



Practical Strategies in Wound Care: Referral Guidelines, Oxygen Therapy and Diagnostic Essentials

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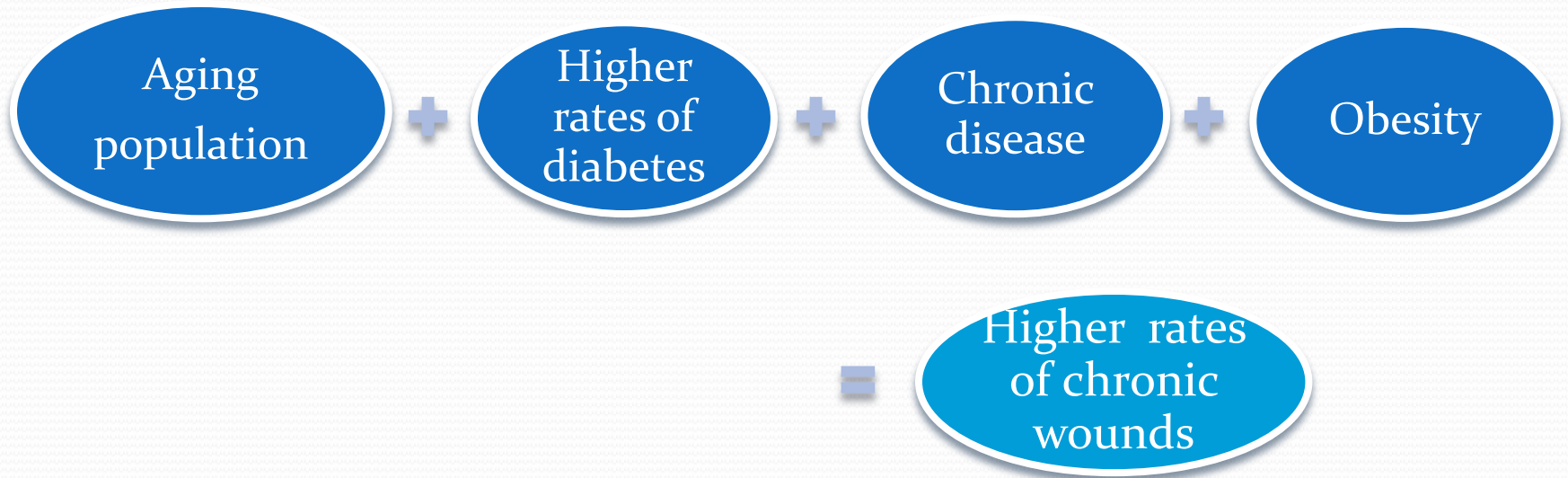
MUSC Health Wound Care Florence Medical Center

Conway Regional Wound Healing Center

DISCLOSURE

- I am an independent contractor for Healogics, the leading provider of advanced wound care and hyperbaric oxygen therapy. I work as a wound care specialist and the medical director of wound clinics as needed.
- I am an employee of Prisma Health. I work as a wound care specialist and have been a medical director.
- These relationships have been disclosed in accordance with conflict-of-interest policies. The presentation provides a balanced, evidence-based overview of wound care and reflects my independent professional judgement.

Growing Need for Wound Care



What is Specialized Wound Care?

Specialized wound care is a focused, evidence-based specialized approach to the treatment of chronic wounds.

Specialized wound care addresses the many conditions and co-morbidities that impact wound healing requires the intervention by multiple healthcare disciplines applying the appropriate therapy at the proper time.

Types of Wounds Treated:

Venous stasis

Pressure ulcers

Diabetic ulcers

Arterial ulcers

Vascular insufficiencies

Osteoradionecrosis

Late-effect radiation tissue damage

Necrotizing infections

Chronic refractory osteomyelitis

Skin irritations

Surgical wounds

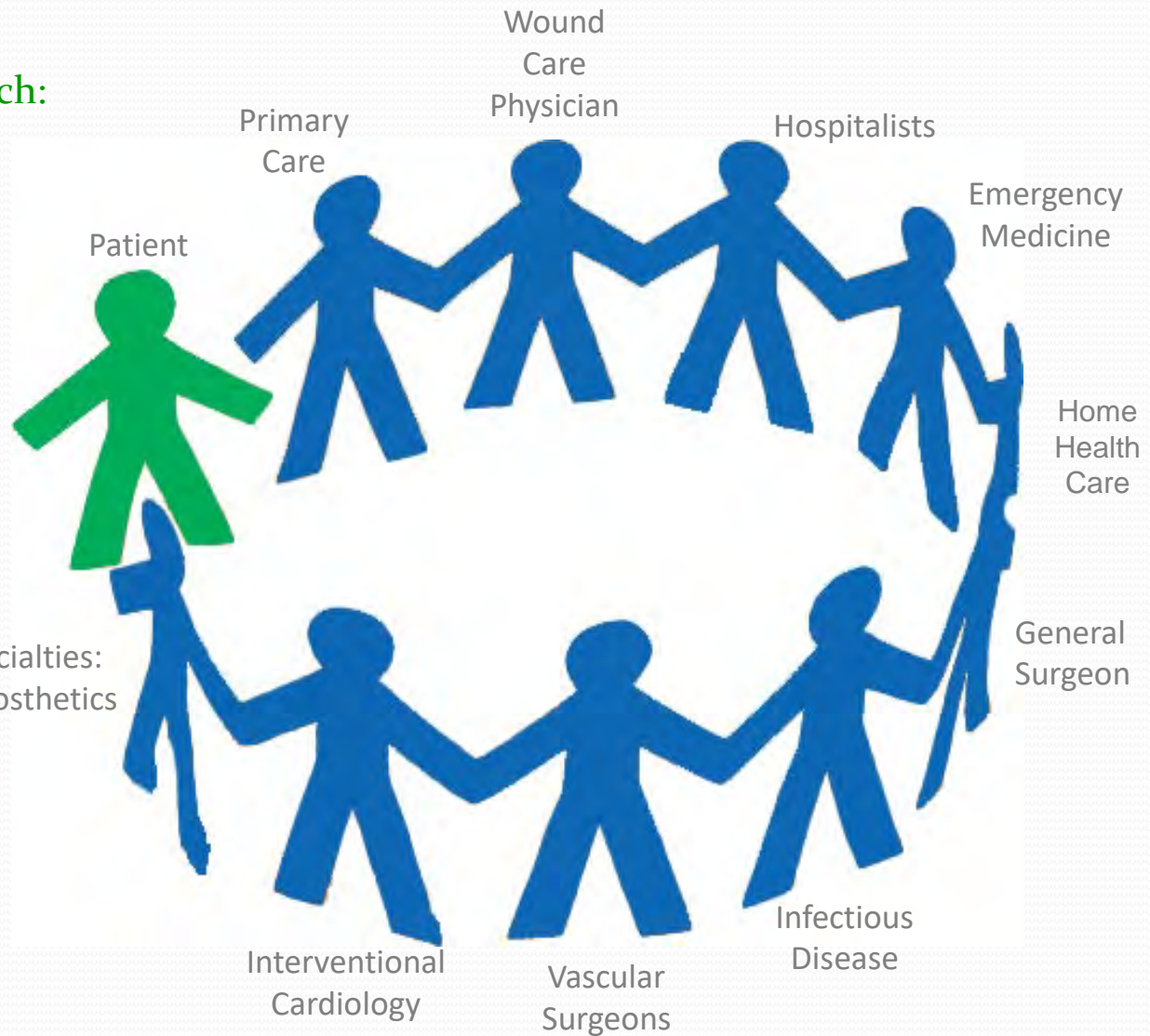
Neuropathic ulcers

Wound Care Center is Physician & Nurse Practitioner-Driven

An Interdisciplinary Approach:

