Wound Care in the Hospital

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The Problem

Human Skin Wounds: A Major and Snowballing Threat to Public Health and the Economy

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Wound Repair Regen. 2009 Nov–Dec; 17(6): 763–771

Scope of the Problem

- “Silent epidemic” of chronic wounds
- 6.5 million people with chronic wounds in the U.S. alone
- Estimated cost of caring for these wounds exceeds $50 billion per year
- Over 1,000 outpatient wound care centers in the U.S.
- U.S. represents the largest and fastest growing market for wound care products and services

Barriers to Outpatient Treatment of Chronic Wounds

- Need for specialized equipment or facilities (Hoyer lift, powered exam chairs, room to accommodate a gurney)
- Time consuming visits involving removal and replacement of specialized dressings
- Unfamiliarity of physicians with basic principles of evaluation and management of such wounds
- Unfamiliarity with advanced wound care products and modalities
- Challenging comorbidities and preselection as “tough cases”

Common Wound Types

- Venous insufficiency ulcer
- Pressure ulcer
- Diabetic foot ulcer
- Nonhealing surgical wound
- Arterial ulcer
- Traumatic wound

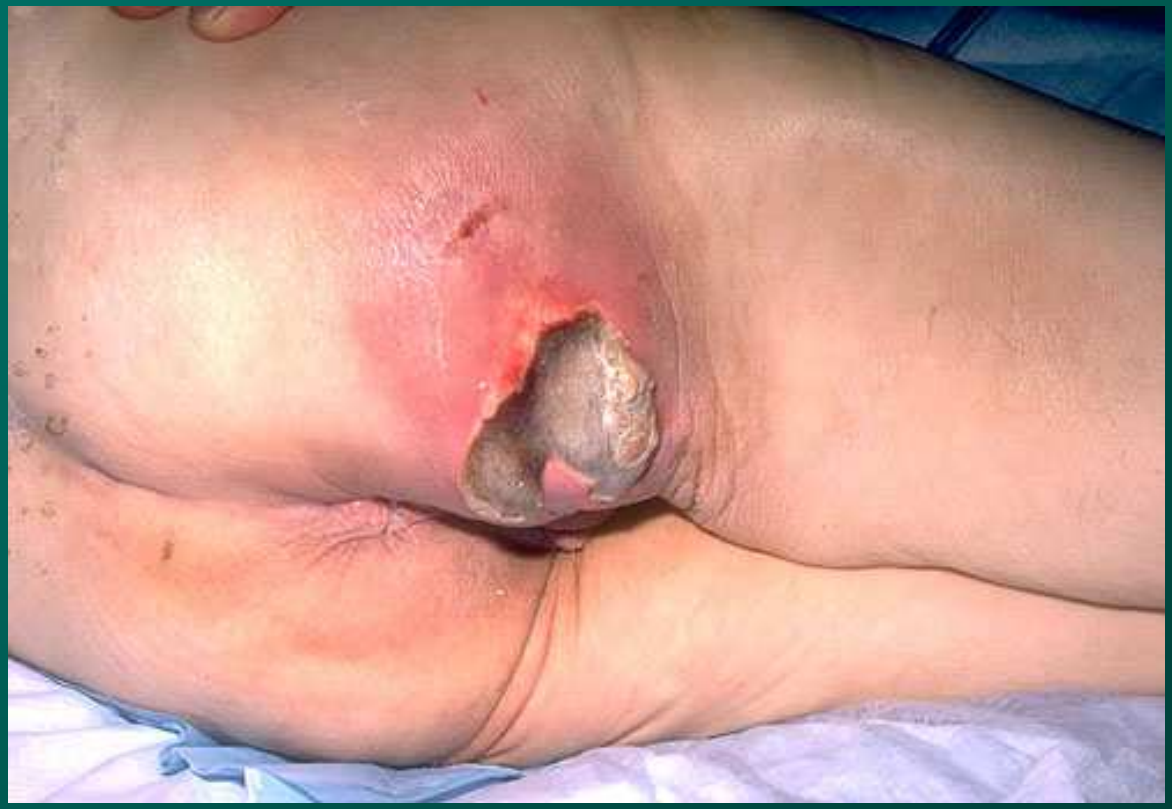
Less Common Wound Types

- Vasculitic ulcers
- Radiation ulcers
- Medication-related ulcers
- Infection-related ulcers
- Inflammatory ulcers
- Malignancies

Wounds of Major Importance to Hospitalists

- Pressure ulcers
- Diabetic foot ulcers
- Arterial ulcers
- Venous ulcers

Pressure ulcers



Pressure Ulcer Facts

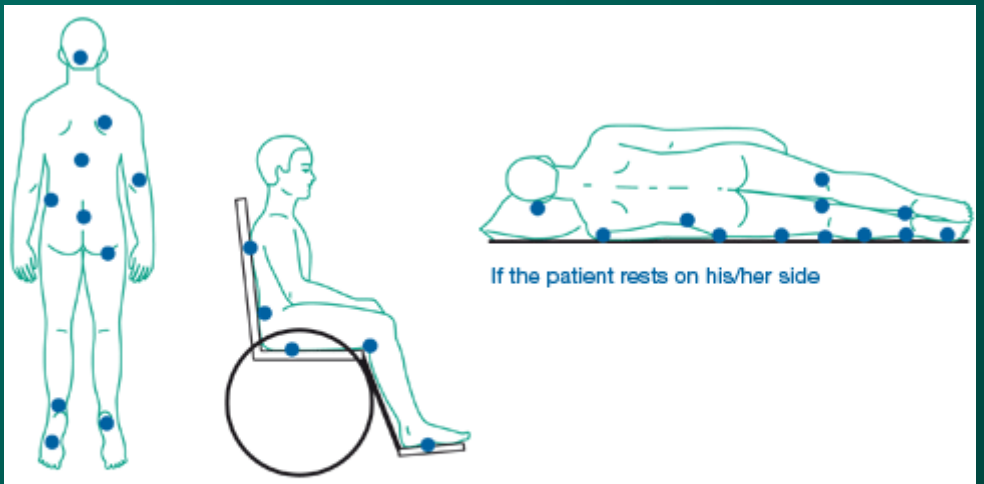
- Affect up to 3 million patients per year in the US
- About 60,000 patients die every year as a direct result of pressure ulcers
- Cost of care ranges from $20,000 to $150,000 per ulcer
- 2007 Medicare estimate of $43,000 added to cost of a hospital stay for each pressure ulcer
- More than 17,000 lawsuits annually for pressure ulcers (second only to wrongful death)

Chou R et al, Ann Intern Med. 2013

Pressure Ulcer Formation

- Develop where soft tissue is compressed between a bony prominence and an external object
- Shear forces (parallel to the skin surface) can also contribute
- Pressure exceeding normal capillary pressure produces local ischemia
- Pressures from a standard mattress may induce tissue death within a few hours

Pressure Points



Adapted from *Clinical Practice Guidelines #3*, Agency for Health Care Policy and Research, US Department of Health and Human Services.

Risk Factors for Pressure Ulcers

- Advanced age
- Chronic illness
- Smoking
- Immobility
- Sensory impairment
- Malnutrition
- Incontinence

Pressure Ulcer High-risk Groups

- Cardiovascular and vascular surgery
- Acute orthopedic
- ICU
- Spinal cord injury
- Terminally ill

Nixon J, McGough A: Prevention and Treatment of Pressure Ulcers, Mosby: 2001

Prevalence of Pressure Ulcers by Mobility Category

- Totally Ambulatory 2%
- Partially ambulatory 7%
- Partially bedfast/chairfast 10%
- Totally bedfast/chairfast 20%

Barbenel JC et al: Lancet 1977

Pressure Ulcer Risk Assessment

- Braden scale: assesses sensory perception, exposure to moisture, activity, mobility, nutrition, and friction or shear
- Norton scale: assesses physical condition, mental condition, activity, mobility, and incontinence
- Low score = high risk of skin breakdown
- Help identify patients who need higher levels of preventive intervention

Norton Pressure Ulcer Risk Scale

Factor/score	*4*	*3*	*2*	*1*
Physical condition	Good	Weak	Ill	Very ill
Mental state	Alert	Apathetic	Confused	Stuporous
Activity	Ambulant	Walks with help	Chair bound	Bed-ridden
Mobility	Full	Slightly impaired	Very limited	Immobile
Incontinence	No	Occasional	Usually urinary incontinence	Double incontinence
Interpretation of scale	Score of >18 – low risk Score of 14-18 – medium risk Score of 10-<14 – high risk Score of <10 – very high risk			

