Assessing and Managing Pressure Injuries

Barbara M. Bates-Jensen PhD, RN, WOCN, FAAN
Professor of Nursing & Medicine
School of Nursing & David Geffen School of Medicine,
University of California, Los Angeles

DISCLOSURES

- Grant/research support from:
  - VA Health Services Research and Development (IIR 16-267, PI Burkhart),
  - NIH-NINR (PI, Bates-Jensen/Yap),
  - Mölnlycke Health Care (PI, Bates-Jensen)
- Royalty from UCLA as co-inventor SEM Scanner

Pressure Injuries (PrIs): A Global issue

- ***Worldwide*** hospital prevalence: 12.8% to 18.5%
- HAPrI rate: 8.4%
- Critical care incidence: 10-26%;
- Long term care incidence: 9-12%
- Most common locations:
  - Sacrum & Heels
  - Medical device related PrIs

Where are they coming from?

- Community acquired (CAPrI): 6.6-14.9%.
- CAPrI patient characteristics:
  - 31% live alone
  - 77% at PrI risk
  - mobility limitations and inadequate/poor nutrition
  - 21.4% receiving home care
  - Discharge:
    - NH 51%, Home 33%, Died/Hospice 14%
  - 30-day readmission 15.5%

Newly admitted NH residents:

- 9.2% transferring from hospital stage 1+ PrI on admission

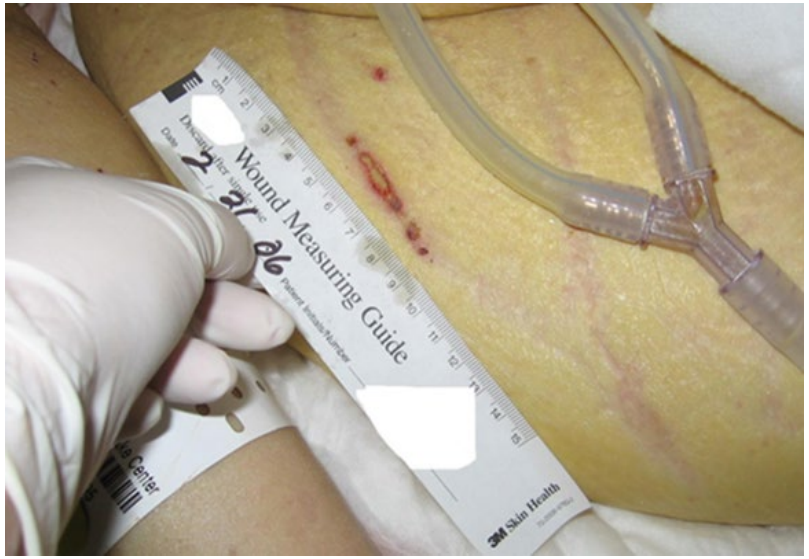
VS

- 2.6% transferred from community

- transfer from hospital vs community associated with increased PrI risk equally across subgroups of less and more susceptible residents

Medical Device Related PrI

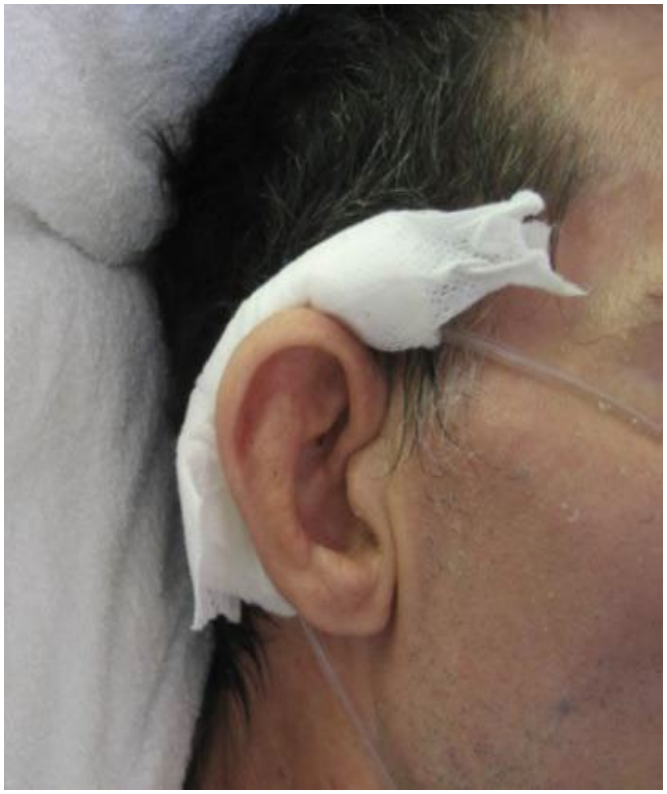
- Incidence 12%
- Prevalence 10%
- Patients with medical devices 2.4 times more likely to develop PrI
- ET tubes: 4.2%
  - stabilize
- NT tubes: 21%
  - Barrier dressings

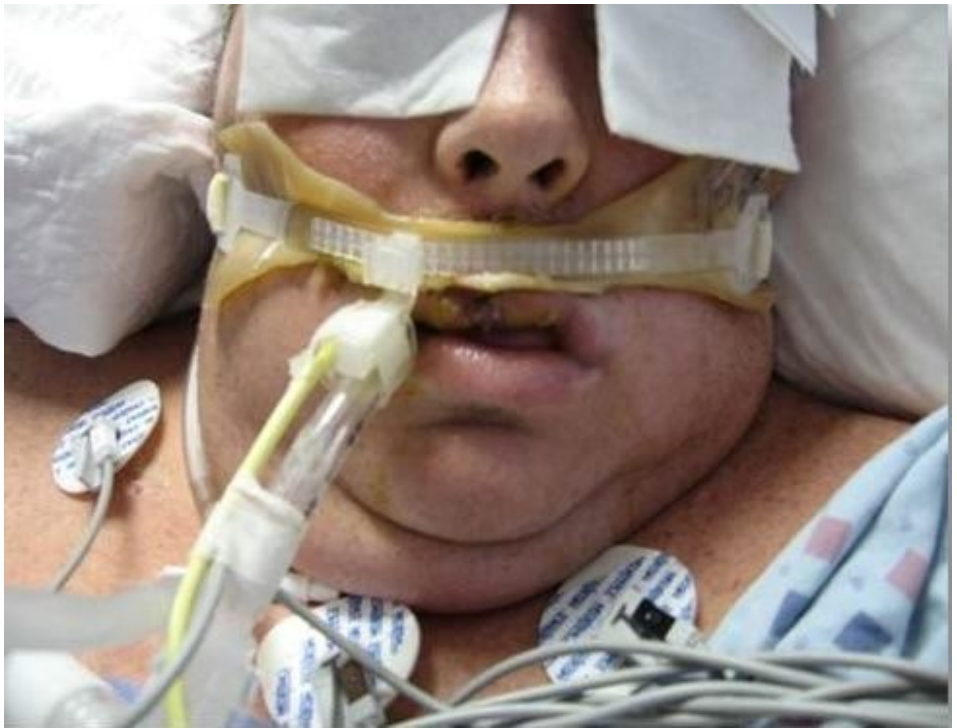


http://img.medscape.com/

Medical Device Related PrI

- Silicone foam or hydrocolloids around devices such as trach tubes or oxygen tubing
- Alternating full face with CPAP masks