- Works with all specialties
- Brings the providers and specialists together

Other Medical and Subspecialties:
Dieticians, Orthotics and Prosthetics



Systematic Approach to Wound Healing

- Comprehensive evaluation & assessment
- Define etiology for wound (wound type)
- Design an individualized treatment plan
 1. Adequate perfusion
 2. Presence of nonviable tissue
 3. Signs of infection or inflammation
 4. Presence of edema
 5. Conduciveness of wound healing environment
 6. Optimization of tissue growth
 7. Appropriateness of pressure offloading
 8. Controllability of pain
 9. Optimization of host factors

We Care for Patients - We Care for Their Wounds

The referring physician is the most important member of the patient's wound care management team.

- Partnering with the Primary Care Physician (PCP), the wound care team develops a treatment plan.
- Information about patient progress is provided to the PCP at time of referral, monthly during treatment and at discharge.

Benefits to Patients

- Faster healing and a shorter recovery period
- Limb salvage
- Restoration of health and mobility
- Improved quality of life
- Wound Care education to help patients and caregivers understand their condition and prevent complications

APPROPRIATE TESTS TO ORDER PRIOR TO REFERRAL

CRP or Sed Rate

WBC if Infection Suspected

Albumin or Prealbumin

Arterial Brachial Indexes

Venous Insufficiency Studies

X-rays of Affected Extremity

X-rays of Long-term Decubiti Site

Approaches to Treatment

- For non-infected ischemic ulcers, maintain a dry, stable eschar; otherwise debride to remove periwound callus, slough, and necrotic tissue
- Choose dressings that provide a moist wound environment
- Watch for signs of infection and treat appropriately
- Critically colonized wounds can benefit from antimicrobial treatments
- Offload the wound
- Use adjunct treatments for more severe or chronic wounds
- Monitor nutrition status and blood glucose levels
- Educate patient

Debridement

- Treatment for non-ischemic ulcers begins with wound cleansing followed by aggressive debridement of the ulcer
- Debridement removes necrotic and infected tissue, and reduces bioburden, as well as allowing better wound visualization
- Periodic debridement is necessary throughout healing **and improves healing rates***



*Steed DL, et al. J Am Coll Surg 1996;183:61-4.
Steed DL, et al. Wound Repair Regen 2006;14:680-92.
Photo: Allegro Medical

Types of Debridement

- 1. Surgical - Uses surgical instruments such as scalpel, curette, scissors, rongeur, and forceps. Promotes wound healing by removing biofilm and devitalized tissue. The level of debridement is determined by the level of devitalized tissue removal.



- 2. Mechanical - Irrigation, hydrotherapy, wet-to-dry dressings, and an abraded technique. This technique can damage healthy tissue, and is usually painful.



- 3. Autolytic - slowest method and there is no pain. Uses the body's own enzymes and moisture beneath a dressing, and non-viable tissue becomes liquefied. Maintaining a balance in moisture is important. Dressing types commonly used are hydrocolloids, hydrogels, and transparent films (semi-occlusive and occlusive).



- 4. Enzymatic - prescribed topical agent that chemically liquefies necrotic tissues with enzymes. These enzymes dissolve and engulf devitalized tissues within the wound matrix.

- 5. Biological - use of maggots, *Lucilia sericata* (green bottle fly), that are grown in a sterile environment and digest dead tissue and pathogens. The sterile maggots are applied to the wound bed with a dressing used to "confine" the maggots to the wound.



Wound Dressings

- Dressings should be selected to maintain a moist wound environment.
- Wet-to-dry dressings are not considered continually moist
- The type of dressing selected will depend on the amount of exudate, as well as prevention of periwound maceration
- The dressing should also minimize shear and friction and stay in place



Steed DL, et al. Wound Repair Regen 2006;14:680-92
Photo: Allegro Medical



Types of Dressings

- **Calcium Alginate** - wounds with moderate to heavy discharge



● Wound gel - wounds that are dry or mostly dry



● Foams – light to heavily exuding wounds



● Cadexomer Iodine – exuding wounds, infected, slough



● Honey – infected or colonized, none or light drainage



● Silver – infected or colonized wounds



- **Collagen** – encourage the deposition and organization of newly formed collagen fibers and granulation tissue in the wound bed. For minimal to heavy drainage



Offloading

- Offloading is the removal of pressure on an ulcer
- The gold standard for offloading is total contact casting, and the evidence level for its efficacy is **high**
- CROW walkers, other removable boot devices, knee scooters, football dressing and orthotics for wounds are alternatives
- Patient compliance is a big issue



Calhoun JH, et al. Adv Skin Wound Care 2002;15:31-45I

Wu SC, et al. Diabetes Care 2008; 31: 2118-9.

Steed DL, et al. Wound Repair Regen 2006;14:680-92

Photos: Elite Orthotics, Inc; Podiatry Today (B. McCurdy)

Many suffer for years, even decades, with wounds such as these:

