

Optimal Management of Diabetic Foot Ulcers

**Valerie Palmer, RN, ACHRN, CWCN,
CWS, CMBS, FACCWS**

OPTIMAL MANAGEMENT OF DIABETIC ULCERS OF THE LOWER EXTREMITY



Valerie Palmer, RN, ACHRN, CWCN, CWS, CMBS, FCCWS, UHMSADS
Director of Operations and Compliance
National Baromedical Services, Inc.

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 matrix metalloproteinases (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

- | <u>Intentional</u> | <u>Incidental</u> |
|--------------------|---|
| • ORIF | • Retained suture |
| • Joint implant | • Bone (sequestrum) |
| • IV Access | • Needle |
| • Mesh | • Retained dressing Material |
| • Synthetic grafts | • 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

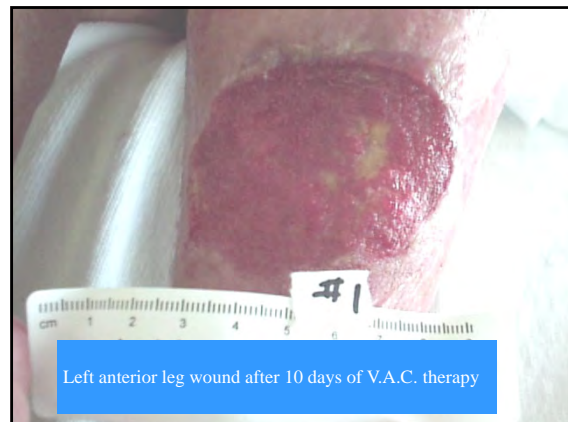
- | | |
|-----------------------------|-----------------------------|
| ● Surgery | ● Pressure relief |
| - Debridement | ● Nutritional supplements |
| - Revascularization | ● Removal of foreign bodies |
| - Skin graft | ● Resolution of infection |
| - Flap | ● Excise malignancy |
| - Amputation | ●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





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 foot wounds:

IT IS ADJUNCTIVE THERAPY

CMS CRITERIA

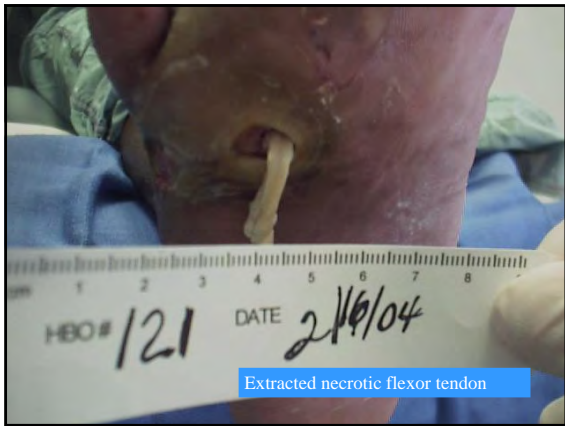
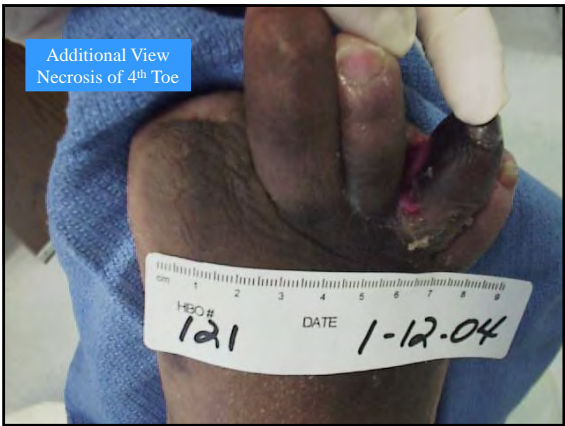
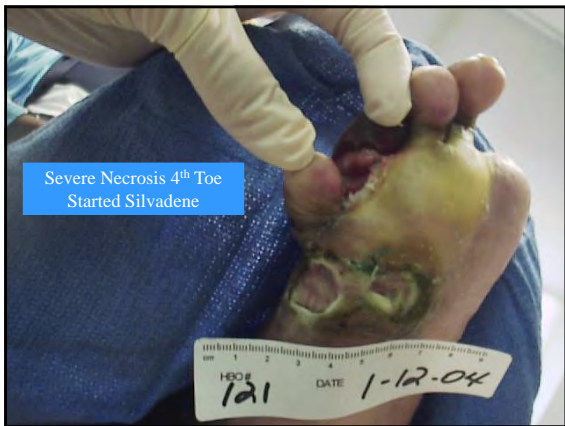
- Diabetic Ulcer
 - Type I or II diabetes
 - Lower extremity ulcer as a result of diabetes
 - Wagner grade 3 or greater
 - 30 days of failed standard wound care

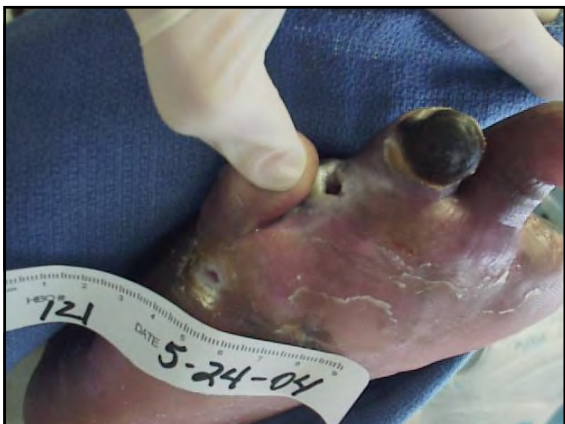
EVALUATION AND TREATMENT MUST ALSO INCLUDE:

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

Nestlé HealthScience
SAME FORMULA NEW LOOK
arginaid
Arginine Powder
Orange
Natural & Artificial Flavor

NUTRITION INFORMATION PER 1 packet (9.2g)

NUTRIENT COMPOSITION	AMOUNT
CALORIES	30 kcal
SODIUM	30 mg
TOTAL CARBOHYDRATE	5 g
VITAMIN C	106 mg
VITAMIN E	48.8 mg
L-ARGININE	4.5 g
TOTAL NITROGEN	3.4 g

INGREDIENTS: L-ARGININE, CITRIC ACID, MALIC ACID, SODIUM ASCORBATE, MALODORANT, AND LESS THAN 2% OF MALTODEXTRIN, FOOD STARCH, D,L-ALPHA-TOCOPHERYL ACETATE, ASPARTAME, ACESULFAME POTASSIUM, NATURAL AND ARTIFICIAL FLAVOR, COLORED SWEETENER, TARTARIC ACID, INWANTO EXTRACTS.
PHARMACEUTICALS: CHONDROITIN SULFATE
Manufactured for Nestlé HealthCare Nutrition, Inc., Englewood, NJ 07630 USA
Product of USA

30 Calories per serving | 4.5g L-arginine per serving | Mixes quickly and easily with water

14 - 0.22 (0.92) g PACKETS / NET WT 4.5 (0.159) g

Nestlé HealthScience
arginaid
Nestlé 4390057046 - Arginaid Extra, Burst Flavor, 8 oz Tetra Prisma
Orange Burst
Natural & Artificial Flavor

NUTRITION INFORMATION PER 237 mL

NUTRIENT COMPOSITION	amount	
CALORIES	250	kcal
TOTAL FAT	0	g
MCT	0	g
SODIUM	50	mg
POTASSIUM	10	mg
TOTAL CARBOHYDRATE	52	g
DIETARY FIBER	0	g
PROTEIN	10.5	g
VITAMIN A		
RETINOL	300	mcg
B-CAROTENE		
VITAMIN C	250	mg
CALCIUM	0	mg
IRON	3.6	mg
VITAMIN D	2	mcg
VITAMIN E	60	mcg
VITAMIN K	16	mcg
THIAMIN	0.3	mg
RIBOFLAVIN	0.34	mg
NIACIN	4	mg
VITAMIN B6	0.4	mg
FOLIC ACID	80	mcg
VITAMIN B12	1.2	mcg
BIOTIN	60	mcg
PANTOTHENIC ACID	2	mg
PHOSPHORUS	850	mg
IODINE	30	mcg
MAGNESIUM	mg	
ZINC	15	mg

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

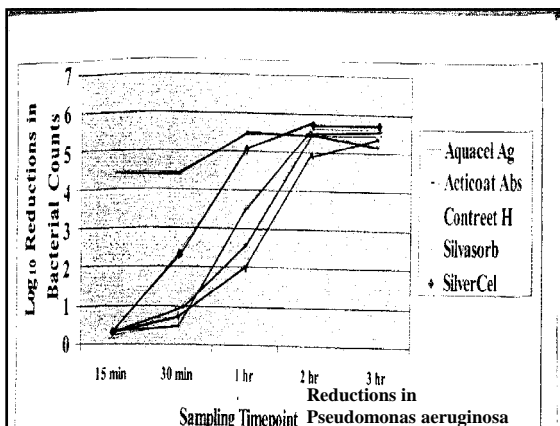
SILVER

- 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

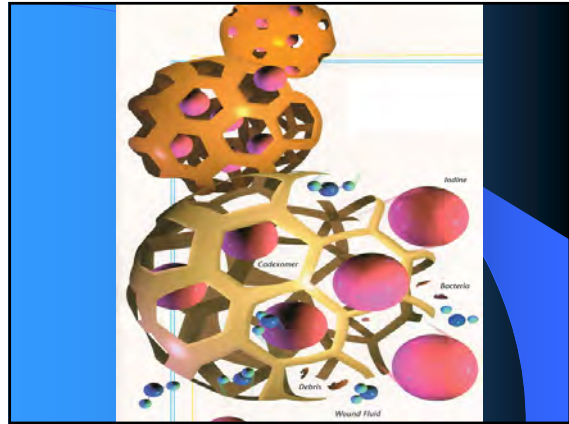


TOPICAL IODINE IS AVAILABLE IN TWO FORMS:

- 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

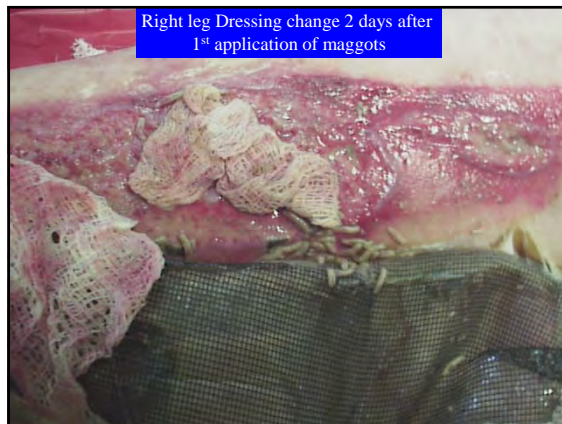
(LOCAL CARE) DEBRIDING AGENTS

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





Right Leg
Completed dressing after application of maggots



Right leg Dressing change 2 days after
1st application of maggots



Right leg
Wound after removing dressing and 1st application of maggots

(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?

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