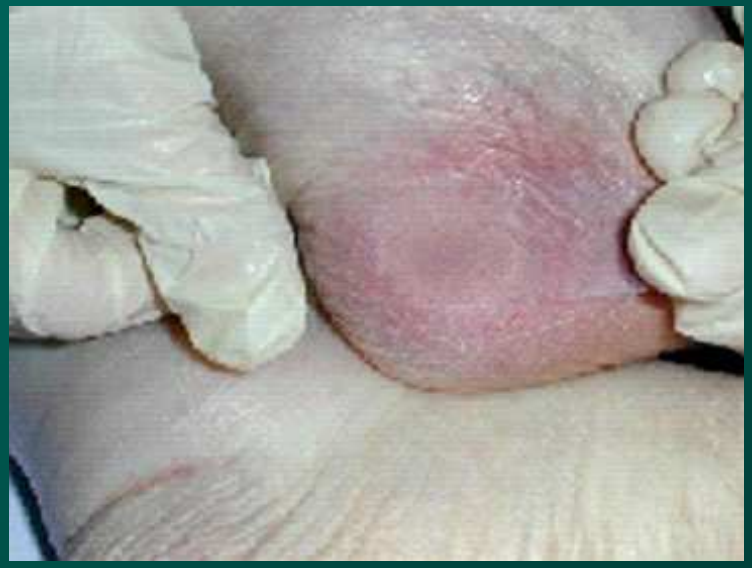
Pressure Ulcer Staging (NPUAP)

- Stage 1: intact skin with nonblanchable redness
- Stage 2: partial thickness ulcer, ruptured blister
- Stage 3: full thickness ulcer, not through fascia
- Stage 4: exposed bone, tendon, or muscle
- Suspected Deep-Tissue Injury: purple skin
- Unstageable: full thickness with slough/eschar

Stage I Pressure Ulcer

- Intact skin with non-blanchable redness
- Usually over a bony prominence
- May be difficult to see with dark skin

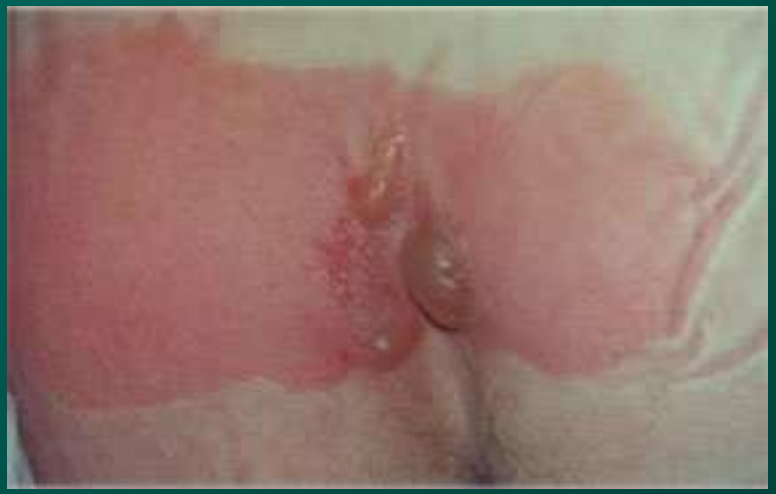
Heel Injury



Stage II Pressure Ulcer

- Partial thickness loss of dermis
- Shallow open ulcer with red/pink wound bed
- May present as intact or ruptured blister

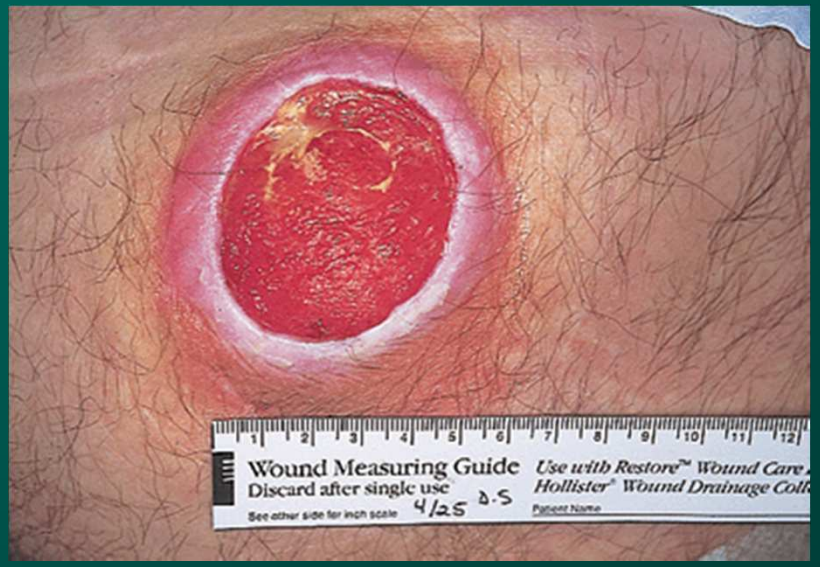
Coccyx ulcer



Stage III Pressure Ulcer

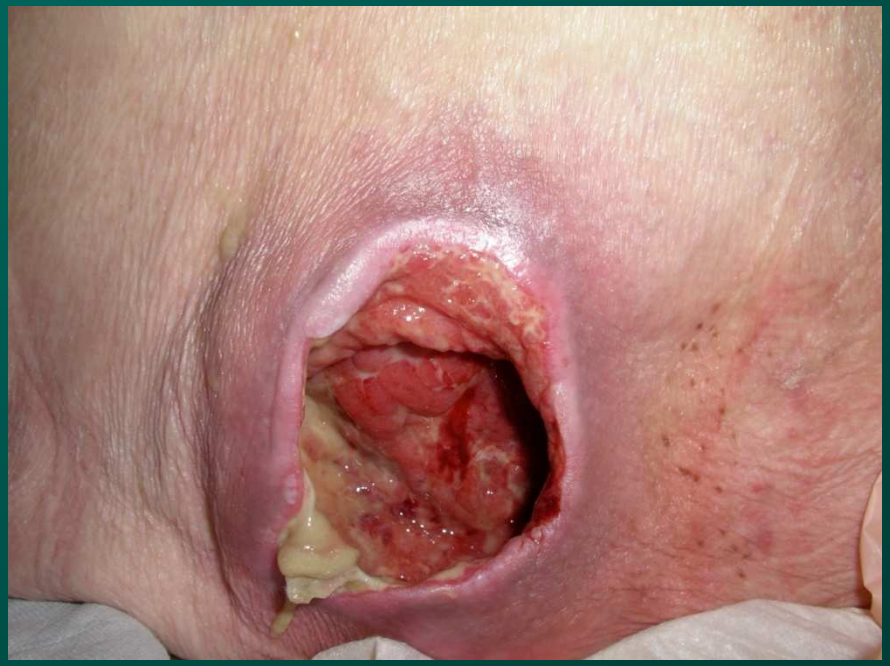
- Full thickness skin loss
- Subcutaneous fat or fascia may be visible
- No bone, tendon, or muscle exposed
- May have undermining or tunneling

- Ischial wound



Stage IV Pressure Ulcer

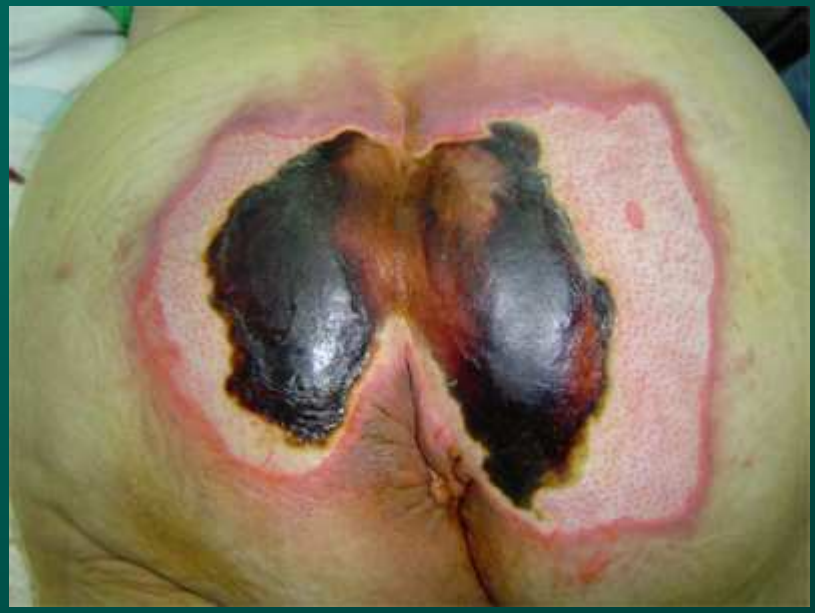
- Full thickness skin loss with exposed bone, tendon, or muscle
- Undermining and tunneling often present
- Visible muscle/fascia



Unstageable Pressure Ulcer

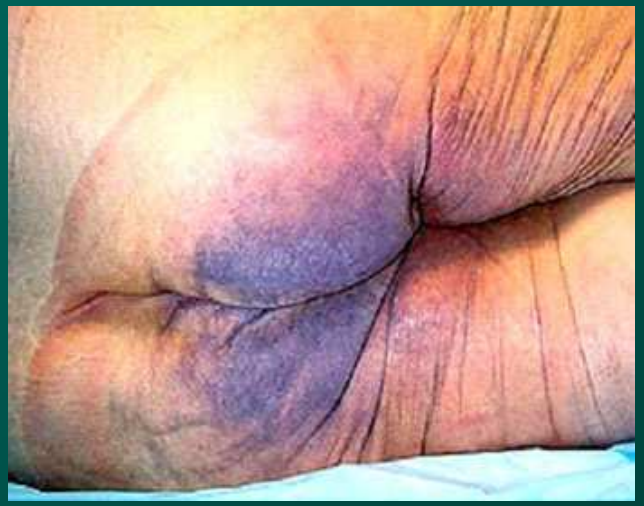
- Full thickness tissue loss
- Base of the ulcer is covered by slough or eschar
- Can only be staged after debridement

- How deep?