Risk Assessment: Braden Scale

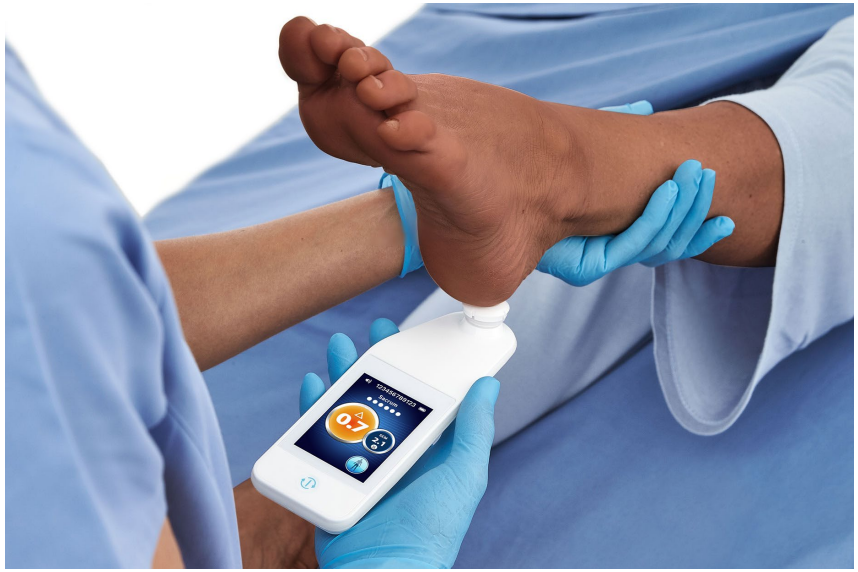
- **Score range 6-23; Low score = High risk**
- Predictor of outcomes for HF patients?
  - Higher (Better) Braden score significant for decreased 30-day mortality and decreased LOS
- Use of EHR to auto-populate risk status
- Use of patient reported symptoms to augment RA
  - Nausea, pain, urinary problems
- 58% of HAPrI found among patients at mild to moderate risk (Braden score)

Biophysical measures : SEM

- Sub-epidermal moisture (SEM)
  - Surface electrical capacitance measures to detect edema/water in tissues as early indicator of inflammatory response, adjunct to skin assessments
- Higher values = more edema, inflammation
  - SEM higher when no visible damage, but PrI 1 week later
- FDA approved for sacral & heel PrI detection

Detection: Sacrum & Heels

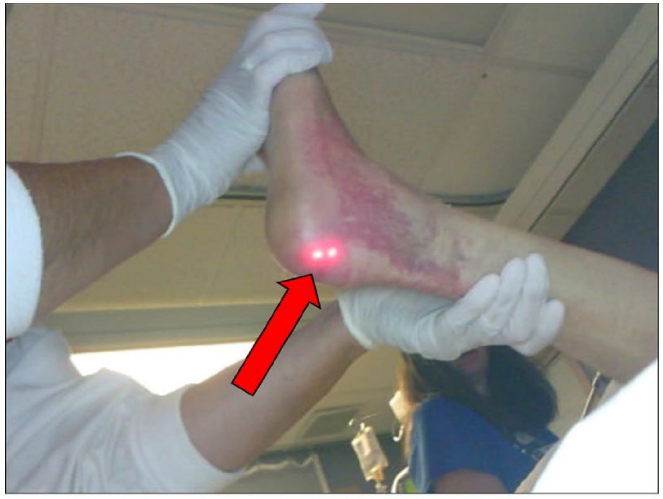
- PrI among 417 NH residents in 19 NHs over 16 weeks
- Elevated SEM with heel and sacral PrI not visible on skin but observed 1 week later
- SEM detected heel Deep Tissue Injury (DTI), differentiated DTI that resolved, remained and deteriorated

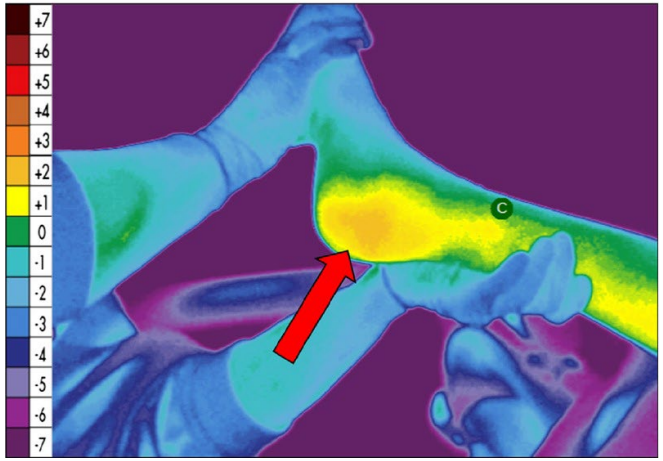


SEM Scanner Acute Care use

- Patients hospitalized 6 days
- SEM versus wound care specialist visual assessment:
  - SEM detected damage **4-5 days earlier than PrI visual diagnosis** by wound care specialists.
- Multi-site implementation of SEM Scanner in 1,478 patients (13 acute care hospitals, 1 palliative care setting, and 1 community care setting):
  - Reduction in HAPrI incidence in all settings
  - 87% reduction in acute care
  - 47% reduction in palliative care

