Optimal Management of Diabetic Foot Ulcers

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OPTIMAL MANAGEMENT OF DIABETIC ULCERS OF THE LOWER EXTREMITY

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NO FINANCIAL CONFLICT OF INTEREST TO DISCLOSE

2021 CDC NATIONAL DIABETES STATISTICS REPORT

- 38.1 Million adults 18 years or older in U.S. have diabetes
- 14.7% of adults 18 years or older in U.S. population have diabetes
- 8th Leading cause of death in U.S.

2021 CDC NATIONAL DIABETES STATISTICS REPORT

- 60%-70% diabetics have nervous system damage
- Severe nervous system damage increases chance of ulceration
- > 60% non-traumatic lower limb amputations occur in people with diabetes

INTERNATIONAL DIABETES FEDERATION GLOBAL POSITION STATEMENT

- Global prevalence 537 million adults in 2021
- Predicted to reach 783 million by 2045
- $966 billion USD spent yearly globally to treat diabetes
- 1 in every 6 people with diabetes will develop foot ulcer
- 85% diabetes related amputations are preceded by foot ulcers
- 49% - 85% of amputations are preventable
- Requires well-organized diabetic multidisciplinary team

So, just how do you evaluate and treat a diabetic ulcer of the lower extremity?

Just like you do any other lower extremity ulcer!

SYSTEMIC FACTORS AFFECTING WOUND HEALING

- Diabetes
- Tobacco use
- Malnutrition
- Hereditary disorder
- Alcohol use
- Malignancy
- Renal failure
- Autoimmune
- Chemotherapy
- Steroids
- Extremes of age
- Systemic infection

LOCAL FACTORS AFFECTING WOUND HEALING

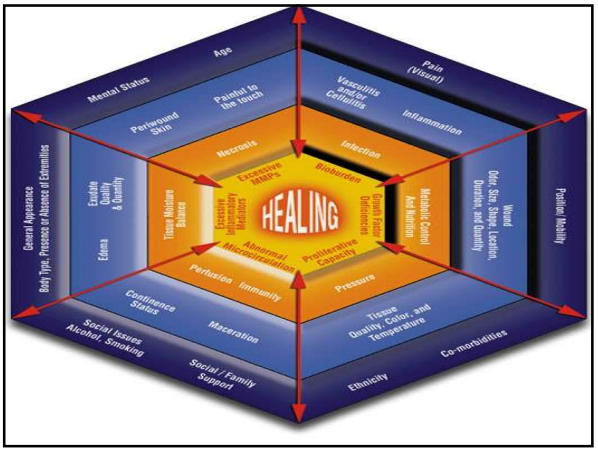
- Ischemia
- Edema
- Infection
- Scarring
- Radiation injury
- Topical steroids
- Local toxins
- Trauma/Pressure
- Foreign bodies
- Local malignancy

Why Diabetics Don't Heal

- High levels of matrixmetalloproteinases (MMP-9)
- Low levels of growth factors (Cullen et. al: Wound Rep Reg 10: 2002)
- If hypoxic:
  1. Poor collagen production
  2. Impaired resistance & response to local infection
  3. Limited angiogenesis
  4. Decreased fibroblast replication

CHRONIC WOUNDS HAVE:

- Inhibitors or blockers of growth factor action
- Inadequate quantities of growth factors
- Primary inadequate response to available growth factors
- Have 30 X more MMP activity than acute wounds



DIAGNOSIS OF DELAYED WOUND HEALING

Evaluation of:

1. Vascular status
2. Infection (local or systemic)
3. Immune system
4. Nutritional status
5. Mechanical factors
6. Malignancy (exclude)

VASCULAR EVALUATION History

- Diabetes
- DVT
- Tobacco use
- Radiation
- Local toxins (Spider bite)
- Collagen vascular disease
- Scarring
- Claudication
- Rest Pain

VASCULAR EVALUATION Examination

- Pulses (palpable/audible)
- Skin color (dependent rubor/hyperpigmentation)
- Rate of capillary refill (< 3 sec)
- Edema (even trace amounts)
- Hair (minor finding)