Venous Stasis, Pressure Ulcer, Osteoradionecrosis, Diabetic Foot Ulcer



Venous Stasis



Pressure Ulcer



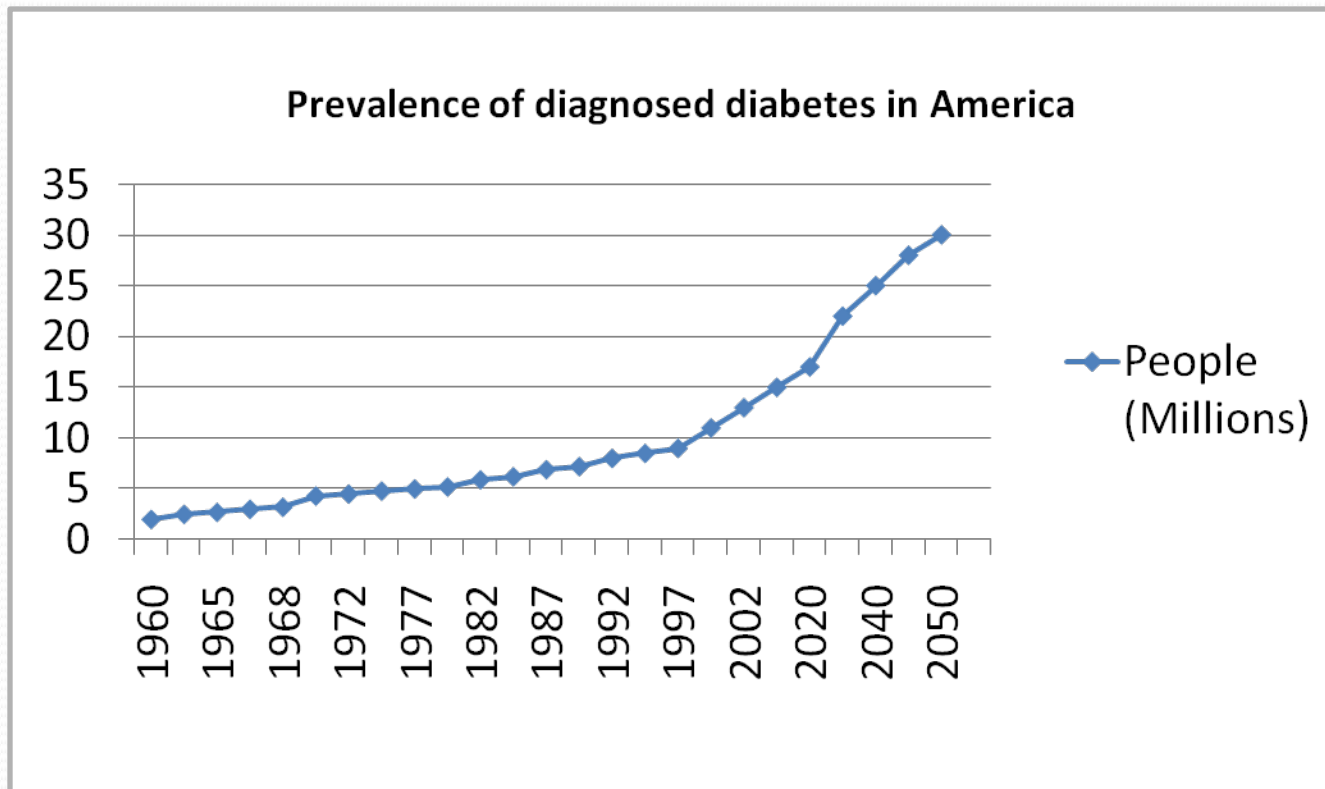
Osteoradionecrosis



Diabetic Foot Ulcer

Diabetes Growth = 165% from 2000-2050

Diabetes-related complications, including amputations, lower-extremity neuropathies and premature cardiovascular disease are a major cause of chronic wounds.



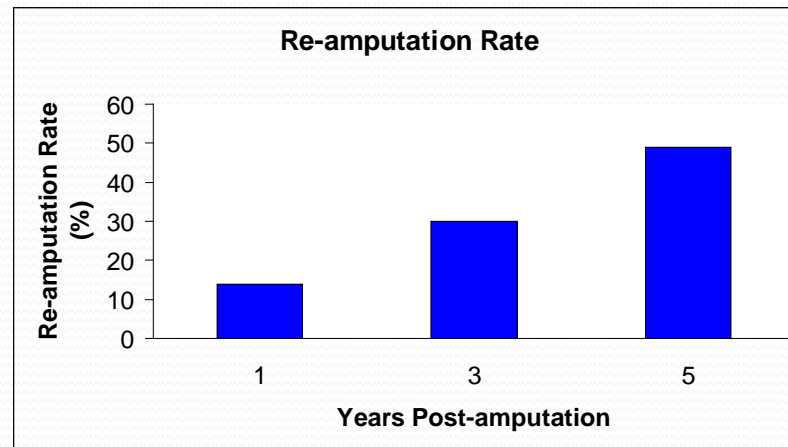
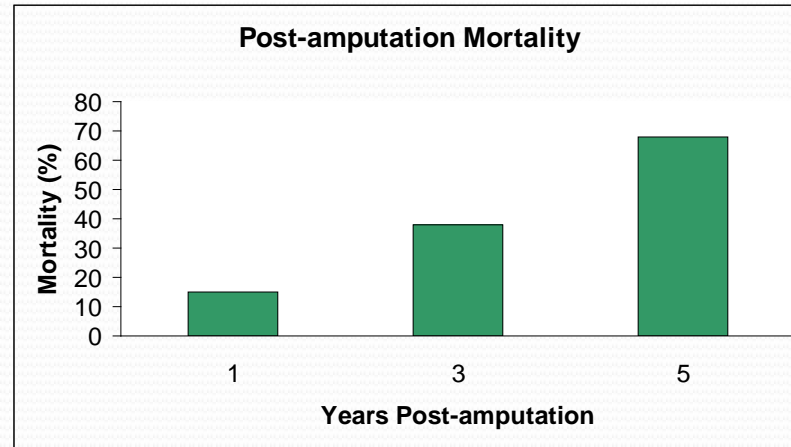
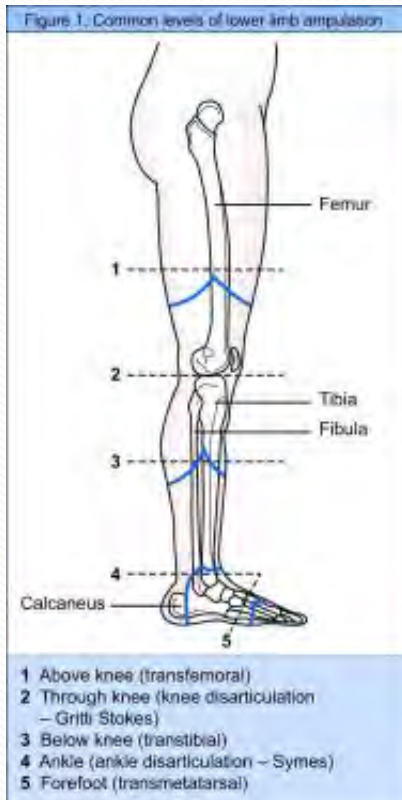
Sources: NCHS, CDC

Diabetes: Negative impact on Wound Healing

Diabetes causes:

- Protein glycation (elevated blood glucose levels cause glucose to become chemically attached to proteins in a random process known as glycation) advanced glycation end-products alter cellular function and tissue quality
- Accelerated atherosclerosis
- Hyperglycemia, which produces sustained:
 - Impaired leukocyte function
 - Increased platelet aggregation
- Impaired collagen synthesis and organization
- Impaired angiogenesis
- Increased levels of MMPs with increased inflammation
- Increased rates of apoptosis

Amputation



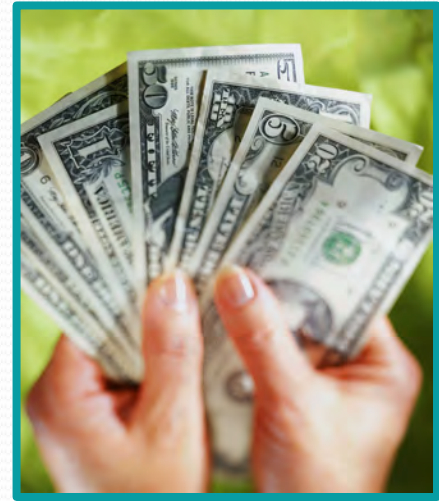
Larsson J, et al. Clin Orthop Relat Res 1998;350:149-58.

