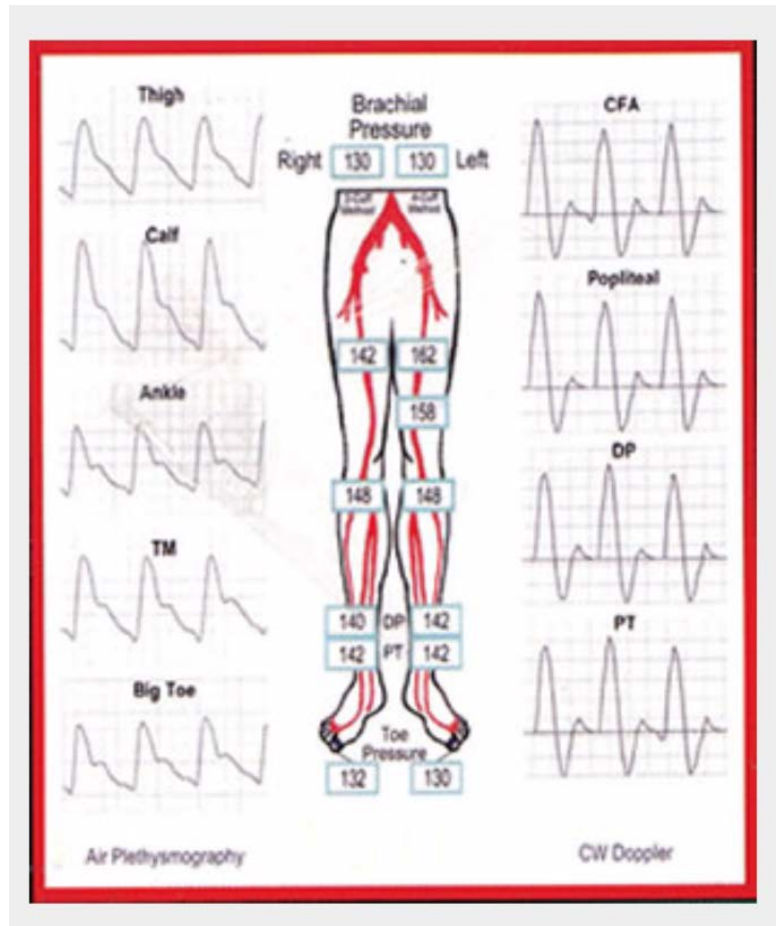


- **H=Hypoxia: Arterial insufficiency or vasoconstrictive disease must be addressed**
 - **Non-invasive vascular work up- ABIs, TBIs, segmental pressures, PVRs.**
 - **Vascular surgeon or interventional radiology consultation**
 - **Smoking cessation**
 - ✦ **each cigarette decreases leg circulation by 30% for one hour**

Assessing Hypoxia



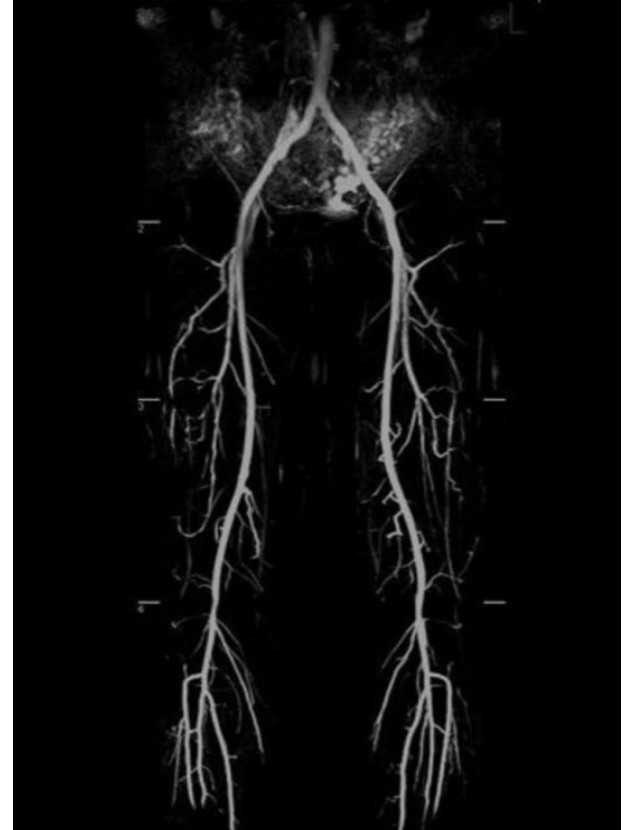
- Assessing tissue perfusion is critical to determine healing potential
- Standard non-invasive vascular tests such as ABIs, TBIs, Segmental Pressures, & TCOM can be limited by calcinosis, scarring, wounds, and infection