Biophysical measures: Thermography

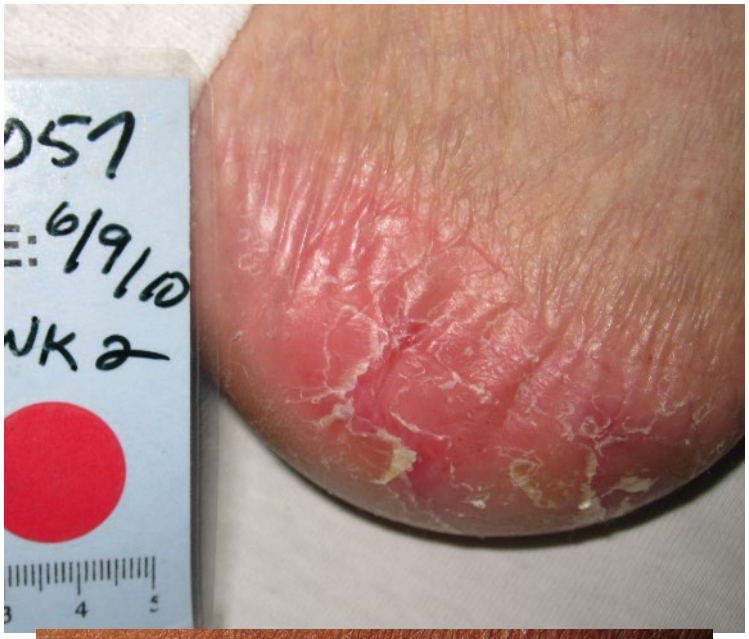


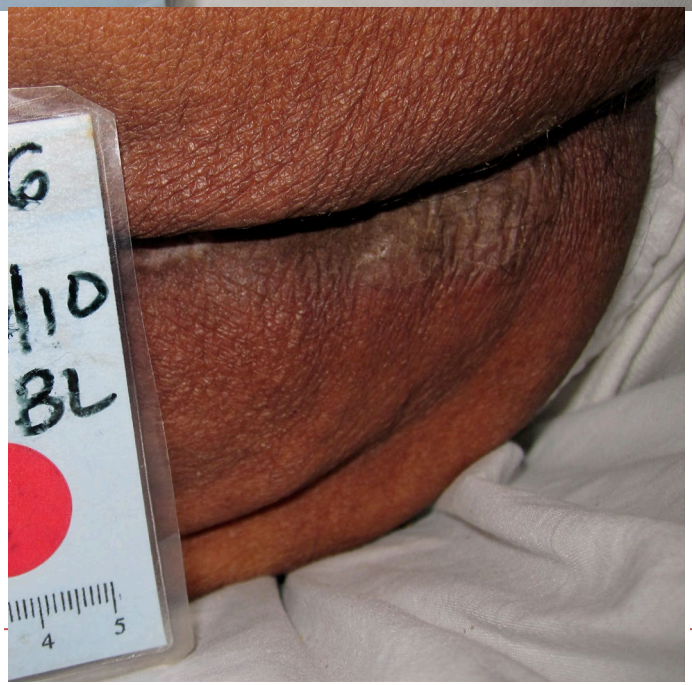


- Long-wave infrared thermography (LWIT) measures radiant heat from body
- Temperature difference between infected chronic wound and normal tissue: elevated temp 3-4° C
- **Elevated temperature 1.2° C may predict PrIs 24-96 hours before visual appearance**

Stage 1

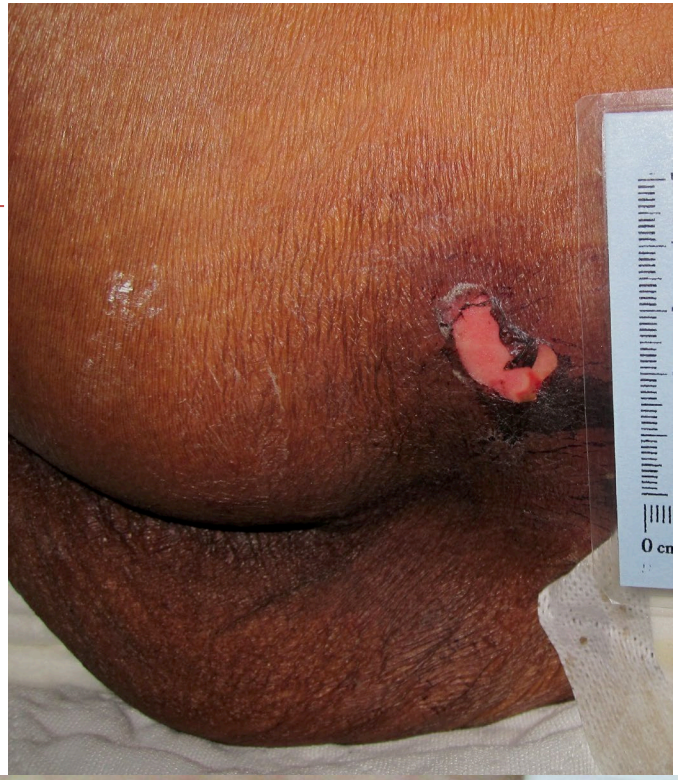
Intact skin with a localized area of non-blanchable erythema, which may appear differently in darkly pigmented skin. Presence of blanchable erythema or changes in sensation, temperature, or firmness may precede visual changes.