Berene J, et al. Clin Pod Med Surg 2003;20:635.

Photo: Harker J. World Wide Wounds 2006.

Cost of Care

- Estimates of cost in case study:
 - Initial care, evaluation, and amputation: \$50,000
 - Post-operative care: \$30,000
 - Prosthesis and rehabilitation: \$30,000
- Typical lifetime costs: \$550,000*
- Quality of life (utility): 0.68*



*MacKenzie EJ, et al. J Bone Joint Surg Am 2007;89:1685-92



Classification of Diabetic Foot Ulcers

Wagner Classification of Diabetic Foot Ulcers

Grade	Lesion Description
0	No open lesions; may have deformity or cellulitis
1	Superficial (partial or full thickness) Subcutaneous
2	Ulcer extension to ligament, tendon, joint capsule, or deep fascia without abscess or osteomyelitis
3	Deep ulcer with abscess, osteomyelitis, or joint sepsis
4	Gangrene localized to portion of forefoot or heel
5	Extensive gangrenous involvement of entire foot

Wagner FW Jr. Orthopedics 1987;10:163-72.

Wagner Grade 1 DFU



Wagner Grade 2 DFU



Wagner 3 DFU



Wagner 4 DFU



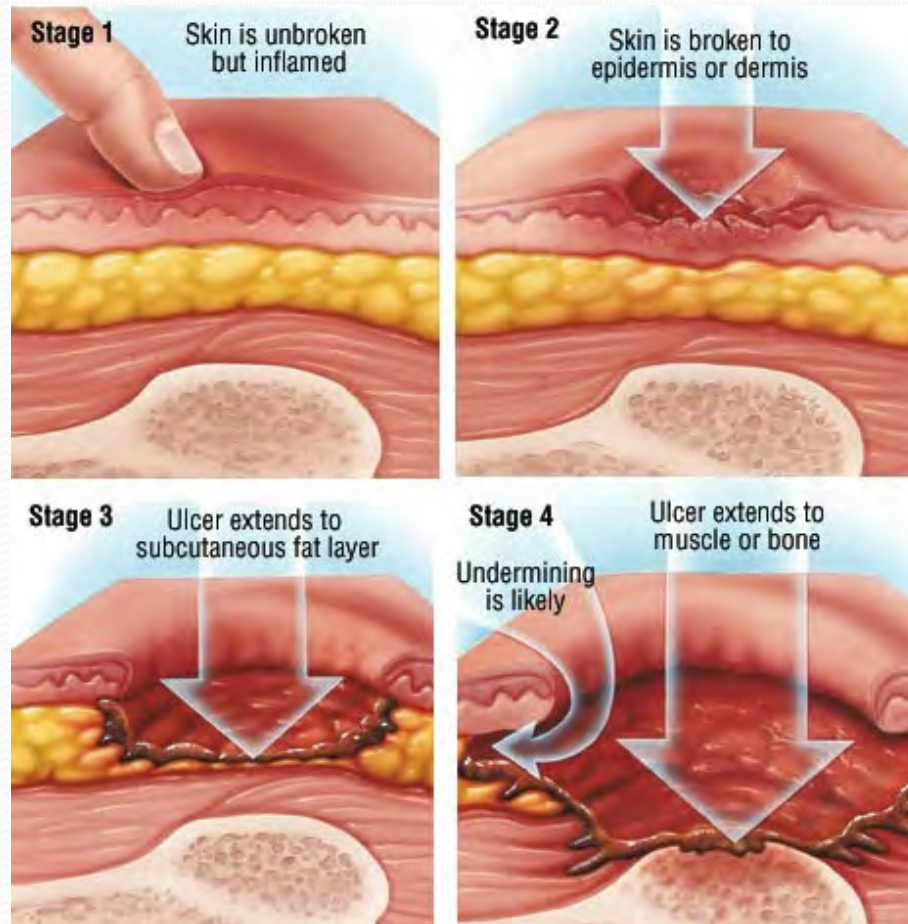
Wagner Grade 5 Diabetic Foot Ulcer



Causes of DFU

- Minor traumatic events, such as a cut or scratch can lead to ulcer formation due to poor healing.
- Infection and ischemia arising from PAD are two complicating factors.
- Sensory neuropathy by far is the most important cause of diabetic wounds and produces localized high-pressure injury
- Glycation of the periarticular soft tissues can also cause foot deformities and limited joint mobility
- The resultant increase in plantar pressure leads to local inflammatory responses, focal tissue ischemia, tissue necrosis, and ulceration

Pressure Ulcer Staging



Stage 1 Pressure Ulcer

- Non-blanchable erythema of intact skin



Stage 2 Pressure Ulcer

- Partial-thickness skin loss with exposed dermis
- The wound bed is viable, pink or red, moist, and may also present as an intact or ruptured serum-filled blister.
- Adipose (fat) is not visible and deeper tissues are not visible.
- Granulation tissue, slough and eschar are not present.

Stage 2 Pressure Ulcer



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Stage 3 Pressure Ulcer

- Full-thickness skin loss
- Adipose is visible in the ulcer and granulation tissue and epibole (rolled wound edges) are often present.
- Fascia, muscle, tendon, ligament, cartilage and/or bone are **not** exposed.


Stage 3 Pressure Ulcer



Stage 4 Pressure Ulcer

- Full-thickness skin and tissue loss
- Exposed or directly palpable fascia, muscle, tendon, ligament, cartilage or bone in the ulcer.



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Unstageable Pressure Ulcer

- Obscured full-thickness skin and tissue loss
- Full-thickness skin and tissue loss in which the extent of tissue damage within the ulcer cannot be confirmed because it is obscured by slough or eschar.



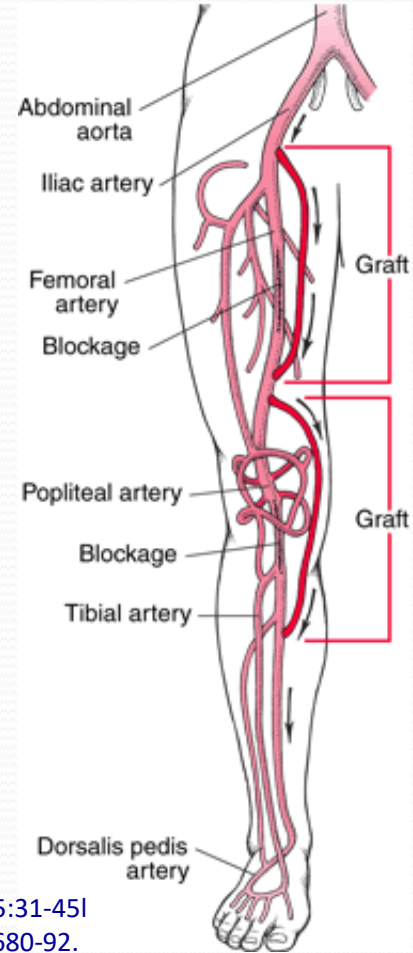
Deep Tissue Injury

- Persistent non-blanchable deep red, maroon or purple discoloration
- May evolve rapidly to reveal the actual extent of tissue injury, or may resolve without tissue loss.
- This injury results from intense and/or prolonged pressure and shear forces at the bone-muscle interface.