VASCULAR EVALUATION Diagnostic Testing

- CBC (anemia)
- TCOM
- Arterial doppler
- Venous doppler
- Tissue biopsy
- Collagen vascular Screening
- Arteriogram
- MRA
- MRV
- CTA
- CTV

NUTRITIONAL EVALUATION

- Physical examination
- Total protein
- Albumin
- PreAlbumin
- CBC (anemia)
- Glucose (blood sugar, HgbA1C 6.5% or <)

EVALUATION OF MECHANICAL FACTORS

- Pressure
- Foreign body
- Edema

EVALUATION OF MECHANICAL FACTORS
Pressure Due To Immobilization

- CVA
- Paralysis (spinal)
- Closed head injury
- Trauma with loss of consciousness
- Surgery
- Traction

EVALUATION OF MECHANICAL FACTORS
Pressure Due To Orthotics

- Shoes
- Stockings
- Braces
- Prosthesis

EVALUATION OF MECHANICAL FACTORS
Pressure Due To Dressings

- Cast
- Splint
- Circumferential dressings
- Dressing packing

EVALUATION OF MECHANICAL FACTORS
Foreign Body

Intentional
- ORIF
- Joint implant
- IV Access
- Mesh
- Synthetic grafts

Incidental
- Retained suture
- Bone (sequestrum)
- Needle
- Retained dressing Material
- Retained fingernail or toenail fragment

EVALUATION OF MECHANICAL FACTORS
Edema

- Trauma
- CHF
- Renal failure
- Lymphedema (congenital acquired)
- Tumor
- Surgery

IMMUNE SYSTEM EVALUATION

- Collagen vascular disease
- Drugs
  - Steroids
  - Chemotherapy
- HIV
- Systemic malignancy

EVALUATION FOR MALIGNANCY

- "Think of It"
  - Primary malignancy
  - Secondary malignancy
- Biopsy
  - Incisional
  - Excisional
- Location
  - Especially lower leg or arm
  - History of "almost healing"

EVALUATION FOR INFECTION

- Soft Tissue "bioburden"
  - Swab culture
  - Wound biopsy (gold standard)
  - (> 100,000 Organisms per gram of tissue)
- Bone infection
  - Clinical inspection
  - Bone biopsy
  - Plain X-Ray
  - CT scan
  - MRI scan
  - Labeled WBC scan

TREATMENT OF DELAYED WOUND HEALING

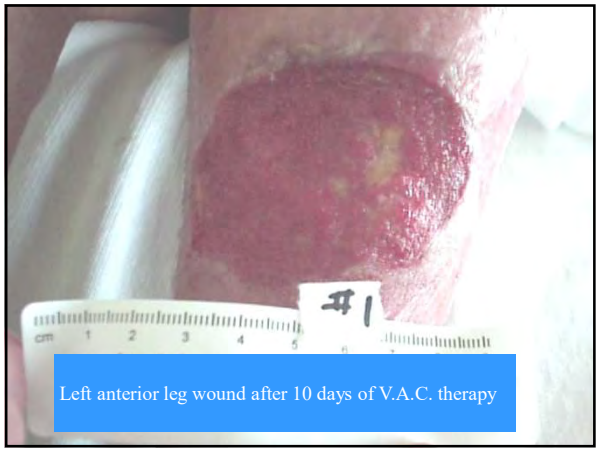
- Surgery
  - Debridement
  - Revascularization
  - Skin graft
  - Flap
  - Amputation
- Edema reduction
- Hyperbaric oxygen therapy
- Pressure relief
- Nutritional supplements
- Removal of foreign bodies
- Resolution of infection
- Excise malignancy
- Medical adjunctive care
- Local care of wound
  - Topical care
  - Dressing care

(SURGERY) SKIN GRAFTS AND FLAPS

- Split thickness skin graft
  - Requires a uniform, granulating, infection Free bed
- Skin and Skin/Muscle flaps
  - To cover non-vascularized wounds (bare bone)
  - To cover pressure areas (sacral, ischial, trochanteric pressure ulcers)
  - To cover exposed, non-infected, foreign body (prosthesis)