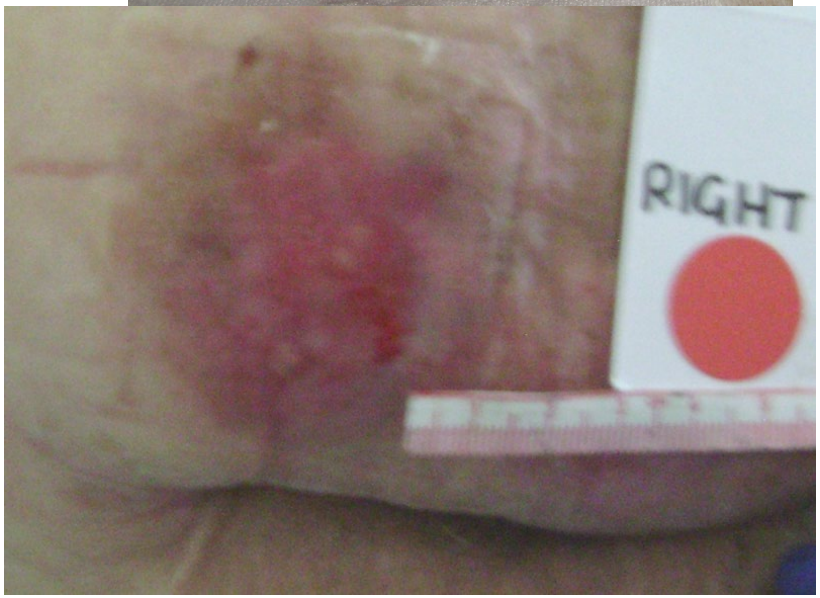


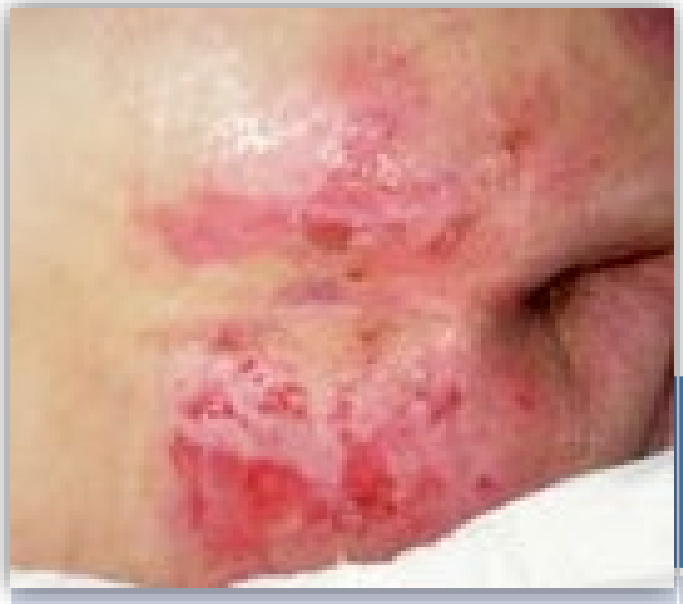


Stage 2

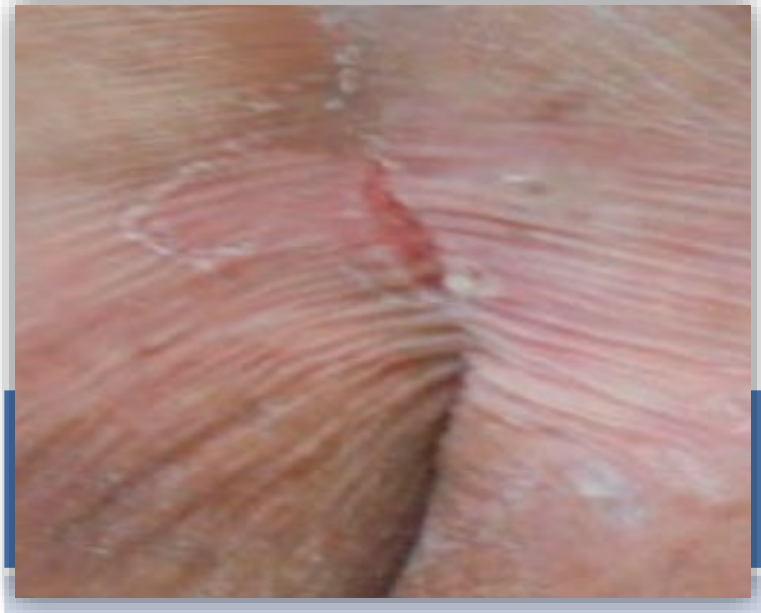
Partial-thickness loss of skin with exposed dermis. The wound bed is viable, pink or red, moist, and may also present as an intact or ruptured serum-filled blister. Adipose (fat) is not visible and deeper tissues are not visible. Granulation tissue, slough and eschar are not present.





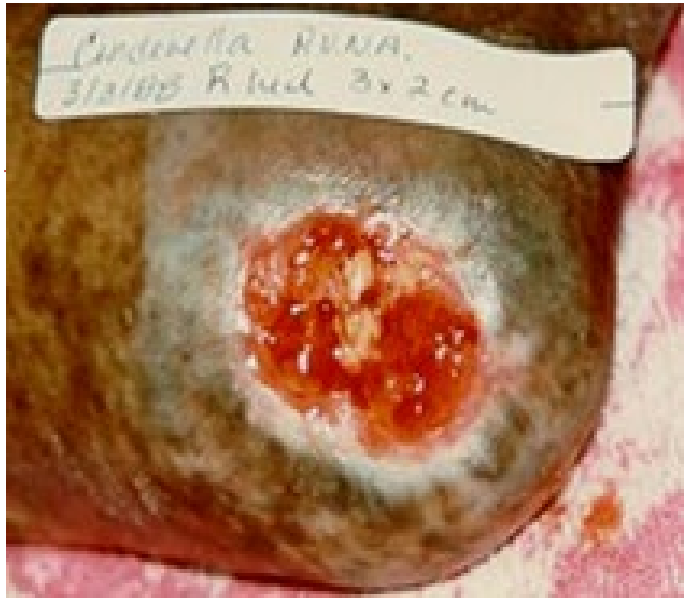


	IAD incontinence associated dermatitis
Location	Buttocks, inner thighs, perianal, perineal area
Depth & shape	Superficial, partial thickness, blisters, multiple
Characteristics	Diffuse blanchable erythema/discoloration Copy lesions, blisters, denudation-erosions, Ulcer edges diffuse, irregular Fungal infection may be present (C. Albicans) with rash and satellite lesions Pain, itching, burning

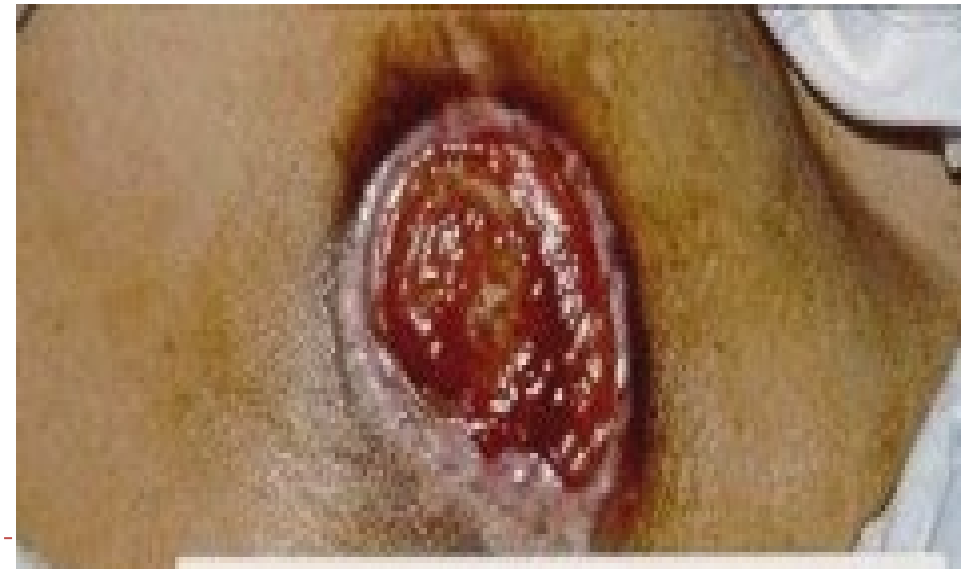


	ITD Intertriginous dermatitis
Location	Intergluteal cleft, under pannus or breasts
Depth & shape	Superficial, partial thickness initially, linear
Characteristics	Surrounding maceration Clear Ulcer edges Fungal infection (C. Albicans) may be present with rash and satellite lesions Pain, itching