Ischemia

- Ischemic ulcers are difficult to heal
- If the patient has absent pulses, a low ABI, or low transcutaneous oximetry for the ulcer area, thorough vascular evaluation is indicated.
- Surgical options include peripheral angioplasty, stenting and peripheral bypass grafting



Calhoun JH, et al. *Adv Skin Wound Care* 2002;15:31-45
Steed DL, et al. *Wound Repair Regen* 2006;14:680-92.

Photo: Merck

Arterial Ulcers

- Punched out appearance
- Usually round in shape with well defined, even margins



Credit: Rattana/Shutterstock.com



Venous Ulcers

- Shallow sore with a red base, sometimes covered in yellow slough
- Unevenly shaped borders
- Surrounding skin may be shiny, tight, warm/hot and discolored



Venous Ulcer Treatment

Main Therapy is compression with compliance a major problem.
Venous ablation can accelerate healing and decrease recurrence.



Osteomyelitis

- Ulcers with deeply infected tissue may be accompanied by osteomyelitis
- If suspected, probing the wound, serial X-rays, MRI, and CT scans can confirm suspicion, but **bone biopsy is definitive**
- Treatment is removal of infected bone and usually 6 weeks of antibiotics
- Ensure that that **deep tissue infection is resolved before wound closure** *with no beta hemolytic streptococci present*
- **HBO can increase ulcer healing and limb salvage rates**



Steed DL, et al. Wound Repair Regen 2006;14:680-92
Photo: Aira Hospital



Advanced Treatment Options

Adjunctive Treatments

- Hyperbaric Oxygen Therapy
- Platelet-derived growth factors:
- Dermal matrix substitutes:
- Skin equivalents
- Negative-pressure wound therapy:
- Fish skin derivatives
- Human Placenta



Hyperbaric Oxygen Therapy

- HBOT involves breathing pure O₂ in a pressurized tube
- The pressure is 2-2.5 times higher than normal air pressure which allows the lungs to gather more O₂
- When tissue is injured, it requires even more oxygen to survive.
- HBOT increases the amount of O₂ the blood can carry
- An increase in blood O₂ temporarily restores normal levels of blood gases and tissue function to promote healing and fight infection.

Using HBO Therapy As Part of the Approach

Hyperbaric Oxygen Therapy (HBOT) is a powerful adjunctive therapy, reimbursed by Medicare and most payers, that is indicated for 10-15% of patients with chronic wounds.

Medicare-Approved Non-Emergent Indications:

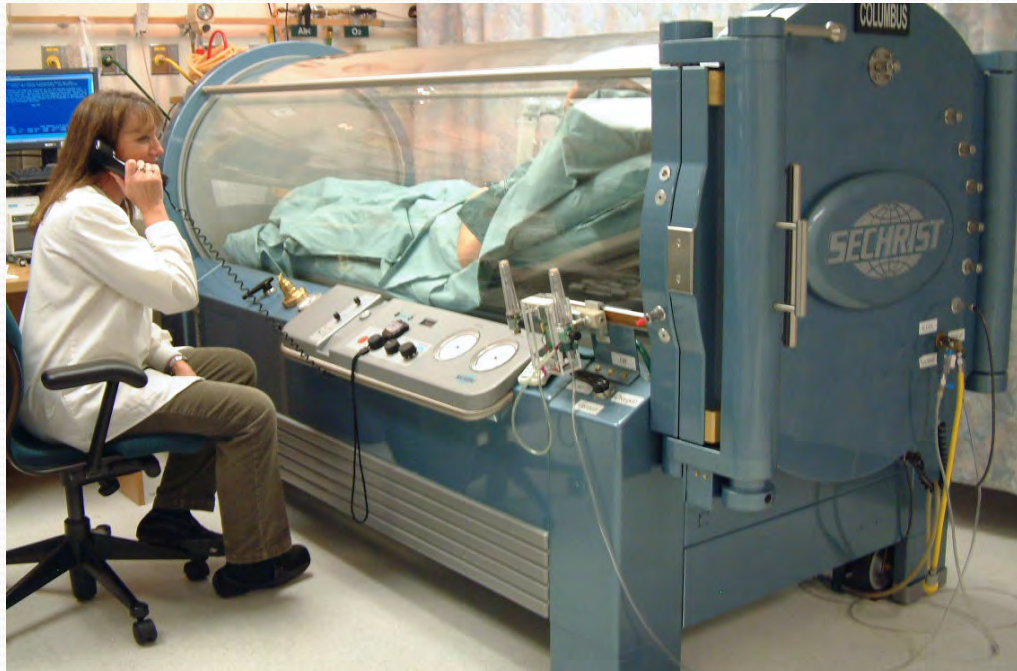
*Prep & Preservation of Compromised Skin Grafts, Osteoradionecrosis, Diabetic Wounds of the Lower Extremity, Soft-tissue Radionecrosis, Chronic Refractory Osteomyelitis, Progressive necrotizing infections
Idiopathic Sudden Sensorineural Hearing Loss, Crush Injuries*

94% of diabetic foot ulcer patients treated with HBOT maintained an intact limb at 55 months post-HBOT.¹



1. Cianci P. Advances in the treatment of the diabetic foot: Is there a role for adjunctive hyperbaric oxygen therapy? *Wound Repair Regen* 2004;12(1):2-10

HBO Improves Ischemia and Wound Healing



Calhoun JH, et al. *Adv Skin Wound Care* 2002;15:31-45I
Faglia E, et al. *Diabetes Care* 1996;19:1338-43.

Hyperbaric Oxygen Uses in Diabetic Ulcers

- Improving ischemia
- Healing chronic wounds
- Treating severe infections or gangrene
- Improving limb salvage



Photo: Sechrist

Summary of HBOT RCTs

- Five small randomized controlled trials of HBOT have been performed in wound care
- Two trials showed statistically significant reduced amputation rates (HBOT) compared to controls
- Two trials showed statistically significant improved transcutaneous oximetry compared to controls
- Two trials showed statistically significant reduced wound sizes compared to controls



Abidia A, et al. Eur J Vasc Endovasc Surg 2003;25:513-8.
 Doctor N, et al. J Postgrad Med 1992;38:111-4.
 Faglia E, et al. Diabetes Care 1996;19:1338-43.
 Kessler L, et al. Diabetes Care 2003;26:2378-82.
 Lin TF, et al. Undersea Hyper Med 2001;28(Suppl):67.