Assessing Hypoxia



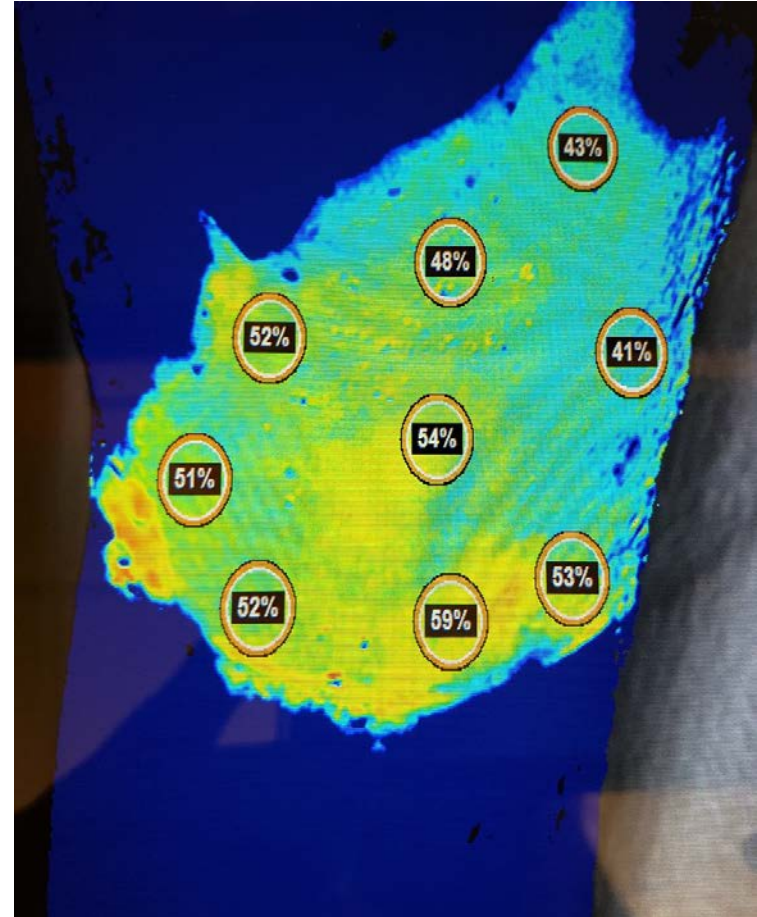
- Minimally invasive vascular studies such as CTAs and arteriograms need to be used cautiously in patients with renal failure
- Only show anatomic or **structural** flow
- Don't truly assess **functional** skin perfusion to our area of interest



Assessing Hypoxia



- Handheld devices are now available to determine oxygen saturation levels in the superficial skin
- One such device uses near infrared imaging to measure the amount of oxygenated hemoglobin in and around wounds
- Provides an estimate of functional perfusion



Near-Infrared Imaging



- NIR light is not absorbed by tissue
- NIR light is mainly absorbed by hemoglobin and water
- The wavelength of light absorbed by hemoglobin differs when it is carrying oxygen.
- NIR is very useful in detecting oxygenated and deoxygenated blood.
- This conveys a comprehensive picture of tissue health and healing capacity of wounds or grafts