Suspected Deep Tissue Injury

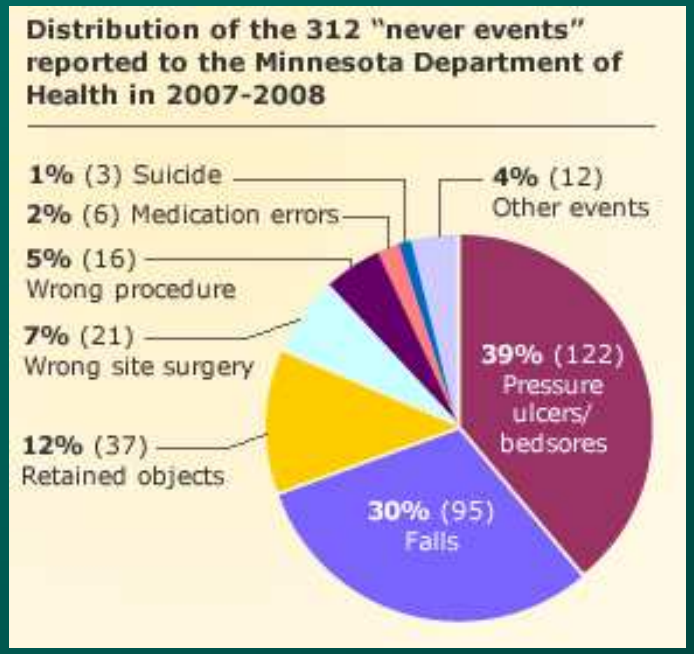
- Purple or maroon-colored area of intact skin or blood-filled blister
- Due to damage of underlying tissue from pressure and/or shear



Pressure Ulcers as “Never Events”

- Latest CMS list of 29 “never events” includes Stage 3 and 4 pressure ulcers
- These are events that ”should never occur in a health care setting”
- 2008: CMS states that hospitals will not be paid for the cost of caring for these ulcers[1]
- 2011: NPUAP Concensus Conference agreed unanimously that not all pressure ulcers are avoidable[2]

1. **CMS correspondence 7/31/08**
2. **Pressure Ulcers: Avoidable or Unavoidable?**


Distribution of the 312 "never events" reported to the Minnesota Department of Health in 2007-2008
1% (3) Suicide
2% (6) Medication errors
5% (16) Wrong procedure
7% (21) Wrong site surgery
12% (37) Retained objects
4% (12) Other events
39% (122) Pressure ulcers/ bedsores
30% (95) Falls

Prevention of Pressure Ulcers

- Initial assessment of risk (risk scale vs. clinical judgement)
- Awareness of early signs of at-risk and injured skin
- Knowledge of options for intervention
- Action plan
- Close follow-up, including direct observation of threatened areas

Early Signs of At-risk Skin

- Blanching erythema is an early warning and a call to action in a high-risk patient
- Intensity and duration of blanching erythema are important variables
- Non-blanching erythema indicates high-risk for subsequent breakdown and requires action to relieve pressure

Pressure Ulcer Prevention

- Repositioning for pressure relief
- Specialized support surfaces
- Nutritional supplementation
- Dressings and pads
- Creams, lotions, cleansers

Repositioning for Pressure Relief

- Goal is to reduce periods of sustained pressure
- “Turn q 2 hours” is traditional approach, but data to support its use is sparse
- Pressure injury may occur in < 2 hours with some patients
- A 30º lateral tilt supported by pillows is adequate

Specialized Support Surfaces

- **Group 1**: mattresses, pressure pads, and mattress overlays (foam , air, water, or gel)
- **Group 2**: powered air flotation beds, powered pressure reducing air mattresses, and non-powered advanced pressure reducing surfaces
- **Group 3**: air-fluidized beds (circulate filtered air through silicone beads)

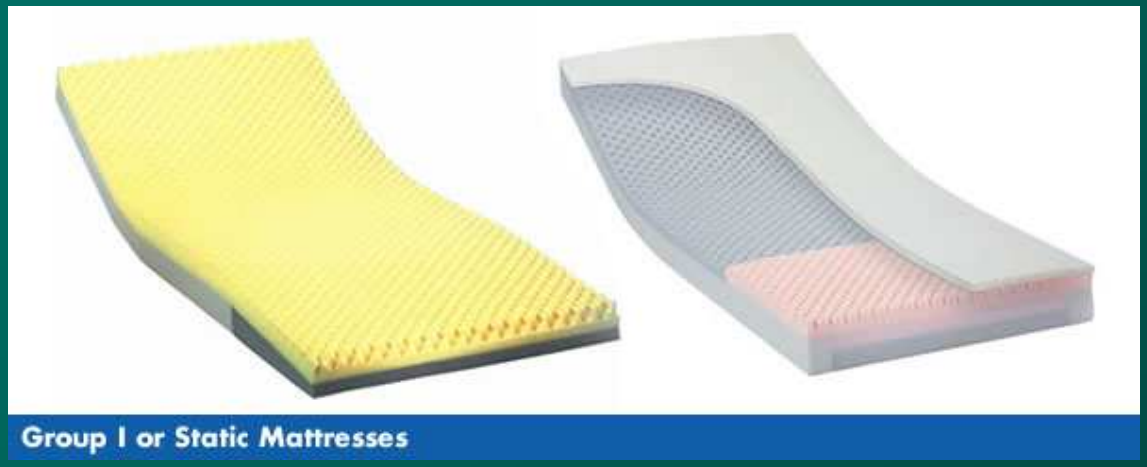
 Egg crate foam mattress is not adequate for pressure relief

CMS: Group 1 Support Surface

- Completely immobile patient qualifies
- Also qualifying: partially immobile or any stage pressure ulcer plus malnutrition, incontinence, altered sensory perception, or compromised circulation also
- Foam mattress shown to be superior to standard mattress in one study of pressure ulcer prevention[3]

Colin D et al, Ann Phys and Rehab Med. 2012

Group 1 Surfaces



Group I or Static Mattresses

CMS: Group 2 Support Surface

- Stage 2 ulcer on the trunk/pelvis, treated for one month (Group 1 surface) without improvement
- Large or multiple Stage 3 or 4 ulcers on the trunk/pelvis
- Recent myocutaneous flap or skin graft for pressure ulcer

Group 2 Surfaces

Group II or Dynamic Mattresses

CMS: Group 3 Support Surface

- Stage 3 or 4 pressure ulcer
- Bedridden or chair-bound
- Would be institutionalized without use of Group 3 surface
- Under close supervision of treating physician
- One month of treatment on Group 2 surface
- Caregiver available and willing to assist
- Alternative equipment considered and ruled out

Group 3 Surfaces

Wheelchair Cushions

“Donut” Cushions

- Increase edema
- Increase venous congestion
- Concentrate pressure on tissue around the opening
- NOT recommended

Heel Offloading Devices

Nutritional Supplementation

- A recent review of the literature on this topic found "little evidence to support the effectiveness of enteral or oral nutritional supplementation for preventing pressure ulcers."[1]
- An older multicenter study did find a lower incidence of pressure ulcers in patients receiving nutritional support versus standard diet.[2]