Stage 3

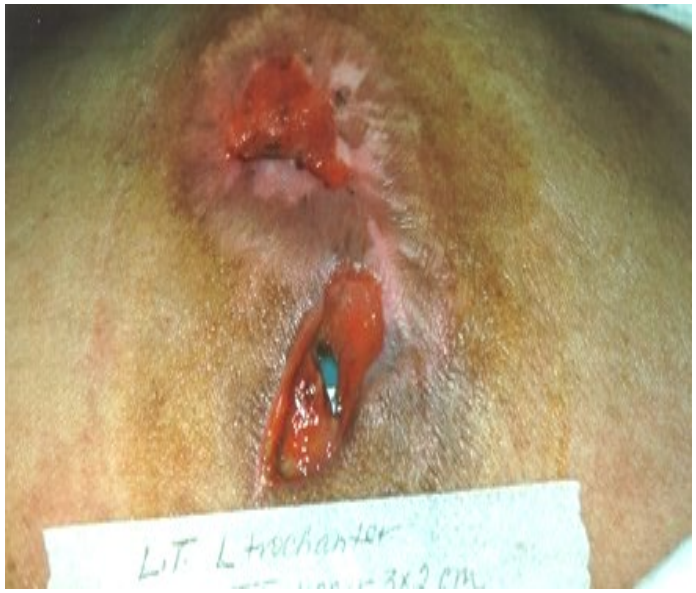


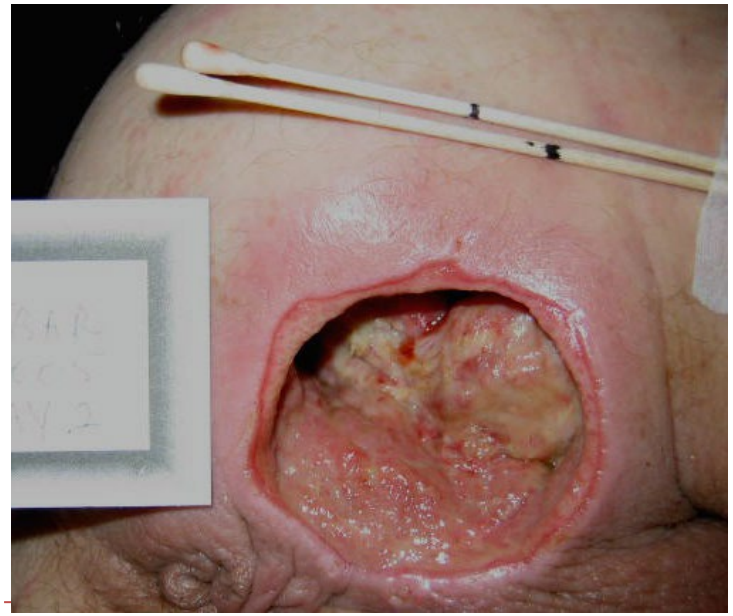
Full-thickness loss of skin, in which adipose (fat) is visible in the ulcer and granulation tissue and epibole (rolled wound edges) are often present. Slough and/or eschar may be visible. The depth of tissue damage varies by anatomical location.



Stage 4

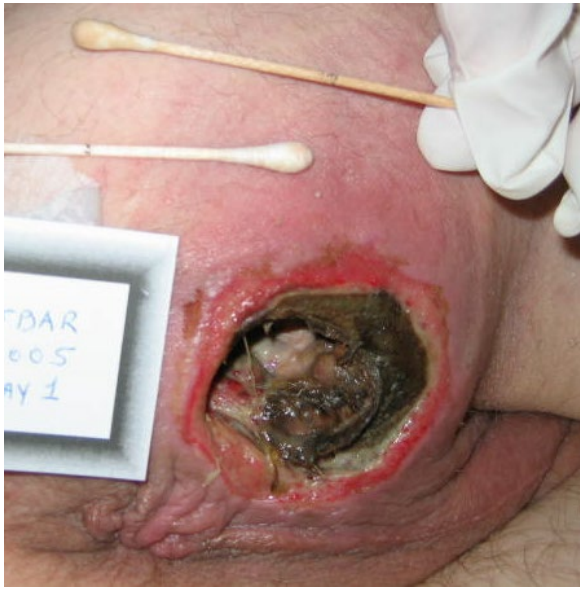
Full-thickness skin and tissue loss with exposed or directly palpable fascia, muscle, tendon, ligament, cartilage or bone in the ulcer. Slough and/or eschar may be visible. Epibole (rolled edges), undermining and/or tunneling often occur. Depth varies by anatomical location.

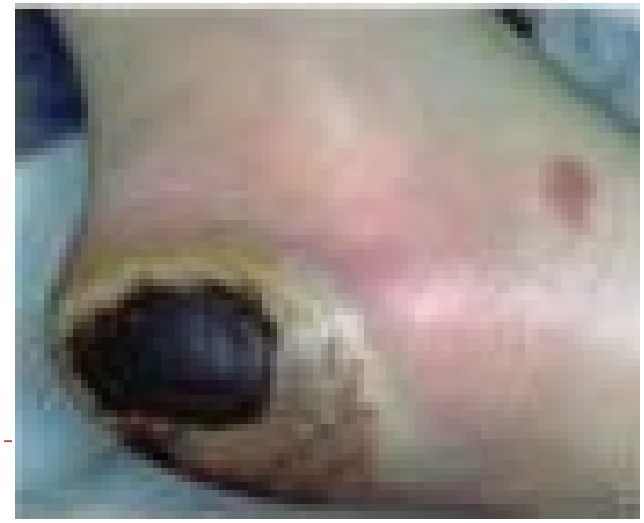




Unstageable Pressure Injury

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.*** If slough or eschar is removed, a Stage 3 or Stage 4 pressure injury will be revealed. Stable eschar on an ischemic limb or the heel(s) should not be removed.