Treating Hypoxia



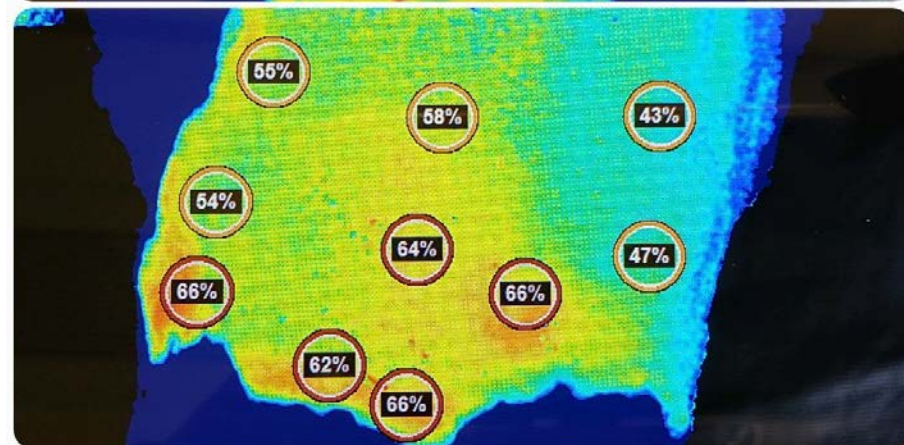
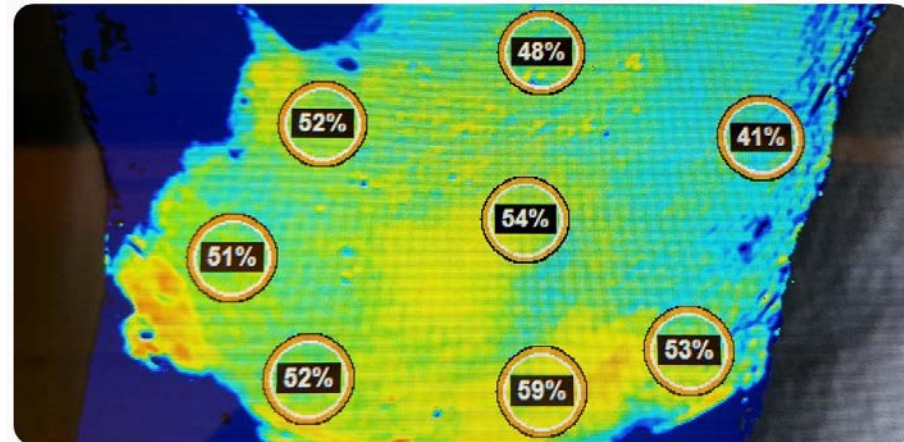
- **Pulsed Acoustic Cellular Expression (PACE)** uses high-energy acoustic pressure shock waves
- Produces compressive stresses on cells and tissue
- Restarts the biological activity of angiogenesis and tissue regeneration



Treating Hypoxia



- PACE treatments penetrate the microcirculation
- Causing vasodilation of existing vessels
- Angiogenic growth factors are released
- New capillary formation occurs
- Increased local perfusion



“Didn’t Heal”



- **E=Edema: Chronic venous hypertension & venous reflux are common causes of edema and chronic wounds.**
 - **Must be controlled with compression.**
 - **MLCT for treatment**
 - **Compression stockings for prevention**
 - **Compression is for life! The right stockings are the one the patient will wear. (Juxtalite, Juzo)**
 - **Compression pumps**

Edema



- **Chronic venous insufficiency (CVI) and Lymphedema are similar in presentation**
- **Both are conditions causing foot and leg swelling**
- **CVI is caused by dysfunctional veins in the legs and is more common in older individuals**
- **Lymphedema is caused by defective lymphatics and can appear at any age**

Edema



- **CVI increases the fluid in the tissues**
- **This can result in the inability for the lymphatic system to adequately drain**
- **The result is lymphedema in the affected areas**

Edema



- Improper functioning of the valves in the veins of the legs cause insufficient amounts of blood to be pumped back to the heart.
- It is neither uncommon or benign
- Major cause of skin disorders, edema and lower extremity ulcerations
- Usually gets worse over time