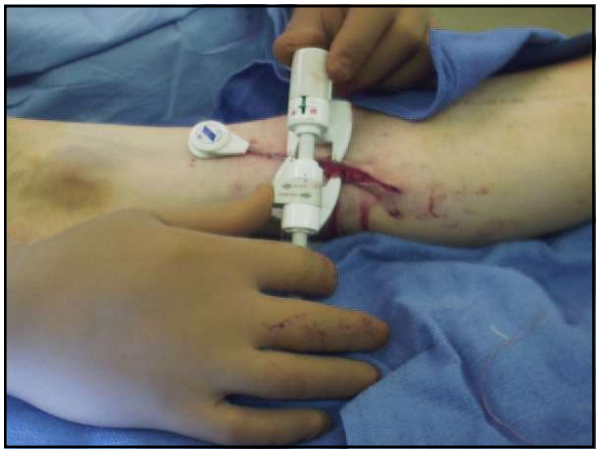
(SURGERY) SKIN GRAFTS AND FLAPS

- Skin stretching device
- Epidermal autograft (CelluTome®)
  - Donor site less painful than STSG
  - Donor site heals in 3-4 days and care be reharvested
  - Good for patients with large wounds
  - Requires no anesthesia
  - Epidermal grafts take on characteristics of recipient site
  - Can be used on patients with scleroderma or pyoderma gangrenosum



Left anterior leg wound after 10 days of V.A.C. therapy


Left anterior leg wound 6 days post-op split thickness skin graft



EFFECTS OF EDEMA

- CIRCULATION
  - Arterial and venous
- MECHANICAL
  - Distracts wound edges
- NUTRITION
  - Protein loss in excessive swelling/ drainage

EDEMA REDUCTION

- Compression
  - Multi-layer compression wraps
  - Unna's boot
  - Compression stockings
  - Sequential pressure devices
  - Ace wrap/short stretch ace
- Elevation (as tolerated)
- Negative pressure wound therapy
- Diuretics

COMPRESSION

- Must be appropriate to arterial circulatory status
- ABI of <0.7 or TCOM of lower extremity <40 mmHg calls for modification of compression strength

COMPRESSION

All patients/caregivers must be instructed on the signs/symptoms of vascular (arterial) compression/compromise and its immediate treatment

Hyperbaric oxygen is not a primary treatment for chronic diabetic ulcers of the lower extremity:

IT IS ADJUNCTIVE THERAPY

CMS CRITERIA

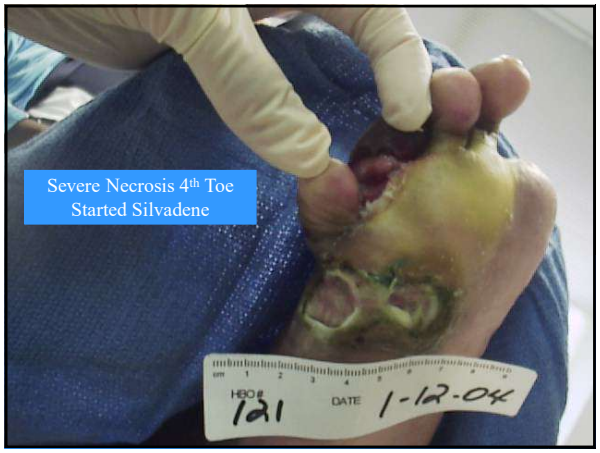
- Diabetic Ulcer
  - Type I or II diabetes
  - Lower extremity ulcer as a result of diabetes
  - Wagner grade 3 or greater
  - 30 days of failed standard wound care

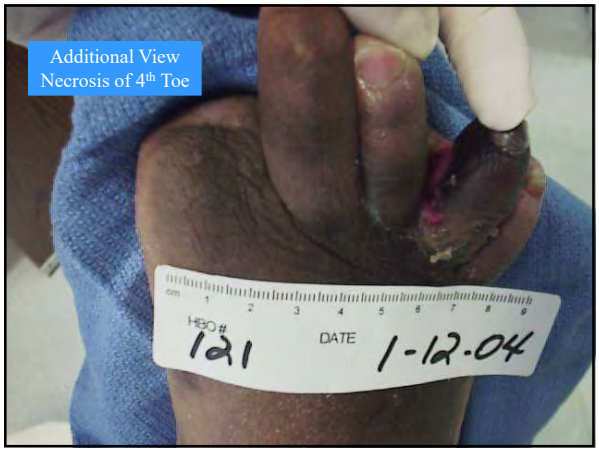
EVALUATION AND TREATMENT MUST ALSO INCLUDE:

1. Appropriate debridement
2. Offloading/pressure relief
3. Optimizing nutritional status
4. Optimizing vascular status
5. Appropriate antibiotics
6. Wound dressings to maintain a moist granulating bed

Patient #121

- 45 year old black male
- Adult onset diabetes mellitus
- History of left BKA
- 10/4/99 Right femoral-distal peroneal bypass with insitu saphenous vein
- 9/23/03 presented to wound center with two diabetic, neuropathic Wagner III ulcers to right foot
- No osteomyelitis
- Previous bypass left no revascularization options
- Began HBO for a total of 40 treatments





PRESSURE RELIEF

- Beds
  - Water beds
  - Egg crate topper
  - Reactive surface beds (low air loss)
  - Clinitron
- Cushions (Foam, Felt)
- Crutches
- Rolling walker
- Turning/Repositioning
- Orthotics
  - Shoes
  - Total contact cast (Gold standard)
  - Active offloading walker
  - Specialty splints

NUTRITION

Probably the most neglected parameter in wound healing, especially in nursing home patients.

NUTRITION TREATMENT

- Maximize glucose control in diabetics:
  - Medication
  - Diet
- Vitamins/Minerals
- Anabolic steroids
- Maximize protein in diet (especially L-Arginine)

L-ARGININE

- Main substrate nitric oxide pathway
- Precursor to endothelial-derived nitric oxide
- Nitric Oxide:
  - Vasodilator (helps pain from PVD)
  - Non-specific immunity
  - Supports collagen production
  - Enhance wound tensile strength

ARGINADE – 4.5 g L-ARGININE

JUVEN – 7.0 g L-ARGININE
1.5 g HMB
(B-HYDROXY – B METHYLBUTYRATE)
7.0 g GLUTAMINE

REMOVAL OF FOREIGN BODY ASSOCIATED WITH WOUNDS

Unintentional Foreign Bodies

- Sewing needles
- Pebbles
- Bullets
- Thorns
- Retained dressings (packing, foam sponges)
- Gouty tophi

REMOVAL OF FOREIGN BODY ASSOCIATED WITH WOUNDS

Intentional Foreign Bodies

- ORIF orthopedic devices (exposed)
- Prosthetic devices
- Retained, non-absorbable suture (infected)

TREATMENT OF INFECTION

- Debride non-viable tissue
  - Soft tissue/Bone
    Excisional
    Enzymatic
    Curettage
    Amputation
- Antibiotics (culture guided)
  (6 weeks for osteomyelitis)
- Topical antibiotics

TREATMENT OF MALIGNANCY

- Surgical excision (with skin margins clear)
- Moh's chemosurgery
- Radiation therapy
- Topical chemotherapy (5-FU)

MEDICAL ADJUNCTIVE CARE

- Anticoagulation
- RBC wall deformation
- Control gout (foreign body)
- Maximize control Of CHF & HTN
  - Circulation
- Maximize control of diabetes
- Maximize control of autoimmune and/or collagen vascular diseases

GUIDING PRINCIPLES FOR LOCAL WOUND CARE

- Many wounds will improve if **anything** is done regularly
- Choice of topicals (and treatment) must be driven by **diagnosis** and not by what product is on the shelf

GUIDING PRINCIPLES, CONTINUED

- Topical agents will **NOT** defeat:
  1. Failure to relieve pressure
  2. Inadequate Circulation
  3. Malnutrition
  4. Unrelieved edema
- Cost **IS** a factor

LOCAL WOUND CARE

- Topical Antibiotics/Antibacterials
- Debriding agents
- Stimulating agents
- Enzyme (MMP) inactivators (Protease modulating dressings)