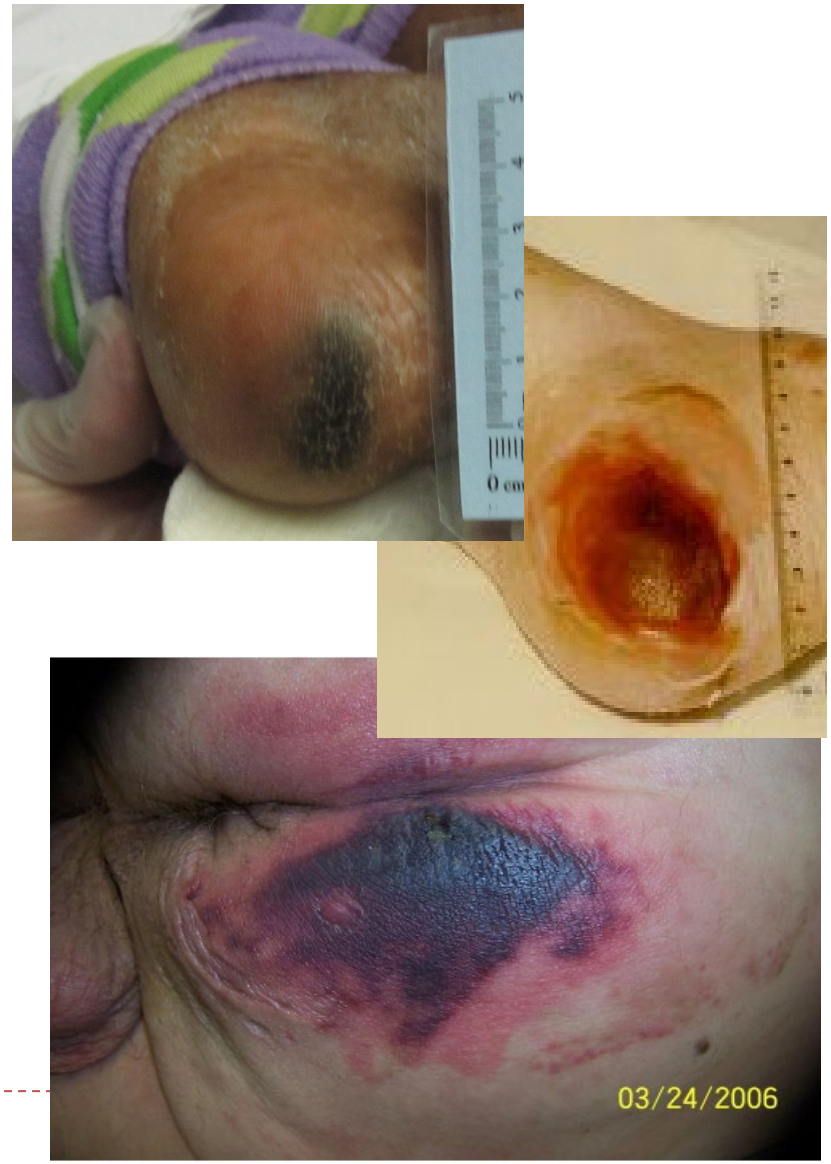




Deep Tissue Pressure Injury

Non-blanchable deep red, maroon, purple discoloration, or epidermal separation revealing a dark wound bed or blood filled blister.

- Highest in ICU (14% of all PrIs)
- More heels in Nursing Homes
- *Time of injury* precedes DTI 3-5 days

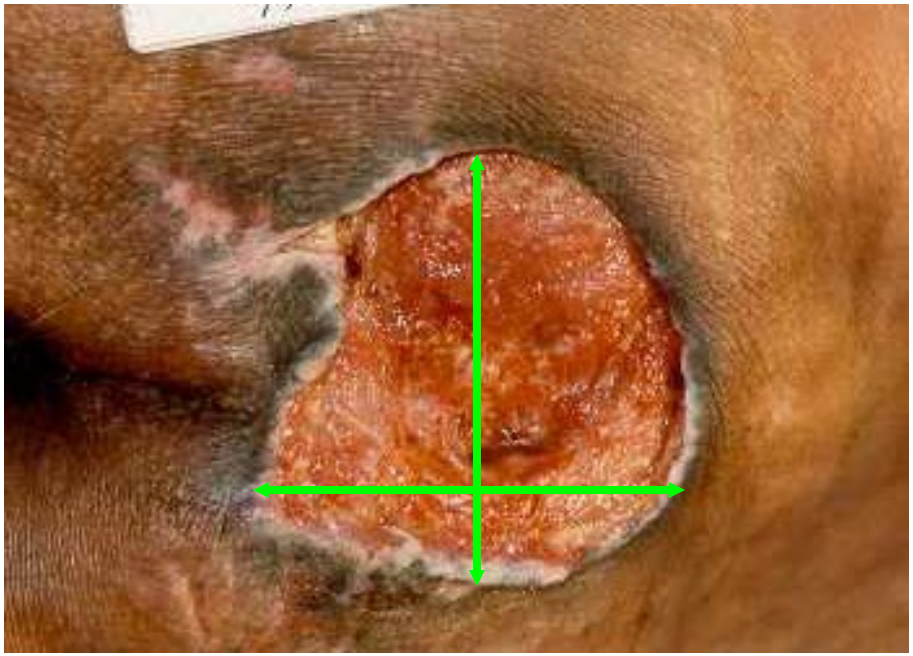


Bates-Jensen Wound Assessment Tool (BWAT)

- 13 items rated 1-5 scale
- Sum for total score (9-65 range)
- Available from author
  - batesjen@sonnet.ucla.edu