1. Chou R et al, Ann Intern Med. 2013
2. Bourdel-Marchasson I et al, Nutrition. 2000

Treatment of Pressure Ulcers

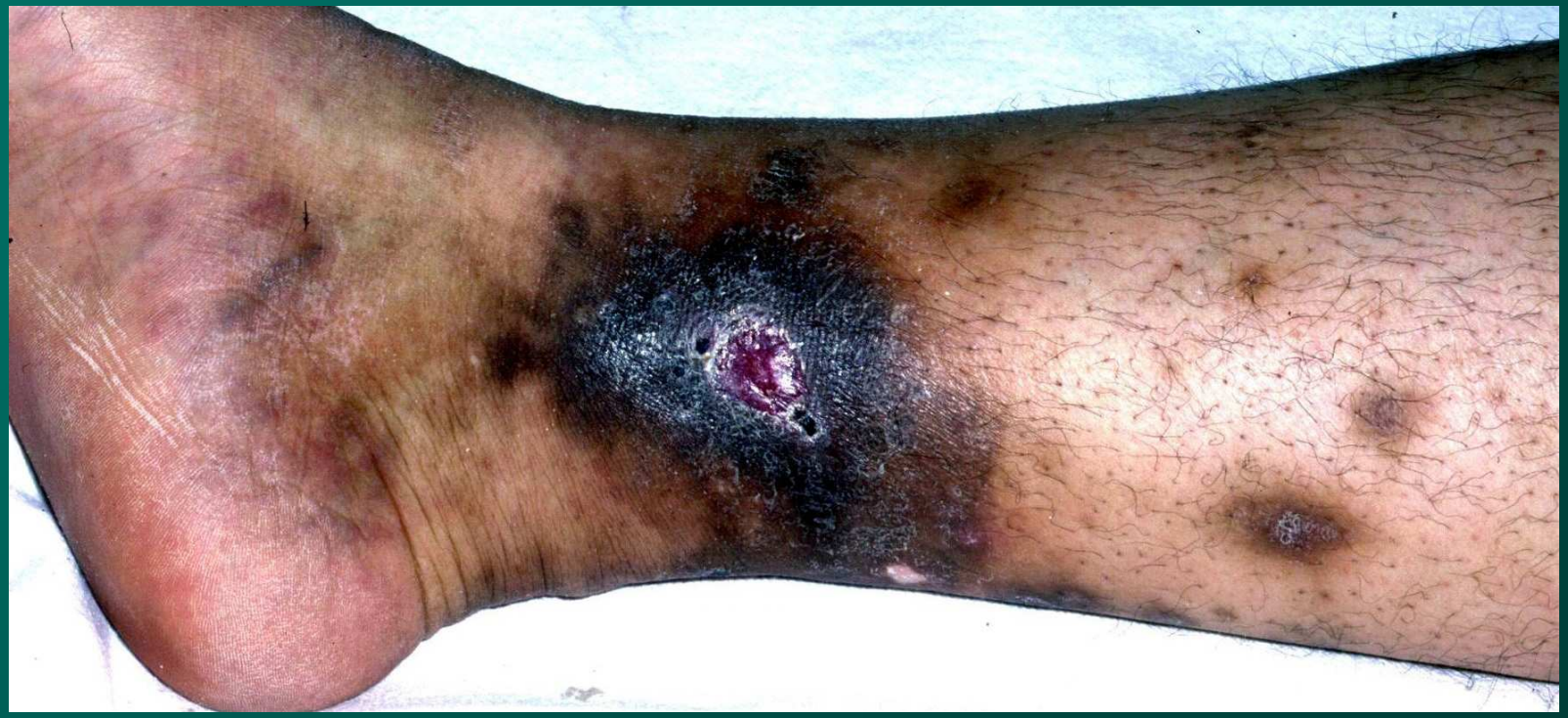
- **Pressure relief** (positioning, appropriate surface)
- Wound debridement, if necessary
- Control of infection
- Maintenance of moist wound environment
- Nutritional supplementation
- Manage incontinence (colostomy, Foley)
- Consider adjunctive therapy (e.g. NPWT)
- Plastic surgery procedures (myocutaneous flaps)

Venous Leg Ulcers

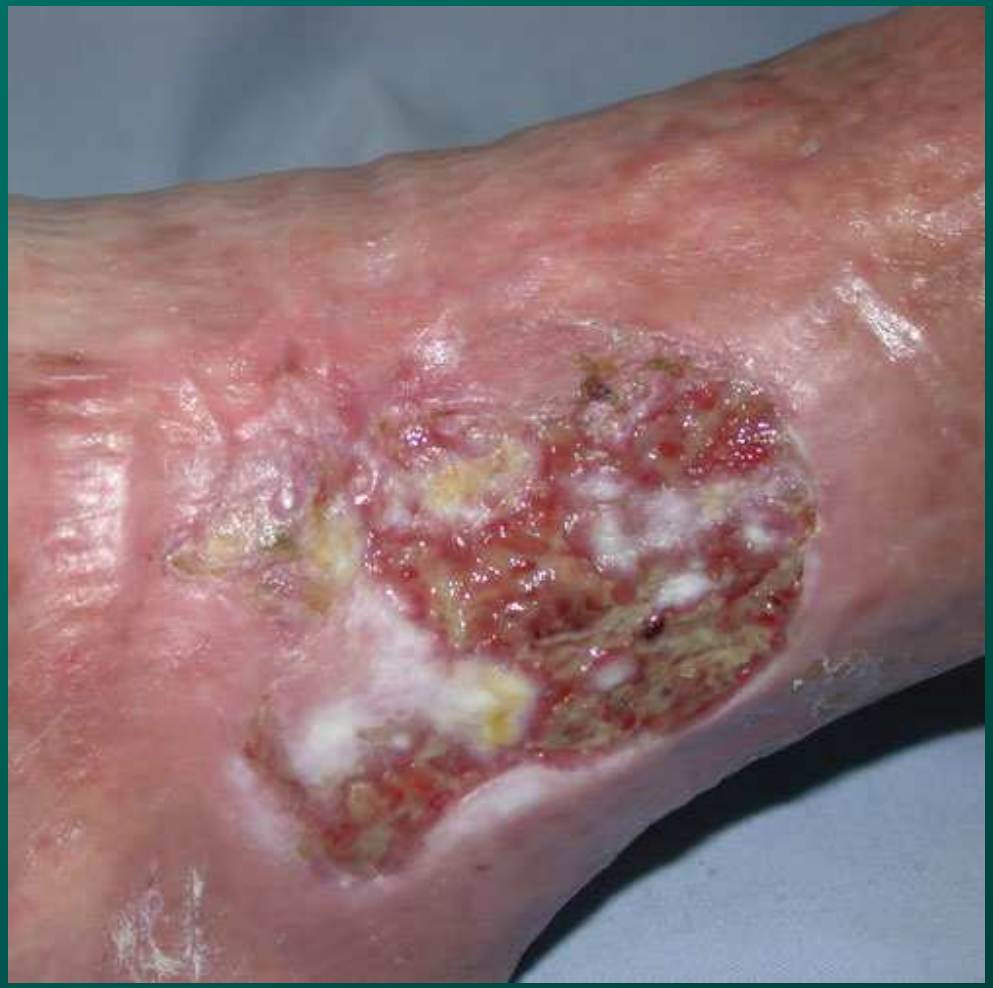
`Gators

Gaiters

Venous ulcer



Venous Ulcer



Venous Leg Ulcers: Incidence & Epidemiology

- 500,000 treated annually (US)[2,3]
- 80-90% of all leg ulcer cases[4]
- $1 billion spent on outpatient treatments annually [1]

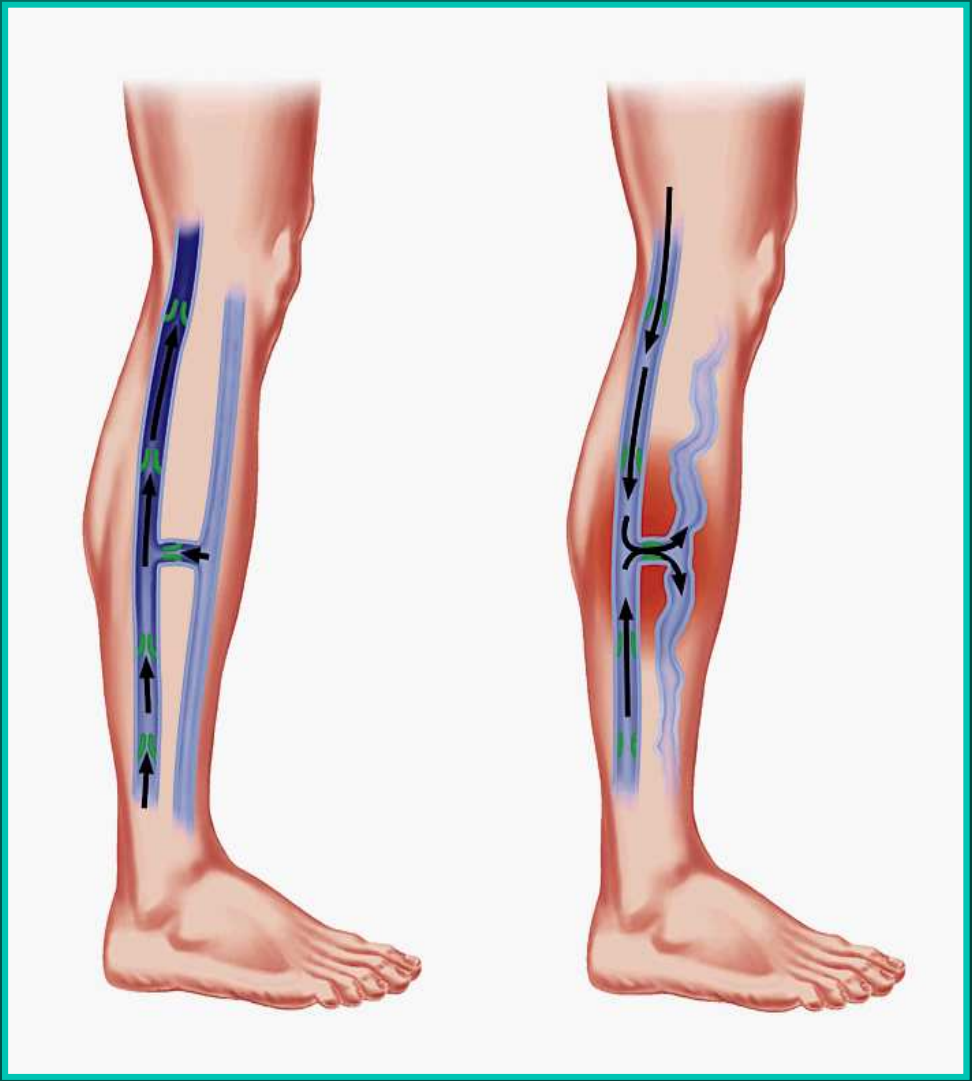
1. Angle N, et al. *BMJ*. 1997;314:1019-1023. 2. Coon WW, et al. *Circulation*. 1973;48:839-846. 3. Mathias SD, et al. *Adv Skin Wound Care*. 2000;13:76-78. 4. Phillips TJ, et al. *J Am Acad Dermatol*. 1991;25:965-987. 5. Olin JW, et al. *Vasc Med*. 1999;4:1-7.