Edema



VARICOSE VEINS

CHRONIC VENOUS INSUFFICIENCY

Bulging Veins

Leg Swelling

Skin Color and
Texture Changes

Venous Ulcers



Photos by Rajabrata Sarkar, MD, PhD

Primary VS Secondary Lymphedema



- Primary lymphedema is a dysfunction of the lymphatic system and can occur at any age
- Secondary lymphedema is caused by damage to the lymphatic system such as trauma, cancer & surgery
- Primary lymphedema usually has foot involvement, secondary lymphedema often may not

Primary VS Secondary Edema



Lipedema



- Cause is unknown
- Suspect that hormones play a role
- Predominantly female
- Often begins in puberty and worsens with pregnancy and menopause
- Thought to be hereditary
- Unlike lymphedema, it targets the upper legs and thighs
- Usually affects both legs

Lipedema

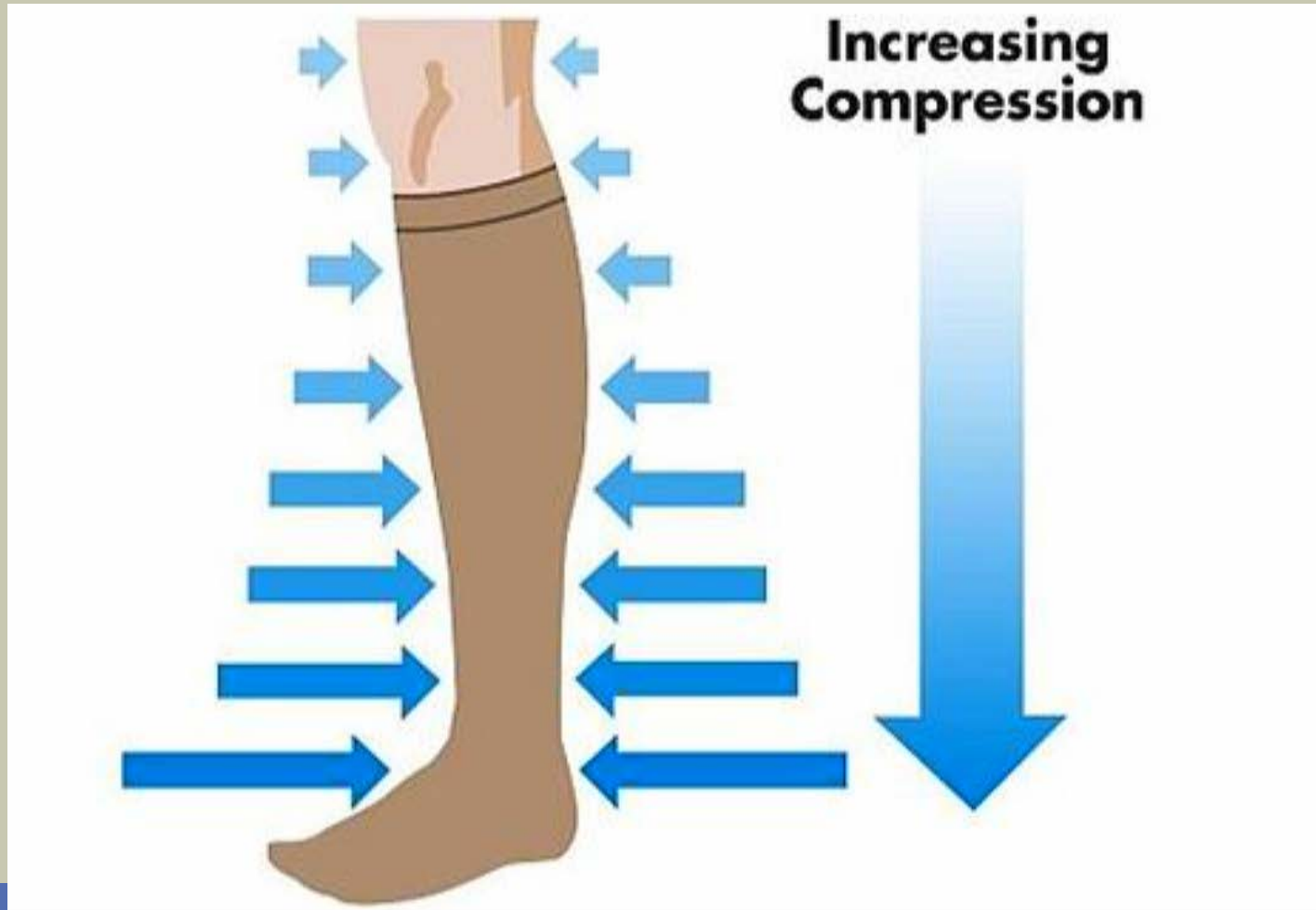