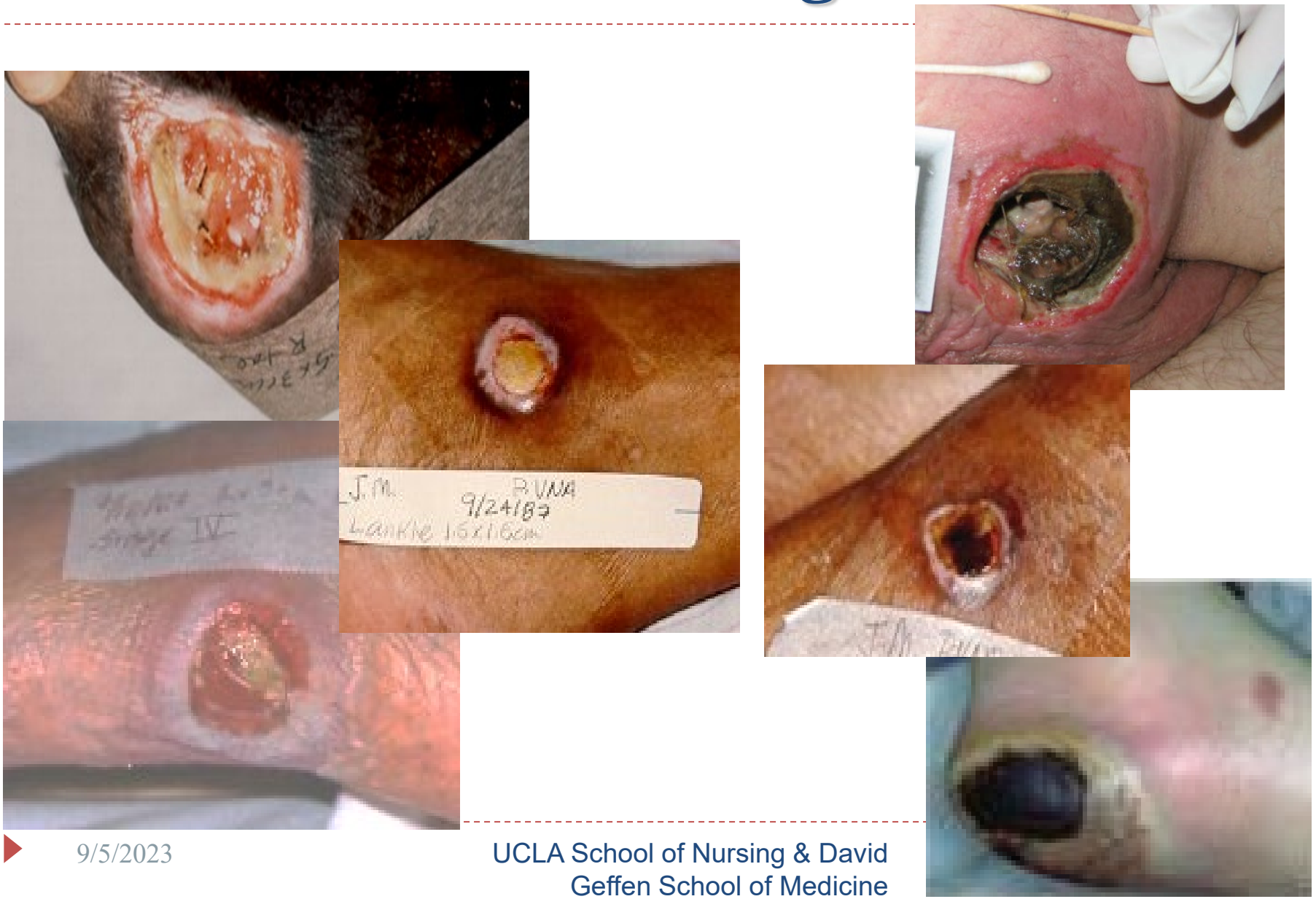
- Size & Depth
- Edges & Undermining
- Necrotic tissue type & amt.
- Exudate type & amt.
- Surrounding Tissue Characteristics
- Granulation
- Epithelialization

Size

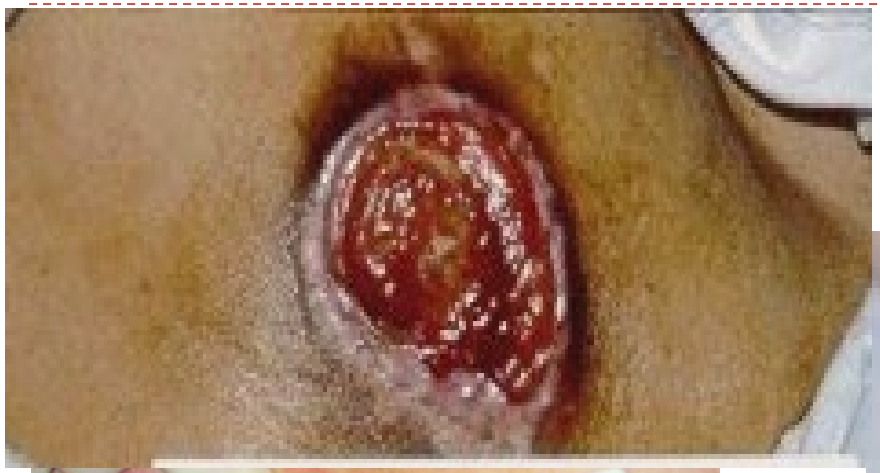


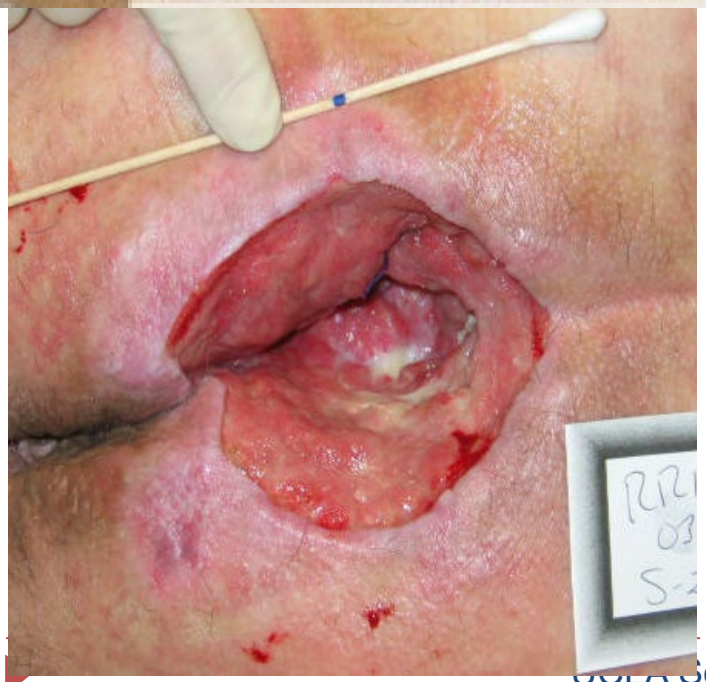
- Measure Length x Width weekly
  - *Use same reference points*
  - *Calculate surface area (Length x Width) to assess healing*