Wagner Score	Sample Size	Helped by HBO: Ulcer Healing or Bipedal Ambulation Preserved (%)
I	3	100.0
II	130	83.1
III	465	77.2
IV	138	64.5
V	37	29.7

Fife CE et al. Wound Repair Regen 2007;15:322-31.

Hyperbaric Oxygen Therapy is Long-lasting

- **One study showed 94% of patients maintained an intact limb (healed wound) at 55 months post-closure**
- **In patients with transcutaneous oximetry values < 40 mmHg prior to treatment, 76% healing rate with intact skin at 3 year follow up compared to 48% healing in control group; 12% amputation rate in HBO group vs. 33% in control group.**

Cienci C, et al. Wound Rep Reg 1997; 5:141-6.

Kalani M, et al. J Diabetes Complications 2002; 16:153-8.

Evidence Level of Hyperbaric Oxygen Therapy

- Cochrane Systematic Review conclusion: “In people with foot ulcers due to diabetes, **HBOT significantly reduced the risk of major amputation** and may improve the chance of healing at 1 year. The application of HBOT to these patients may be justified where HBOT facilities are available, however economic evaluations should be undertaken.”
- Wound Healing Society guidelines for diabetic foot ulcers: in regard to HBOT reducing amputation rate in patients with ischemic diabetic foot ulcers, **level of evidence is 1.**

Kranke P, et al. Cochrane Database Syst Rev 2004;CD004123.
Steed DL, et al. Wound Repair Regen 2006;14:680-92.

HBOT Risks

- Temporary nearsightedness caused from temporary eye lens changes
- Middle ear injuries
- Pneumothorax
- Seizures from O₂ toxicity

- After a HBOT session patients may feel:
 - Tired
 - Hungry

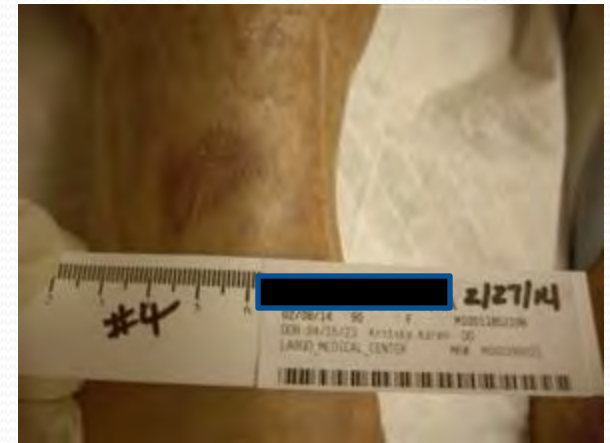
HBOT Contraindications

- Absolute
 - Untreated Pneumothorax
- Relative
 - Asthma
 - Claustrophobia
 - COPD
 - Eustachian Tube Dysfunction
 - Seizures
 - URI
 - High Fever
 - increased risk of seizures
 - Pregnancy
 - Pacemakers or Epidural Pain Pumps
 - Need to know if pressure tested device



Case Studies

Case Study – Venous Stasis Ulcer



Very active 93 y.o. pt. with DM2 and venous insufficiency. Basal cell excision several months prior to admit. Serial debridements and multilayer compression wraps used.

Post-Op Wound

- 34 yo female with PMHx of kidney transplant, obesity of HTN.
- She underwent an abdominal hysterectomy for uterine bleeding
- Post-op she developed an infection at incision site
- OR debridement x 2 and placement of wound VAC.

Post- OP Wound

1/20 VAC and collagen

2/27 collagen



Post –Op Wound

- Healed 6/1



Post - Mohs

- 74 yo female with PMHx of diabetes underwent Mohs procedure on a skin cancer on top of head
- Treated with MediHoney, hydrafera blue, and collagen

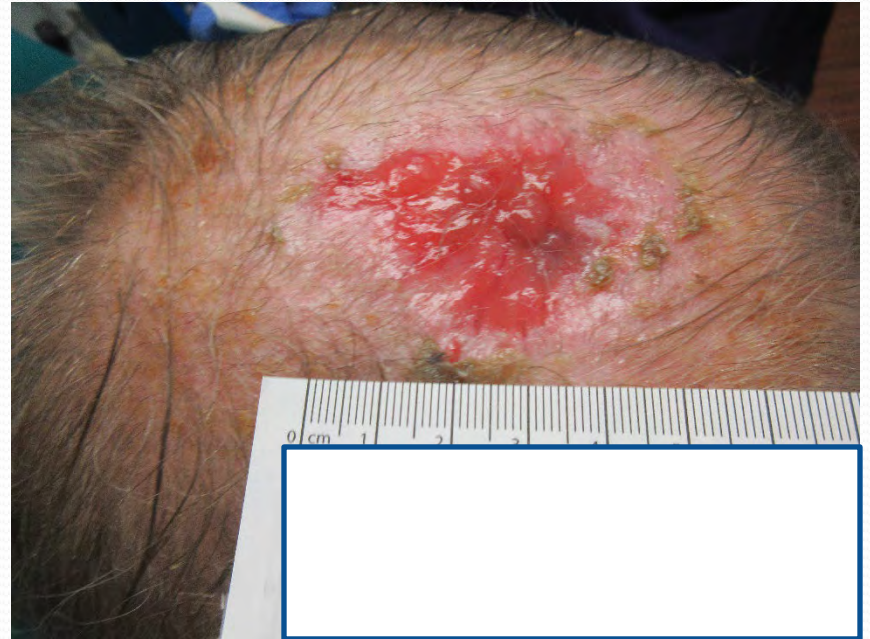


7/14

Post - Mohs

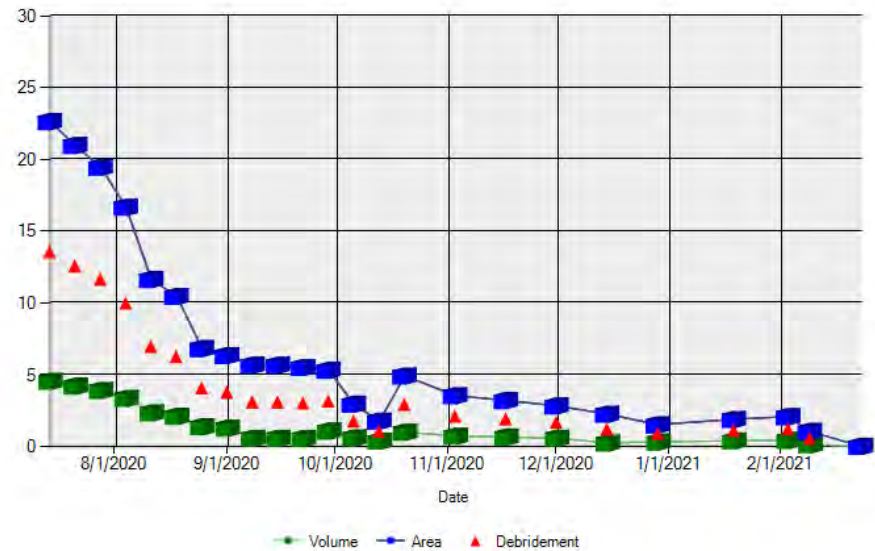
9/22

12/15



Post- Mohs

2/23



Venous Ulcer

- 52yo male presents with venous leg ulcers which had been present for a year.
- Wounds started as blisters that continued to worsen.
- Angiography of both legs was negative for any stenosis.
- Used compression wraps and various dressings