Pathophysiology of Venous Insufficiency

- Incompetence of valves in perforating veins
- Chronic venous hypertension
- Chronic leg edema
- Chronic lower leg skin inflammation

Angle N, Bergan JJ. *BMJ*. 1997;314:1019-1023. Burton CS. *Am J Surg*. 1994;167 (suppl):37S-41S.

Valvular Incompetence



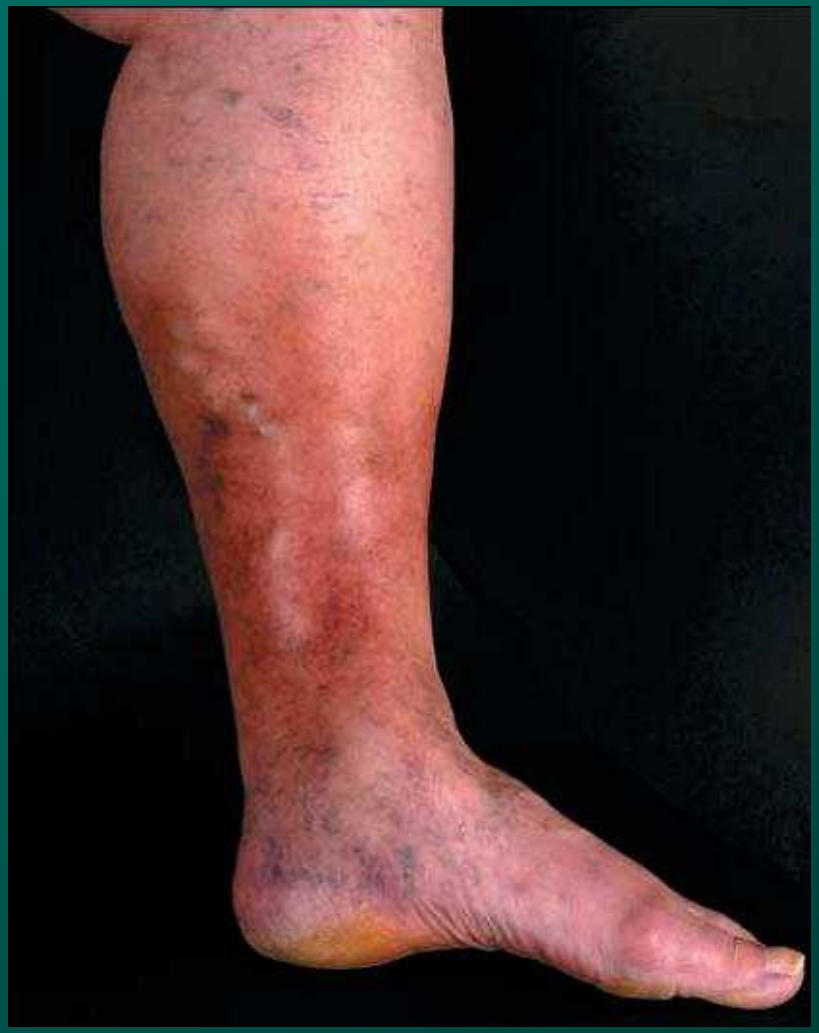
Risk Factors for Venous Ulcers

- History of leg injury (up to 50% of patients)
- Obesity
- History of phlebitis/DVT
- Family history of varicose veins/ulcers
- Job that requires long hours standing

Signs of Venous Disease

- Gaiter localization of findings
- Varicose veins
- Eczematous skin changes
- Hemosiderin pigmentation
- Induration/edema
- Lipodermatosclerosis

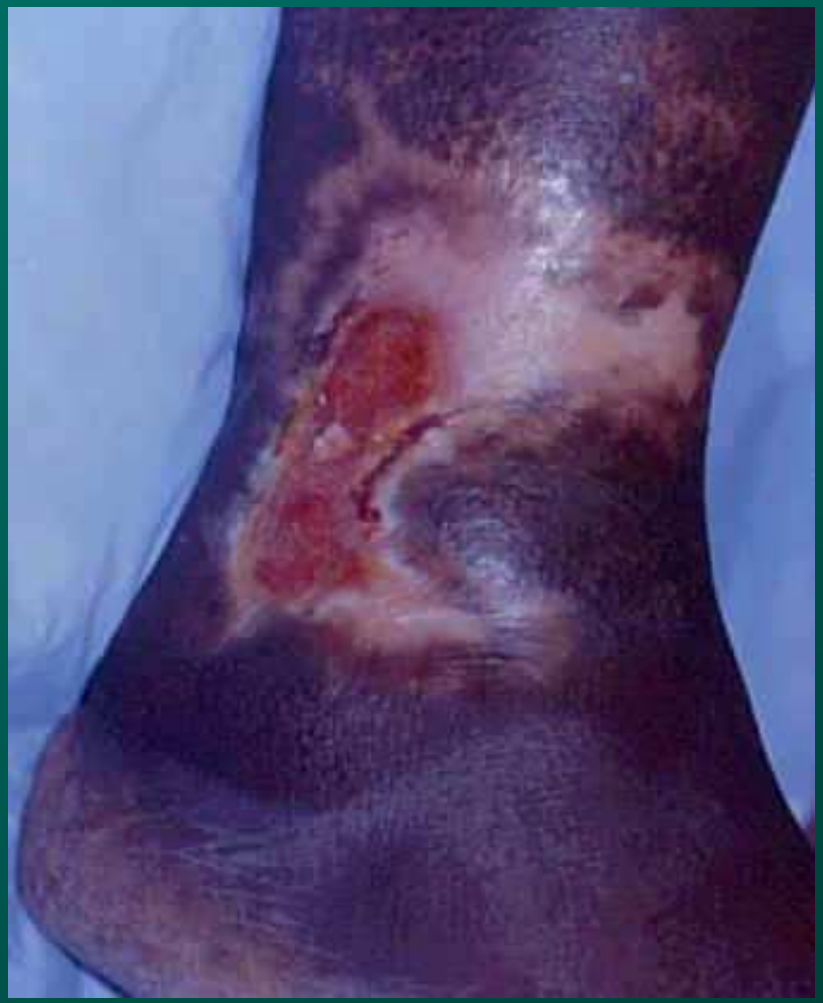
Venous Disease



Lipodermatosclerosis

- Sclerotic process accompanying venous disease
- Full thickness skin/subcutaneous fibrosis
- Acute phase may be mistaken for cellulitis
- Strongly associated with ulceration

Lipodermatosclerosis



Diagnostic Studies

- Venous duplex scan
- Noninvasive arterial studies (25% have PVD)
- CBC, CMP (glucose, albumin)
- Vasculitis labs if suspicious
- Wound culture (after debridement)
- Biopsy if longstanding or not responding

Treatment of Venous Ulcers

- **COMPRESSION** most important
- Correct arterial insufficiency first
- Debride necrotic/senescent tissue
- Treat infection
- Correct nutritional deficiencies
- Smoking cessation
- Pentoxifylline an “effective adjuvant” to compression (Cochrane Review, 2002)

Edema Control

- Leg elevation above level of heart for 30 minutes 3-4 times per day
- Compression devices (wraps, stockings)
- Lymphedema therapy (massage, pumps)
- NOT diuretics unless other indications beside venous disease

Dr. Paul G. Unna (1850-1929)

Compression Therapy

- Elastic wraps, four layer wrap (20-40 mm Hg)
- Unna boot (10-20)
- Compression stockings (20-40 mm Hg)
- Pneumatic pumps
- Caution in CHF patients (increased preload)
- Contraindicated in severe PVD (ABI < 0.5)

Compression Systems

Unna boot

Four Layer
Bandaging System

What's Under the Compression Wrap?