(LOCAL CARE) TOPICAL ANTIBIOTICS/ANTIMICROBIALS

- Antibiotic ointments/Gels (Mupirocin, Bacitracin, Neomycin)
- Sodium hypochlorite (Anasept, Vashe)
- Silver compounds
- Iodine compounds

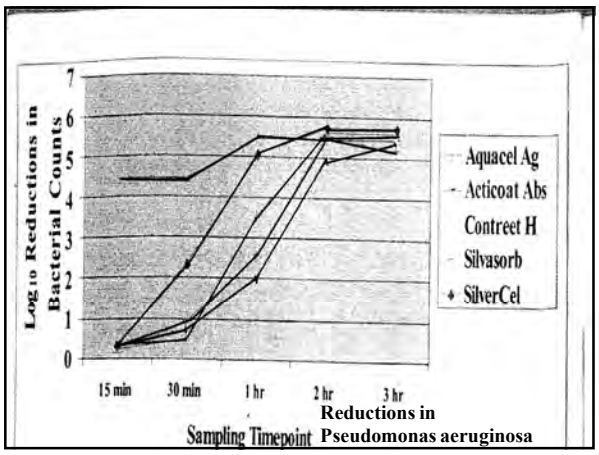
SILVER

- EXISTS IN TWO FORMS:
  1. Elemental or metallic Ag(0)
  2. Ionic silver/Silver cation Ag(I) or Ag+

SILVER

- The biologically active form of silver is the ionic (silver cation)
- **ALL** silver products have to produce the **same** biologically active ingredient to be effective: **Ag+**

If there is any difference in the various silver products it has to be in the dressing, **not** the active agent

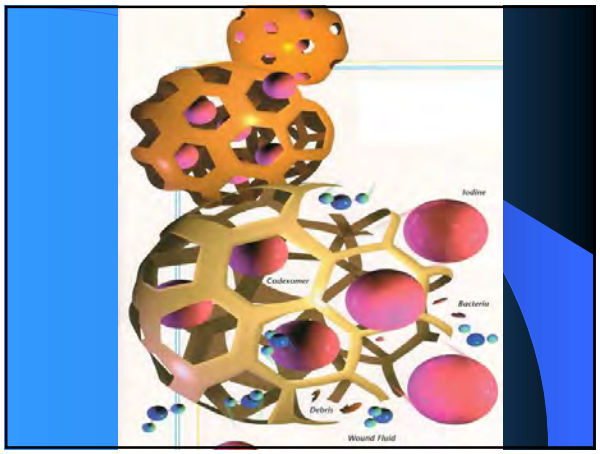


TOPICAL IODINE IS AVAILABLE IN TWO FORMS:

- **Povidone iodine (10%)**
- **Cadexomer iodine**

CADEXOMER IODINE

- **3 dimensional starch lattice formed into spherical microbeads**
  (0.9% Iodine in starch lattice)

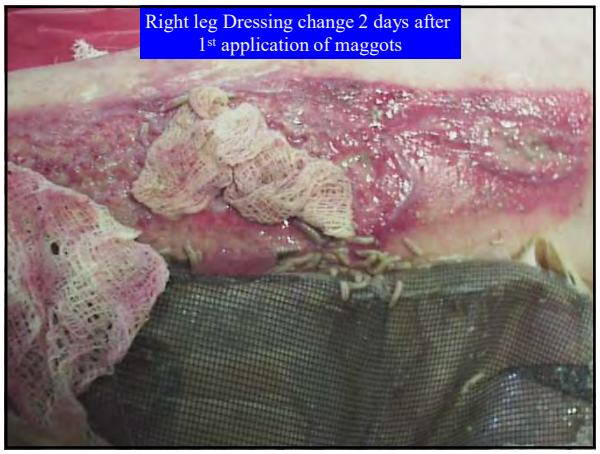


THE LATTICE:

- Has a high absorption capacity
- Absorption increases the size of the lattice, releasing the iodine at 1 part per million, until the reservoir is exhausted

(LOCAL CARE) DEBRIDING AGENTS

- Collagenase/Santyl
- Maggots
- Medical grade honey ?
- Sharp debridement (remains the quickest & most effective means)



