Wound Care in the Hospital

Robert M. Plemmons, M.D., FACP, CWS
Medical Director
Wound Care and Hyperbaric Medicine Clinic
Scott & White
The Problem

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

Chandan K. Sen, PhD,1 Gayle M. Gordillo, MD,1 Sashwati Roy, PhD,1 Robert Kirsner, MD,2 Lynn Lambert, CHT,1,3 Thomas K. Hunt, MD,4 Finn Gottrup, MD,5 Geoffrey C Gurtner, MD,6 and Michael T. Longaker, MD6

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

If the patient lies on his/her back

If the patient uses a wheelchair

If the patient rests on his/her side

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

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

<table>
<thead>
<tr>
<th>Factor/score</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical condition</td>
<td>Good</td>
<td>Weak</td>
<td>Ill</td>
<td>Very Ill</td>
</tr>
<tr>
<td>Mental state</td>
<td>Alert</td>
<td>Apathetic</td>
<td>Confused</td>
<td>Stuporous</td>
</tr>
<tr>
<td>Activity</td>
<td>Ambulant</td>
<td>Walks with help</td>
<td>Chair bound</td>
<td>Bed-ridden</td>
</tr>
<tr>
<td>Mobility</td>
<td>Full</td>
<td>Slightly impaired</td>
<td>Very limited</td>
<td>Immobile</td>
</tr>
<tr>
<td>Incontinence</td>
<td>No</td>
<td>Occasional</td>
<td>Usually urinary incontinence</td>
<td>Double incontinence</td>
</tr>
<tr>
<td>Interpretation of scale</td>
<td>Score of &gt;18 – low risk</td>
<td>Score of 14-18 – medium risk</td>
<td>Score of 10-&lt;14 – high risk</td>
<td>Score of &lt;10 – very high risk</td>
</tr>
</tbody>
</table>
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 ulcers¹
- 2011: NPUAP Concensus Conference agreed unanimously that not all pressure ulcers are avoidable²

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
- 30% (95) Falls
- 39% (122) Pressure ulcers/bedsores
- 4% (12) Other events
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 30° 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 prevention³

Group 1 Surfaces
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

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 $^1$

Pathophysiology of Venous Insufficiency

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

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 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

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

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

Arterial cross-section
Severe peripheral arterial disease (P.A.D.)

Normal
1.0 – 1.29
0.91 – 0.99
0.41 – 0.90
0.00 – 0.40

Borderline (equivocal)
Mild to moderate P.A.D.
Severe P.A.D.
Pulse Volume Recording/ABI Ischemia Evaluation

<table>
<thead>
<tr>
<th>138 BRACHIAL</th>
<th>140</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indexes</td>
<td></td>
</tr>
<tr>
<td>1.01 L. THIGH</td>
<td>0.97</td>
</tr>
<tr>
<td>0.66 CALF</td>
<td>1.06</td>
</tr>
<tr>
<td>0.73 ANKLE-PT</td>
<td>0.99</td>
</tr>
<tr>
<td>0.81 ANKLE-DP</td>
<td>0.94</td>
</tr>
</tbody>
</table>
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 concurrent use 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?