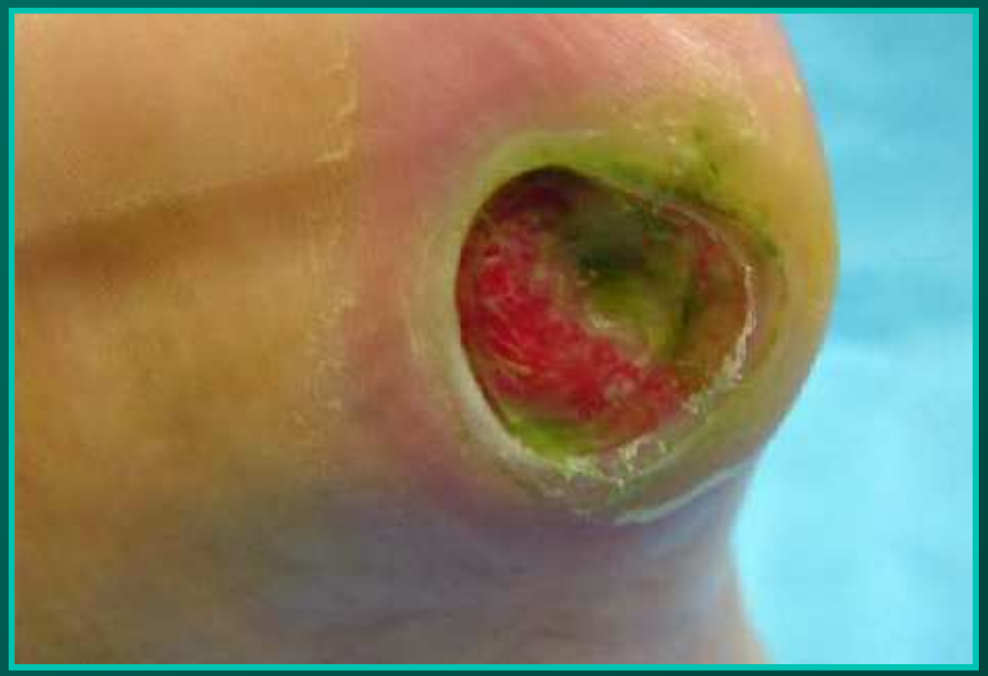
- Plain gauze
- Hydrocolloid dressing
- Foam dressing
- Alginate dressing
- Collagen dressing
- Silver impregnated dressing
- Cadexomer iodine dressing
- Honey-based dressing

Other Therapies

- Radiofrequency vein ablation
- Bioengineered skin equivalents
- Nonliving extracellular matrices
- Topical growth factors
- Negative pressure therapy

Diabetic Foot Ulcer

Diabetic Foot Ulcer



Diabetic Foot Ulcers: Statistics

- Reason for 20% of all diabetes-related hospital admissions
- Result in >86,000 lower extremity amputations per year in U.S.
- Healthcare costs associated with problem exceed $1 billion
- Account for more hospital-bed days than all other diabetes complications

Events After Amputation

- After 1 major lower-extremity amputation
  - 5-year survival rate is 40%
- Predicted contralateral amputation
  - 56% of patients within 5 years after first amputation

American Diabetes Association. Diabetes 1996 Vital Statistics.

Contributing Factors

- Peripheral neuropathy
- Ischemia
- Mechanical stress, minor injury
- Decreased visual acuity

Diabetics Are Different

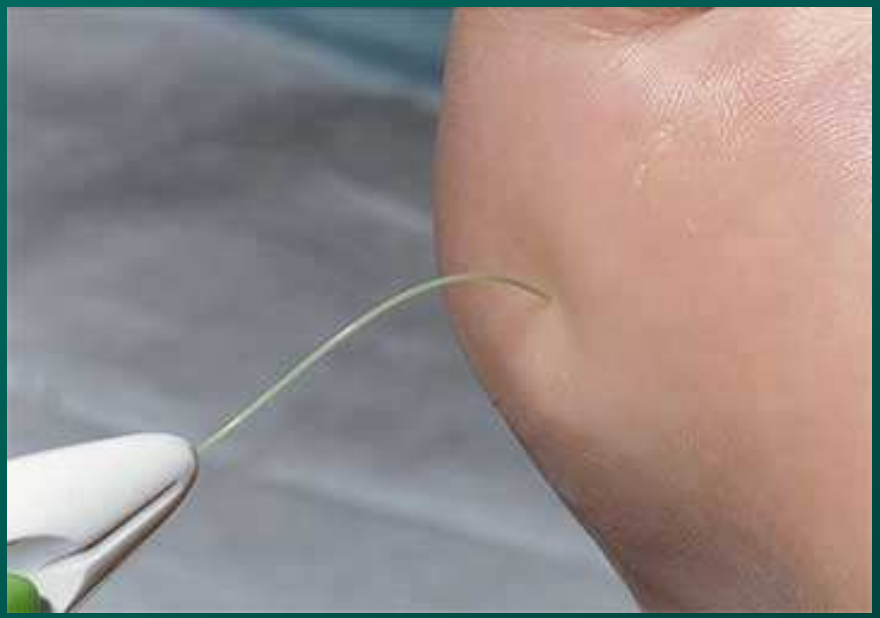
- **Growth factor and cytokine deficiencies** in diabetic mouse and diabetic human wounds: PDGF, VEGF, IGF-1, IGF-II, TGF-B, aFGF, IL-6
- **Arterial occlusive disease:** ischemia predisposes to foot ulceration
- **Neuropathy:** associated with slower conduction velocity of sensory nerves, depression of autonomic responses
- Decreased **angiogenesis**
- Abnormalities in **fibroblast function**

Brem H, et al. *Surg Technol Int*. 2003;11:23-31.

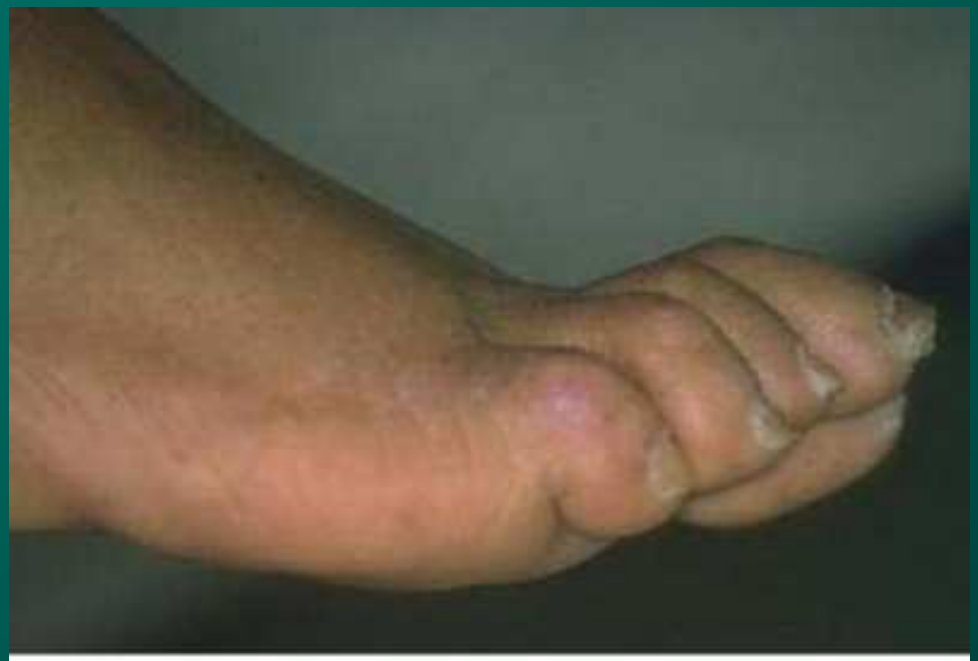
Diabetic Neuropathy

- Sensory/autonomic: numb, dry foot
- Clawing of toes commonly seen
- Weight bearing on metatarsal heads
- Calluses/ulcers over pressure points
- Charcot foot is end-stage result