(LOCAL CARE)
STIMULATORY AGENTS

- Balsam Of Peru (Vasolex)
- Growth factors
  - Platelet derived (Regranex, black box warning >3 tubes)
  - Cultured human neonatal skin (Apligraf & Dermagraft)
  - Allograft (Theraskin, Graft Jacket, Epifix)
  - Porcine xenograft (Oasis Matrix)
  - Bovine xenograft (Primatrix)

(LOCAL CARE)
ENZYME INACTIVATORS
(PROTEASE MODULATING DRESSING)

MMPs:

- Play a key role in wound healing
- Protein degrading enzymes that require calcium for conformation and zinc to be active
- Degrade growth factors, matrix protein, & protease inhibitors
- 24 Identified

INDICATIONS FOR PROTEASE MODULATING DRESSING

- To protect endogenous GF
- To prepare wound bed for application of exogenous GF
- To protect previously applied GF (Apligraf, Dermagraft, Regranex)

PROMOGRAN

- Protease Modulating Matrix
- Bovine Collagen
- Oxidized Regenerated Cellulose
- Can bind growth factors but they remain biologically active as the Promogran is resorbed

QUESTIONS?

References:

1. Wound, Ostomy, and Continence Nurses Society. (2021). **Guideline for Management of Wound in Patients with Lower-Extremity Wounds Due to Diabetes Mellitus and/or Neuropathic Disease**. Mount Laurel, NJ: WOCN
2. Wound Healing Society Education Committee (2011). **Evidenced-Based Approach to Lower-Extremity Ulcers: Basics of Wound Care 2011.** Wound Healing Society.
3. Shankaran, M. et al. **Advanced Therapies for Chronic Wounds: NPWT, Engineered Skin, Growth Factors, Extracellular Martices**. Dermatology Therapy, 2013; 26:215-221.
4. Ravanti, L. and Kähäri, V. (2000). **Matrix Metalloproteinases in Wound Repair (Review).** International Journal of Molecular Medicine. 2000;6:391-407.

References:

5. Richmond, A. et al. (2013). **Evidence-Based Management of Common Chronic Lower Extremity Ulcers.** Dermatologic Therapy, Vol. 26, 2013, 187-196.
6. Steed, D.L., et al. (2006). **Guidelines for the Treatment of Diabetic Ulcers.** Wound Repair & Regeneration, 2006;14:680-692.
7. Alavi, A. et al. **Diabetic Foot Ulcers: Part II. Management**. Journal Am Acad Dermatology, 2014; 70(1):21.e1-21.e24.
8. Kim, P.J. et al. (2012). **Wound Care: Biofilm and Its Impact on the Latest Treatment Modalities for Ulcerations of the Diabetic Foot.** Seminars in Vascular Surgery, 2012;25:70-74.
9. Centers for Disease Control and Prevention. (2020). **National Diabetes Statistics Report: Estimates of Diabetes and its Burden in the United States, 2020.** Atlanta, GA: U.S. Department of Health and Human Services; 2020.

References:

10. Boykin, J.V.,Jr and Baylis, C. (2006). **Homocysteine-A Stealth Mediator of Impaired Wound Healing: A Preliminary Study.** Wounds. 2006;18(4): 101-116.
11. Hayden, M.R. and Tyagi, S. (2004). **Homocysteine and Reactive Oxygen Species in Metabolic Syndrome Type 2 Diabetes Mellitus, and Atherosclerosis: The Pleiotropic Effects of Folate Supplementation.** Nutrition Journal. 2004, 3:4
12. Jude, E.B. et al. (2002). **The Role of Matrix Metalloproteinases in Wound Healing.** Journal of American Podiatric Medical Association. 2002;92(1):12-18.

References:

13. Cullen, B., et al. **An in vitro evaluation of advanced wound dressings and the chronic wound environment**. Wound Rep Reg 2002;10: 16- 25.
14. Diabetes Metab Res Rev 2016; 32(Suppl. 1): 154–168. DOI: 10.1002/dmrr
15. Diabetes Metab Res Rev 2016; 32(Suppl. 1): 75–83. DOI: 10.1002/dmrr.2700
16. International Diabetes Federation. (2020). https://www.idf.org