Venous Ulcer

10/2



2/13



Venous Ulcer

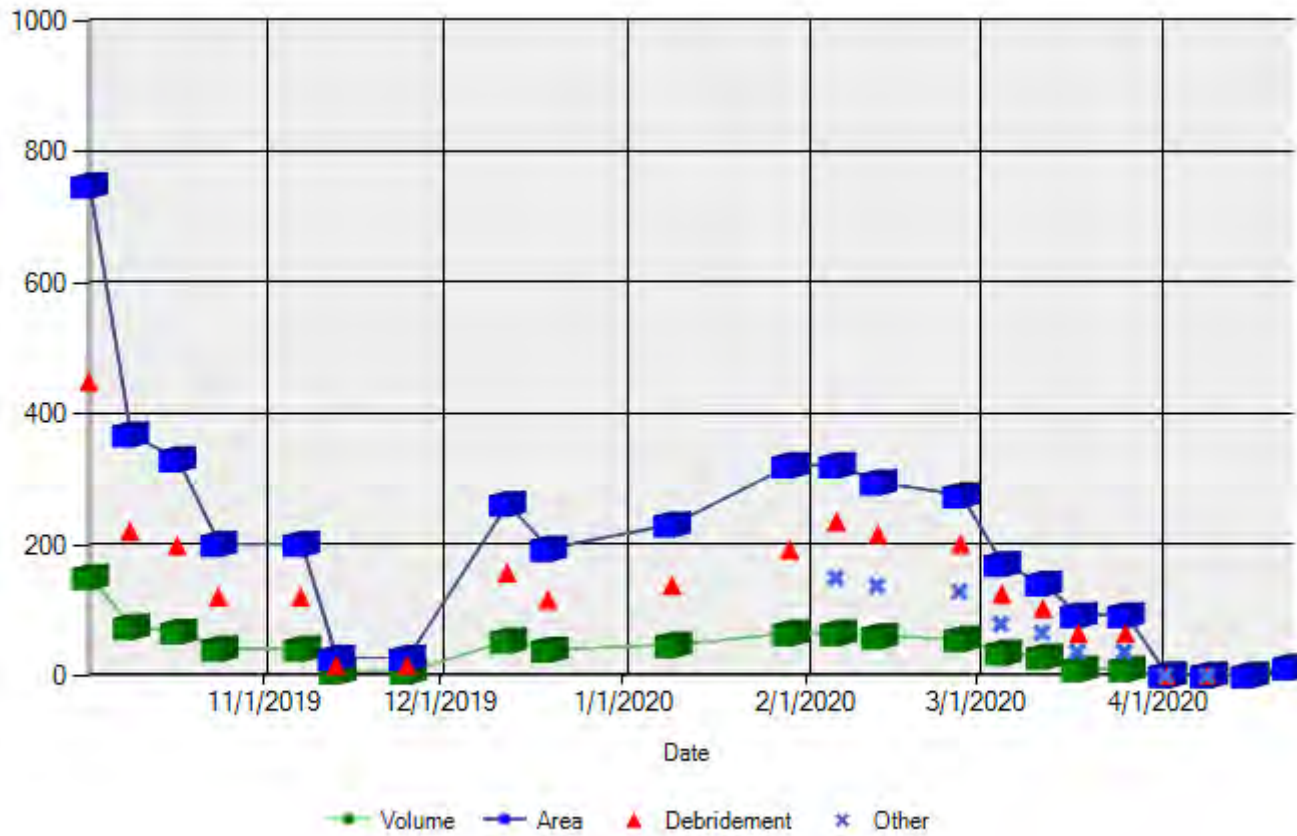
3/12



4/2



Venous Ulcer



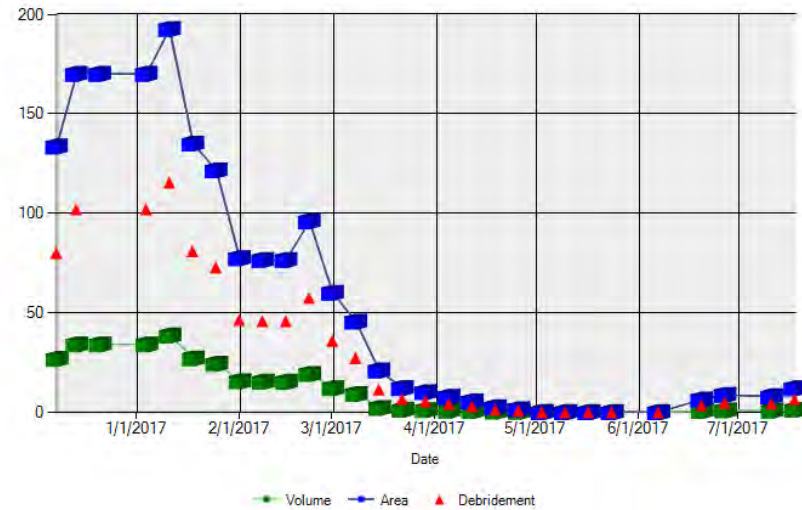
Arterial Ulcers

SD -69 yo



Revascularization 1/16

SD



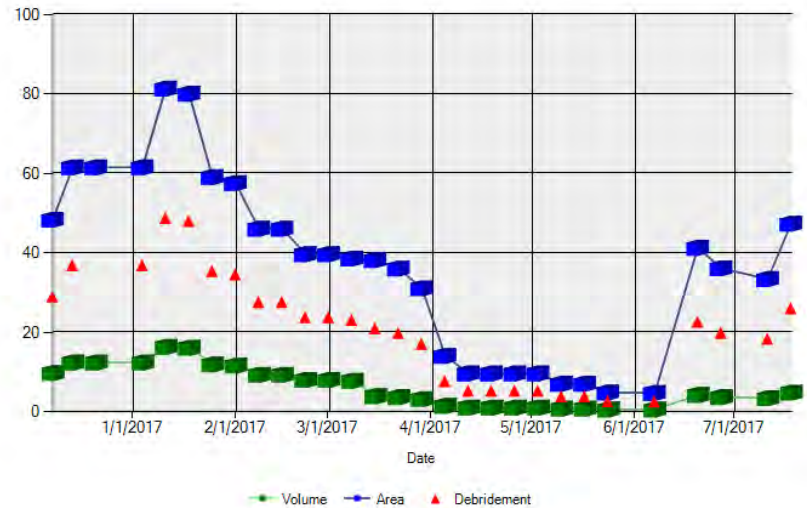
Left atherectomy AT, perineal vessels 7/14