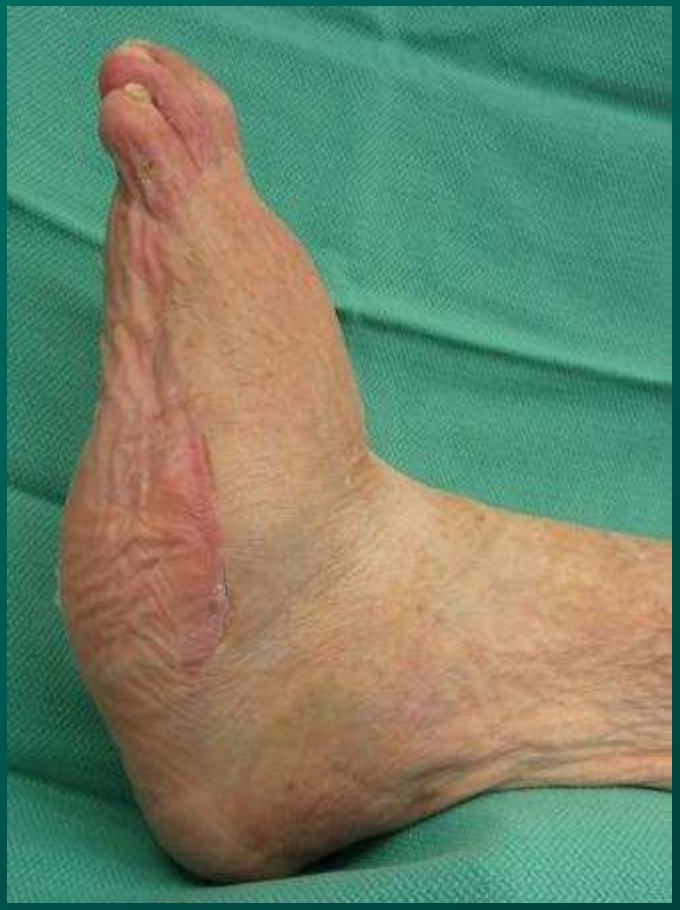
Standardized Monofilament testing



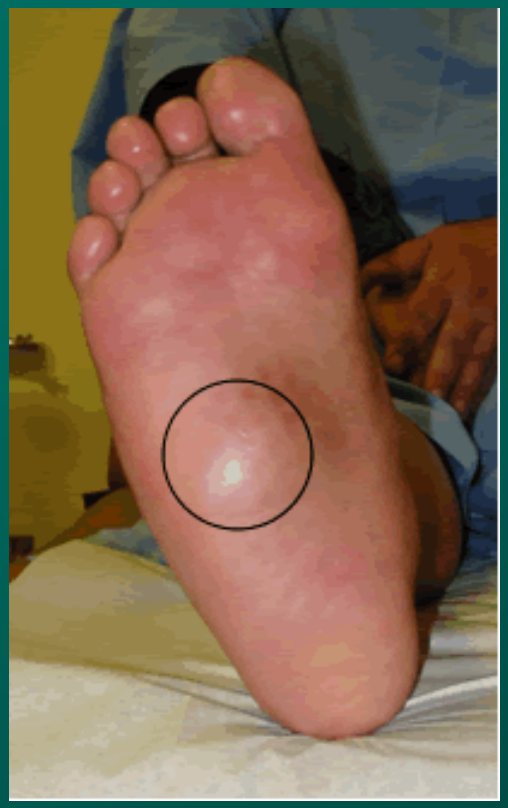
Claw Deformity

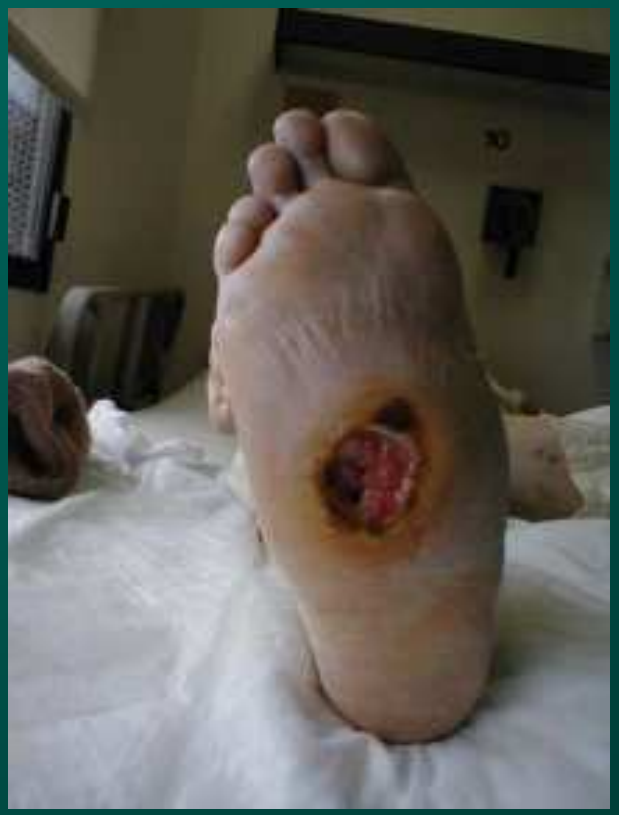


Charcot Foot



Charcot Foot





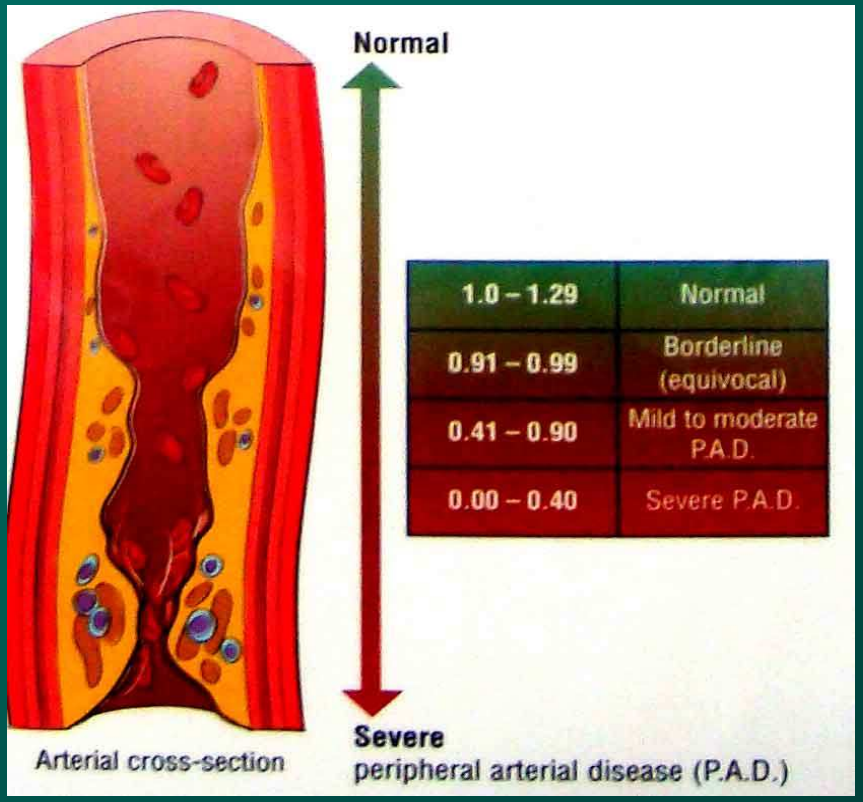
Diabetic Vasculopathy

- Classic macrovascular lesion of diabetic PVD is medial calcinosis
- PVD occurs at an earlier age and is more rapidly progressive than in nondiabetic patients
- Infrapopliteal “trifurcation” disease more common in diabetics

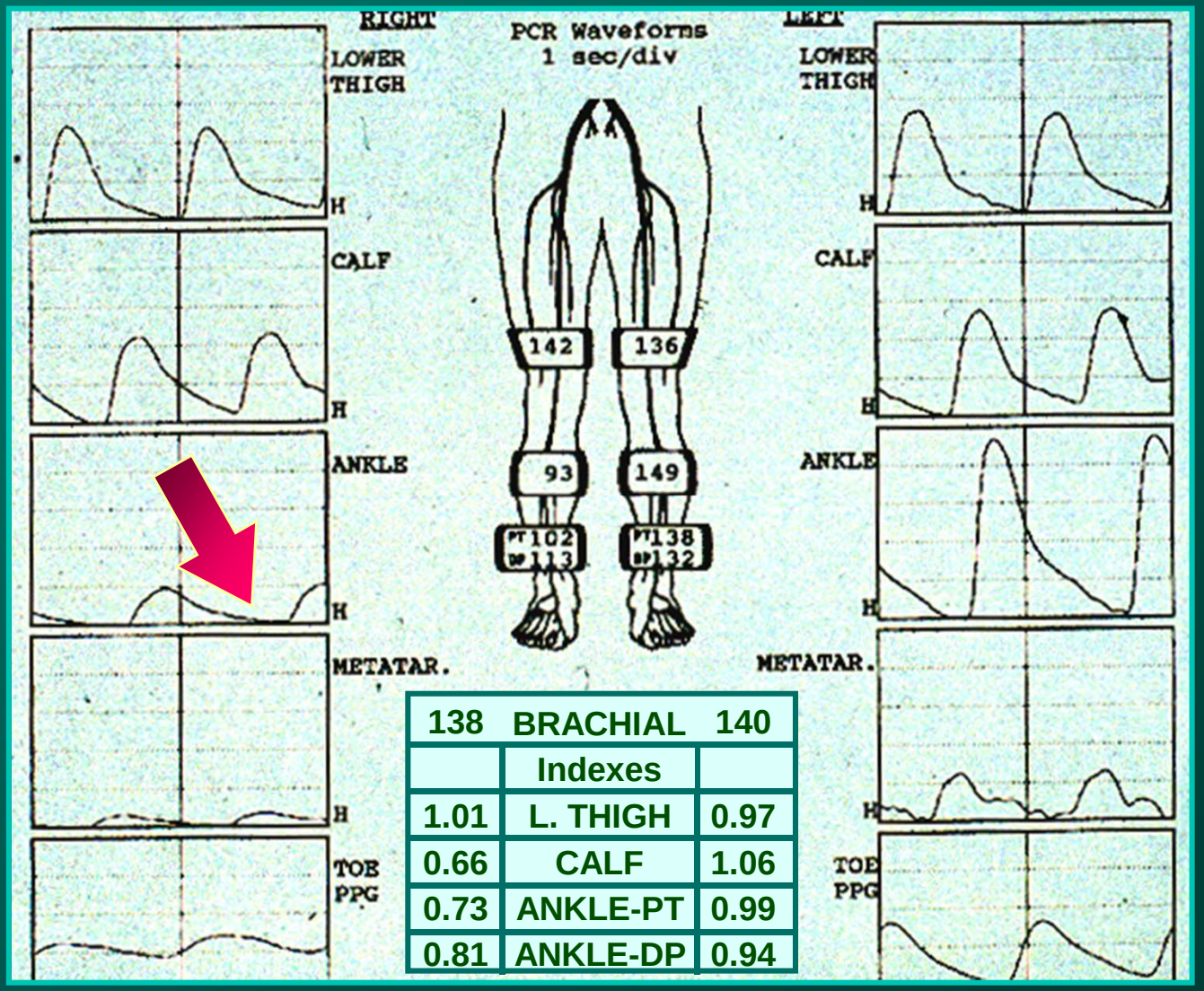
Ankle Brachial Index

- Ankle systolic BP/Arm systolic BP
- ABI < 0.9 indicates PVD
- ABI > 1.3 indicates poorly compressible vessels
- ABI may not be reliable in diabetics with medial calcinosis
- Toe pressure may be more reliable than ABI in diabetics (> 30 mm Hg usually adequate for healing)