Venous Insufficiency



- **Most commonly hereditary**
- **Can be caused due to varicose veins or DVT**
- **May affect up to 40% of the population**
- **More common in woman**
- **Even with very successful treatment, recurrence is common**
- **Graduated compression is the cornerstone of modern treatment of PVD**

Graduated Compression



COMPRESSION

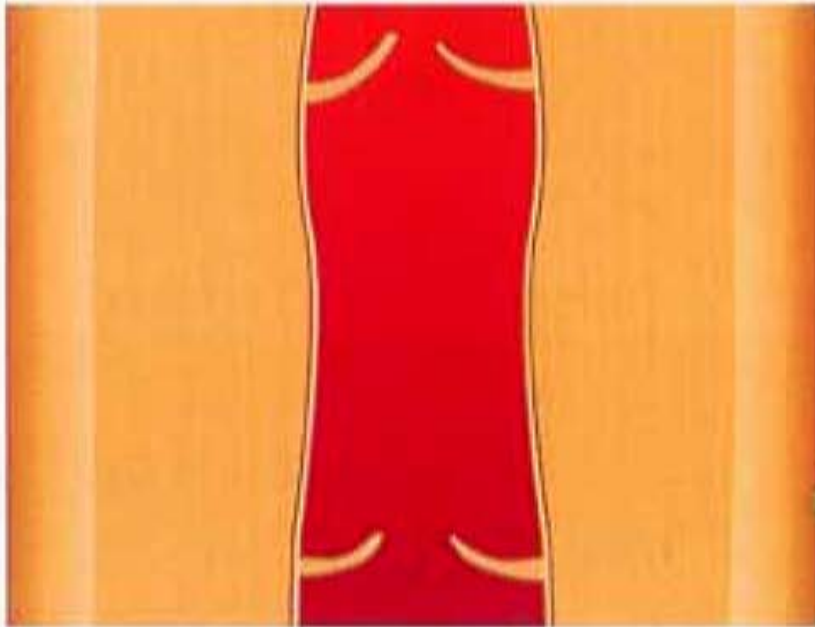


Compression therapy is one of the most ancient treatments employed by man; its role has been defined over the centuries by a wealth of experience and a large number of scientific studies.

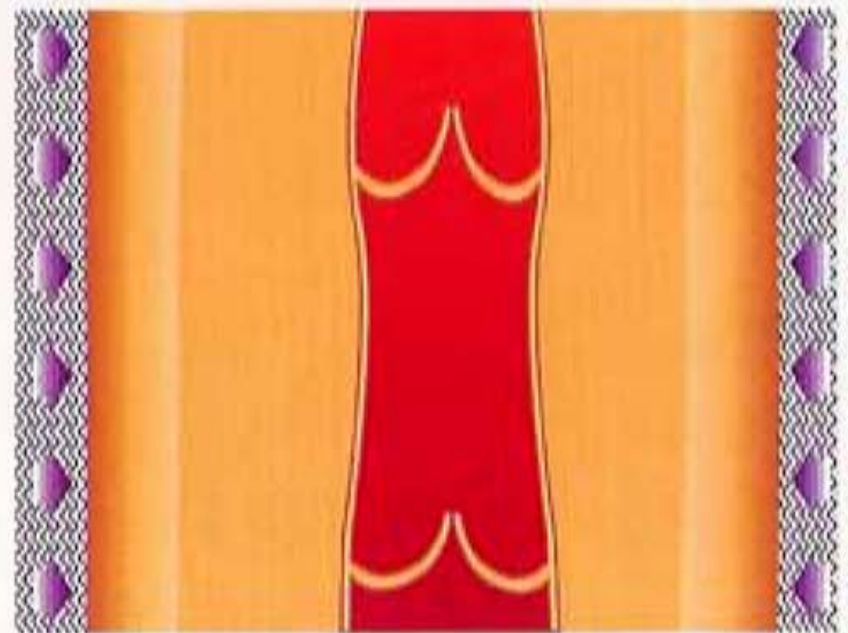
COMPRESSION



without compression stocking



with compression stocking



CAUTION

**Most professional wound care organizations
recommend
an ABI as an initial screening tool for PAD
in both diabetics and non-diabetics.**