SD – left medial ankle/leg



Left LE revascularization 1/6

SD – left medial ankle/leg



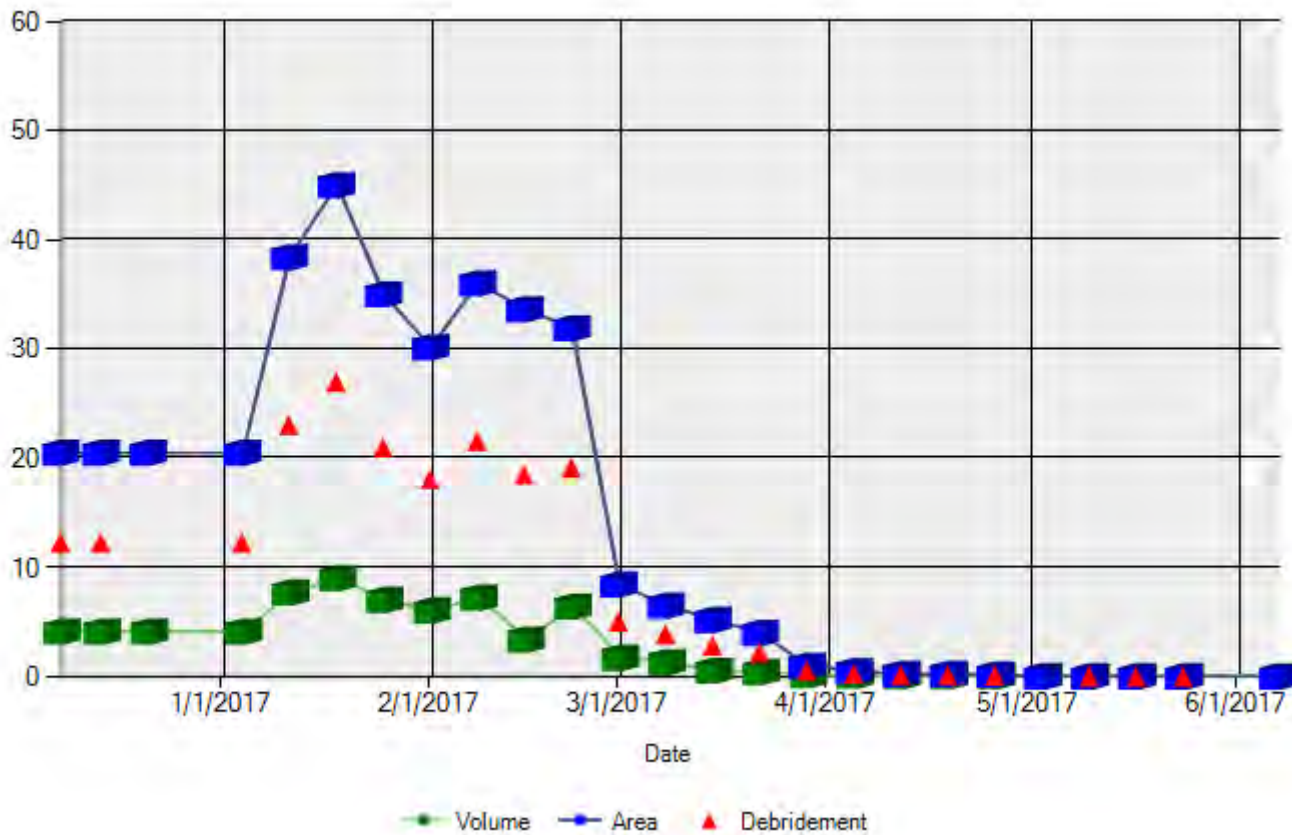
Left atherectomy AT, perineal vessels 7/14

SD-Right medial ankle/leg



Right LE revascularization 3/3

SD- right media ankle/leg



Arterial Ulcer

RN – 70yo



- PMHx: h/o left TMA, smoker
- Vascular Studies 12/2017 showed no hemodynamically significant stenosis, Right ABI 0.98 and Left ABI 0.95

12/19/17

RN – 70yo

- On 2/27/18, interventional cardiologist stented the left iliac artery



1/30/18

RN – 70yo

- On 3/11/18, an atherectomy was performed on the right popliteal and right SFA, stent placed in right SFA and right PTA



3/13/18

RN – 70yo



Offered STSG - refused

3/27/18



5/22/18

RN – 70yo



8/21/18

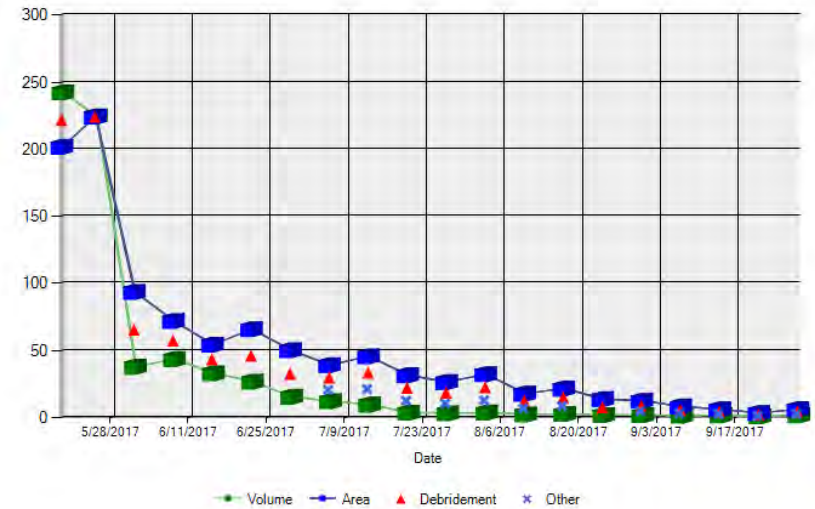


11/13/18

Traumatic MM – 90yo



MM – 90yo



Traumatic MH – 52yo



- PMHx: DM, Kidney transplant x 2
- Treated for MRSA and Pseudomonas
- Treatments: Collagen, Epifix, and Oasis

MH – 52yo



MH – 52yo



Inpatient Wound Care Team

- Inpatient Wound Care Nurse
 - Assess and evaluate wounds
 - Will consult wound care physician if needed
 - Change VACs
 - Not a daily dressing change team

Wound Care Physicians

- What is a Wound Care Physician?
 - Specialized training in advanced wound care
 - Hyperbaric Oxygen Therapy Training
 - Trained to apply specialized skin substitutes
- When to consult a Wound Care Physician?
 - Any stage pressure ulcer
 - Deep Tissue Injury
 - Diabetic Foot Ulcers
 - Venous Leg Ulcers
 - Arterial Ulcers
 - Chronic Osteomyelitis
 - HBO Eval

Wound Care Center vs. Home Health Care

- HHC nurses need an order from a physician for dressing changes
- HHC nurses perform dressing changes per physician orders
- HHC nurses do NOT perform debridements
- HHC nurses are not able to apply a skin substitute
- HHC are not allowed to change the type of dressing as the wound evolves