Ankle-Brachial Index



Pulse Volume Recording/ABI Ischemia Evaluation



Toe Pressure Cuff

Diagnostic Studies

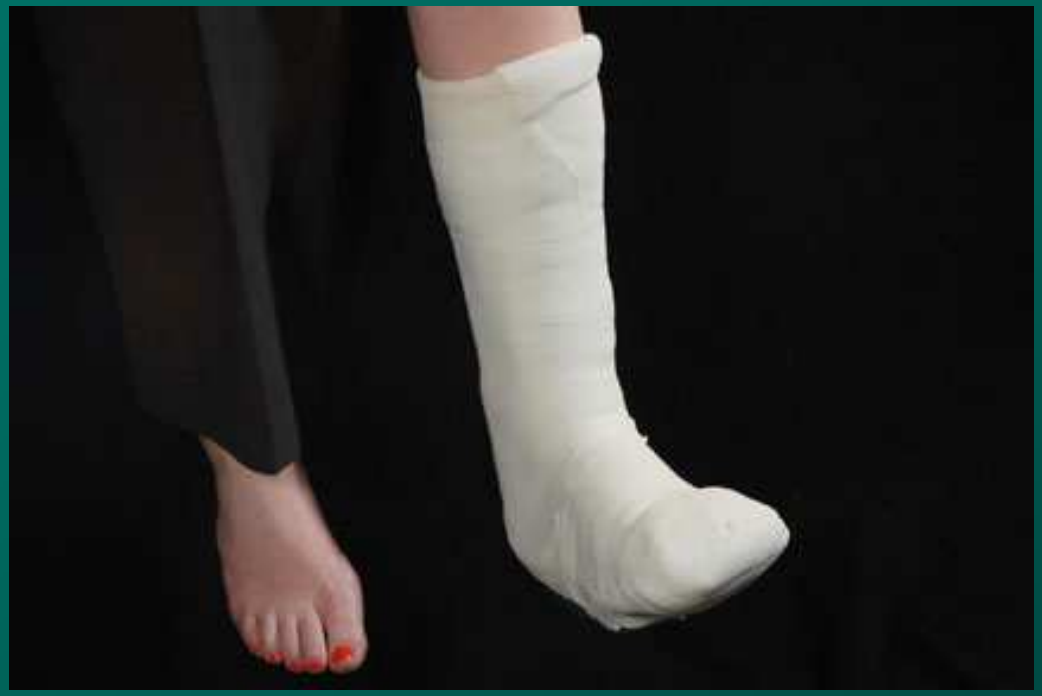
- CBC, CMP, HgbA1C
- Plain X-rays of foot (3 view)
- Wound culture
- MRI
- Noninvasive vascular studies
- MRA vs. standard arteriogram
- TcPO2 (< 30-40, poor healing)

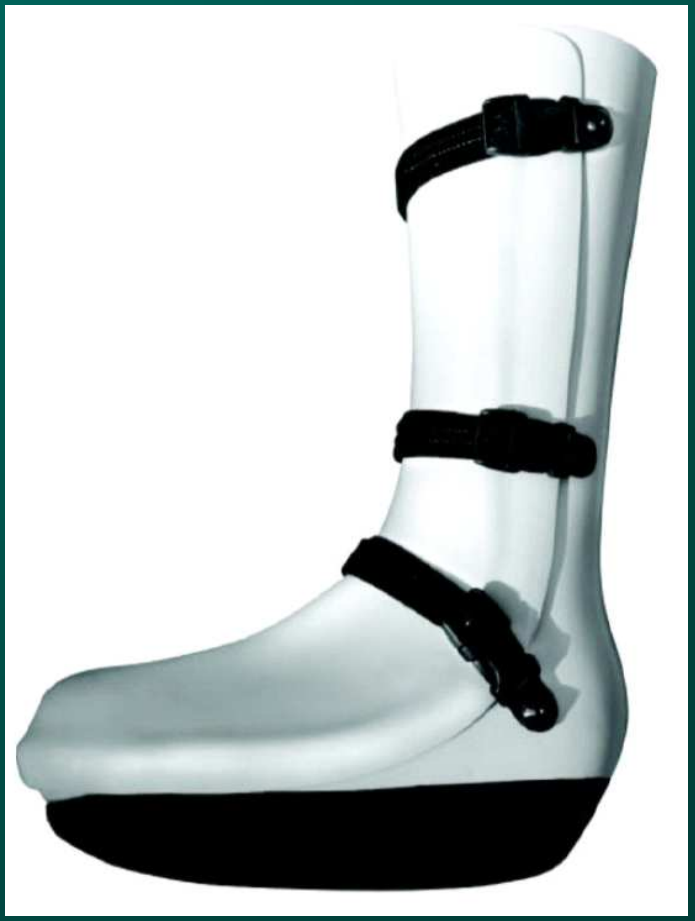
Treatment of Diabetic Foot Ulcer

- OFFLOADING is primary
- Treat infection
- Debride wound
- Revascularize limb if necessary
- Optimize glycemic control
- Stop smoking
- Hyperbaric oxygen for Wagner 3 and 4

Offloading the Diabetic Foot

Offloading the Diabetic Foot





Ultimate Offloading

Treating Infection in the Diabetic Foot

- Always cover *Staph aureus* (including MRSA) and beta-hemolytic *Streptococcus*
- Should also cover aerobic Gram-negative rods (coliforms) and anaerobic Gram-negative rods
- IV therapy for serious infections
- Sample PO regimen: trim/sulfa + amox/clav
- Sample IV regimen: vancomycin + pip/tazo
- Sample IV regimen if penicillin allergic: tigecycline

Treating Peripheral Vascular Disease

- Stop smoking…NOW
- Medicine: statin, antiplatelet agent, vasodilator
- Exercise program
- Catheter-based intervention
- Open bypass procedure

Negative Pressure Wound Therapy

- Reduces local edema/fluid
- Stimulates granulation tissue growth
- Protects wound from contamination
- Enhances migration of epithelium

Hyperbaric Oxygen Therapy

What is hyperbaric oxygen therapy?

- Patient breathes 100% oxygen while his or her entire body is enclosed in a pressure chamber (pressure greater than sea level)

Hyperbaric Oxygen Therapy

- Modern therapy dates to early 1960s with use for gas gangrene and severe anemia
- Currently a primary treatment for DCS, air embolism, and acute CO poisoning
- Adjunctive treatment for multiple conditions sharing the common pathophysiology of tissue hypoxia

CMS Approved Indications for HBOT

- Decompression sickness (“the bends”)
- Air or gas embolism
- Acute carbon monoxide poisoning
- Gas gangrene (clostridial myonecrosis)
- Acute peripheral ischemia
- Diabetic foot wounds (Wagner 3 and 4)
- Soft tissue radionecrosis, osteoradionecrosis

More Approved Indications

- Necrotizing soft tissue infections
- Chronic refractory osteomyelitis
- Compromised skin grafts and flaps
- Crush injuries

Potential Complications of HBOT

- HBOT is generally safe and well tolerated
- Reversible myopia may occur due to oxygen toxicity to lens; weeks to months to resolve
- Otic barotrauma (alleviated by P.E. tubes)
- Pulmonary oxygen toxicity (chest tightness, cough, dyspnea); reversible
- Seizures due to oxygen toxicity (1 in 11,000 treatments); increased risk with steroids, thyroid replacement, and insulin

Contraindications to HBOT

- Absolute contraindications include untreated pneumothorax and concurrentuse of bleomycin, cisplatin, doxorubicin, disulfiram, and sulfamylon.
- Relative contraindications include obstructive lung disease (especially bullous disease), CHF with LVEF < 30, URI, recent ear surgery or trauma, and claustrophobia.
- Patients with a history of seizure disorder, pneumothorax, or chest surgery are at increased risk for complications.

QUESTIONS?