**All patients receiving compression
therapy
must have an
Ankle–Brachial Index Test
ABIs $\geq 0.8-0.6$**

Compression Material



There are basically two different forms of compression therapy

- Non Elastic:** these bandages only have an effect during movement, when contraction and relaxation of the muscles cause volume changes of the extremities. (Unna's boot)
- Elastic:** these bandages adjust to the volume changes of the extremity, and by their elastic tension exert continuous pressure on the surface of the skin. (MLCT)

Types of Compression

Elastic Material (*long-stretch*)



Multicomponent Multilayer: (*short/long-stretch*)



Non Elastic Material: (*short-stretch*)



Effects on Microcirculation



Edema triggers alterations in the endothelium which starts a complex process.

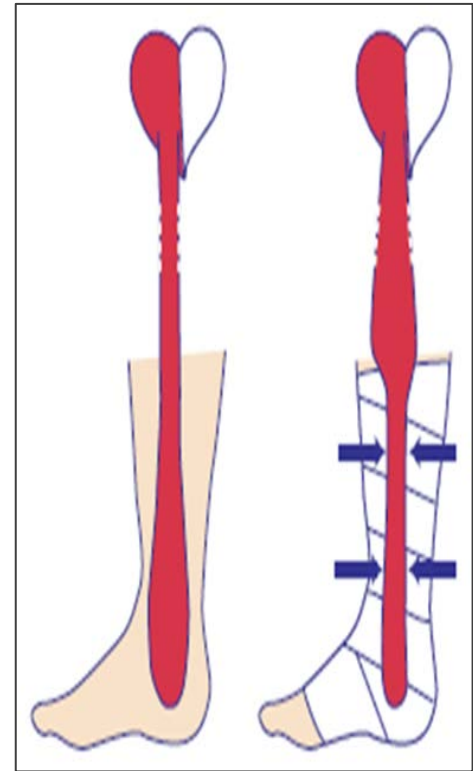
- Neutrophils become activated and adhere to capillary walls creating a reperfusion injury
- Adhesion molecules release cytokines, oxygen free radicals, and proteolytic enzymes
- Hypoxia increases, driving the tissue deeper into the inflammatory cycle and creating more MMPs
- Dermal tissue fibrosis occurs and results in reduced skin perfusion and ulceration

Contraindications



Congestive Heart Failure

Patients with decompensated heart failure may receive compression therapy with caution because compression therapy redistributes blood towards the center of the body, thereby increasing the pre-load of the heart and possibly causing further overload and or even death.



MOORE
7/13



“I’m wrapping it tightly to keep the ankle from swelling.”

Possible Risks



- **Pregnancy: compression may influence maternal and fetal heart rates.**
- **Infection: in the acute phase of severe skin infections (edema increases the risk of infection).**
- **Allergies: to textile materials, particularly latex.**
- **Major Neuropathy: loss of autonomic venous tone and the absence of skin sensation increases the risk of pressure damage.**

Compression Selection



The evidence reviewed suggests...

- **Active and Mobile Patients:** can safely and effectively use inelastic or elastic/multilayer compression bandages. *New research suggests that inelastic may be more effective.*
- **Immobile and or Patients with Fixed Ankle Joint:** should use elastic/multilayer compression bandages only.
- **Patients with Mixed Venous and Arterial Disease:** should use inelastic compression with caution.

Davis J, Gray M: Is the Unna's boot bandage as effective as a four-layer wrap for managing venous leg ulcers? J WOCN 2005; 32 (3): 152-156.

Franks P, et al. Randomized trial of cohesive short-stretch versus four-layer bandaging in the management of venous ulceration. WRR 2004; 12: 157-162.

“Didn’t heal”



- **A=Another wound: Competition for the nutrients and substrates required for healing will delay wound progression.**
 - **Check both extremities at each appointment**

“Didn’t Heal”



- **L=Loads:** Increased pressure, friction, or shear forces will decrease wound healing.
 - Total contact casts (TCC), off-loading shoes, removable cast boots
 - Diabetic shoes/insoles, CROW walkers
 - Become friendly with a Pedorthist in your area

Didn't Heal



- **Loads**

- **Diabetic foot ulcers can be directly attributed to the debilitating triad of:**

***peripheral neuropathy**

***vascular compromise**

***increased plantar foot pressures**

Didn't Heal



- **Loads**

- Relief of pressure from the area of the wound is an important issue that should be addressed
- Plantar foot ulcers result as a consequence of abnormal foot pressures and repetitive stress
- Some type of pressure relieving footwear, removable walking boot, or total contact cast to off-load pressure from the foot should be employed

Many Options



Total Contact Cast (TCC) vs. Removable Cast Walker RCW



- Removable cast walkers(RCW) have several advantages:
 - allows access to wounds for bandage changes
 - ability to remove to sleep and shower.
- Potential RCW downfall due to lack of forced compliance seen with TCCs
- Although studies show similar plantar pressure reduction in both groups, patients had faster healing rates with TCCs

TCC

Indications/Contraindications

Indications:

Patient must be non-infected

Adequate blood supply to heal (ABI \geq 0.7)

Wounds that probe to tendon, capsule, or bone, or with abscesses

Contra-indications:

Acute infection

Severe ischemia

Wagner grade 3 and 4

Non-compliance with visits

Allergy to casting material

Didn't Heal



- **Loads**

- **How TCCs work**



Didn't Heal



✦ Loads

- TCC is the ideal method of off-loading for most patients
- It is supported by the highest level of evidence
- Pressure and stress reduction are imperative in healing plantar foot wounds in people with neuropathy
- TCC is considered the gold standard for off-loading

Off-loading Consensus Article

ORIGINAL ARTICLES

The Management of Diabetic Foot Ulcers Through Optimal Off-Loading

Building Consensus Guidelines and Practical Recommendations to Improve Outcomes

Robert J. Snyder, DPM, MSc*
Robert G. Frykberg, DPM, MPH†‡
Lee C. Rogers, DPM§
Andrew J. Applewhite, MD||
Desmond Bell, DPM¶#**
Gregory Bohn, MD††
Caroline E. Fife, MD‡‡§§
Jeffrey Jensen, DPM*
James Wilcox, RN||||

Background: We sought to develop a consensus statement for the use of off-loading in the management of diabetic foot ulcers (DFUs).

Methods: A literature search of PubMed for evidence regarding off-loading of DFUs was initially conducted, followed by a meeting of authors on March 15, 2013, in Philadelphia, Pennsylvania, to draft consensus statements and recommendations using the GRADE (Grading of Recommendations Assessment, Development, and Evaluation) approach to assess quality of evidence and develop strength of recommendations for each consensus statement.

Results: Evidence is clear that adequate off-loading increases the likelihood of DFU healing and that increased clinician use of effective off-loading is necessary. Recommendations are included to guide clinicians on the optimal use of off-loading based on an initial comprehensive patient/wound assessment and the necessity to improve patient adherence with off-loading devices.

Conclusions: The likelihood of DFU healing is increased with off-loading adherence, and, current evidence favors the use of nonremovable casts or fixed ankle walking braces as optimum off-loading modalities. There currently exists a gap between what the evidence supports regarding the efficacy of DFU off-loading and what is performed in clinical practice despite expert consensus on the standard of care. (J Am Podiatr Med Assoc 104(6): 555-567, 2014)

- Total Contact Casting (TCC) is the preferred method for offloading plantar foot ulcers
- TCC has most consistently demonstrated the best healing outcomes
- TCC is a cost-effective treatment
- The likelihood of ulcer healing is increased with offloading adherence
- Advanced therapeutics are unlikely to succeed in improving wound healing outcomes unless effective offloading is obtained

Any Questions?



Contact Info



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