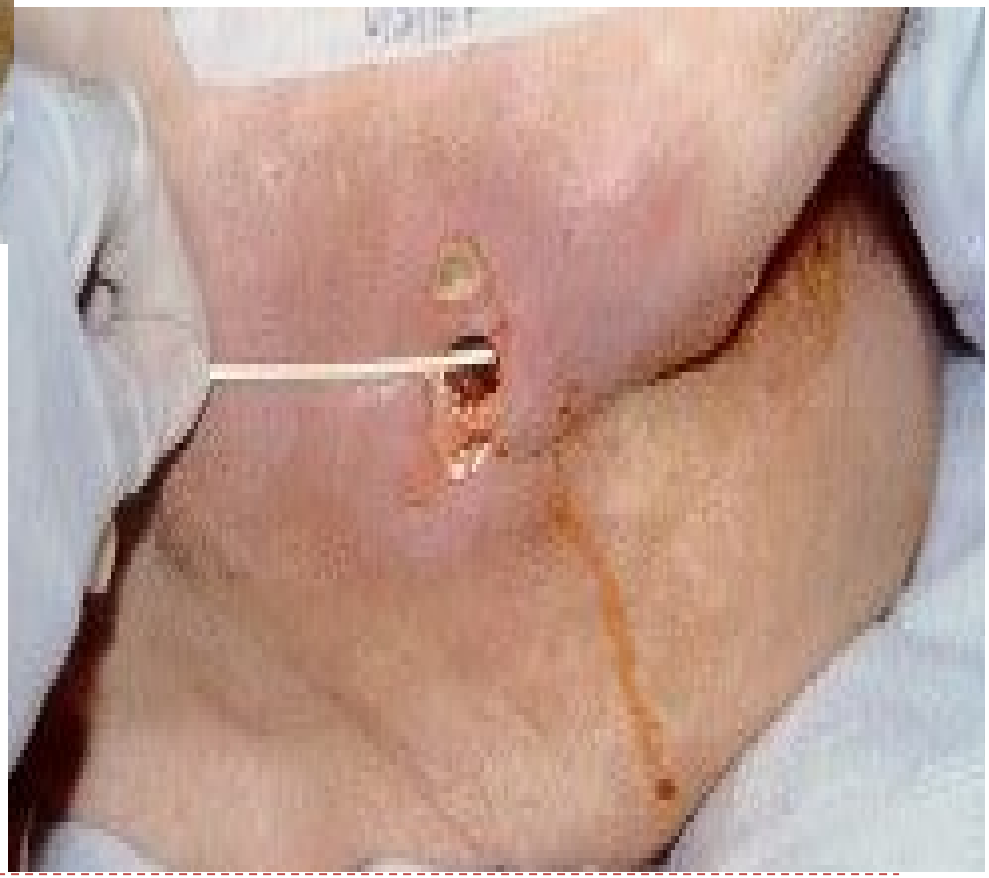
Necrotic Tissue: Slough & Eschar



Wound Edges & Undermining







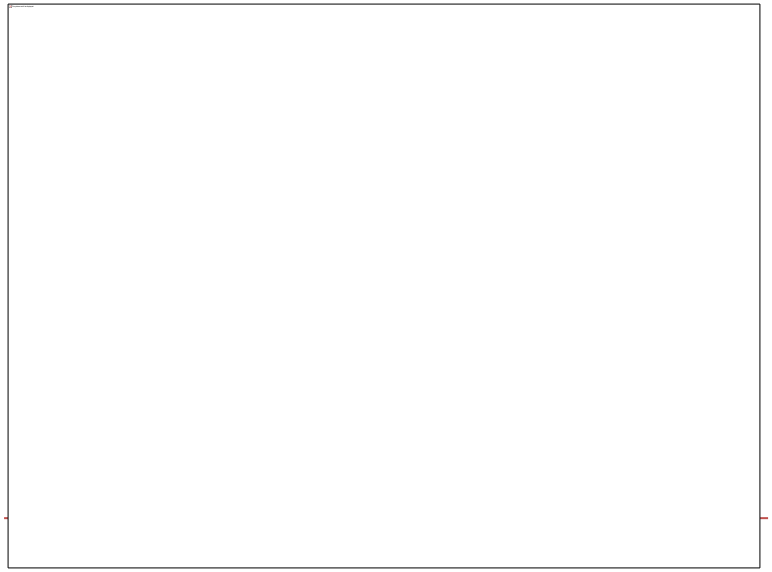
Pain Assessment

- 35% with stage 3/4 mean NRS 54.2
- 17% with stage 2, mean NRS 47.5
- tender, throbbing, sharp, burning, aching, stabbing, heavy, and shooting pain at wound site and radiating away
- Pain intensity higher for more severe ulcers compared to Stage 1:
  - Stage 2 11% higher;
  - Stage 3 14% higher
  - Stage 4 24% higher;
  - DTI 22% higher

Nutrition Support

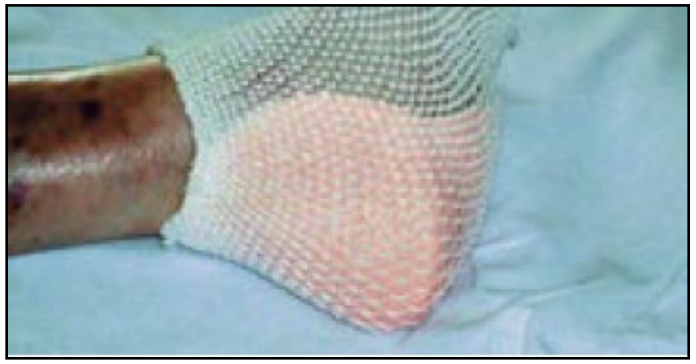
- If consistent with goals & not contraindicated:
- 30-35 kcal/kg/day
- 1.25-1.5 protein gms/kg/day
- Fluid intake 30ml/kg/day
- Multi-vitamin supplement
- High cal, High protein, arginine, zinc, antioxidant ONS for those with Stage 2 +

- At risk:
  - Screen for malnutrition
  - Weight loss:
    - 5% 30 days
    - 10% 6 months
  - Monitor nutrition by observing meal intake



Prevention of Pressure Injury

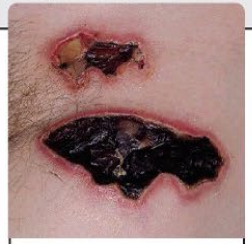
- Polyurethane silicone foam dressing to sacrum, heels
- HAPrIs significantly less in patients treated with foam dressing than control group (0.7% vs 5.9%, P = .01)



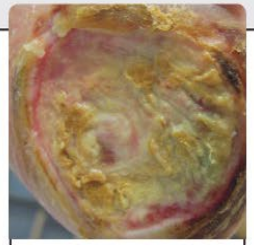
Decide appropriate treatment

T — Tissue non-viable[1–2]

1. IDENTIFY THE BARRIERS TO WOUND HEALING



Necrotic



Slough

3. WOUND MANAGEMENT OUTCOME

Viable healthy wound bed

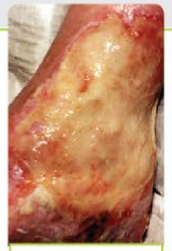
2. SELECT PRIMARY & SECONDARY INTERVENTIONS

Cleansing and debridement

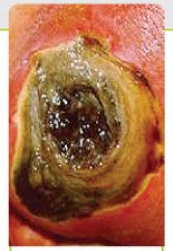
- Surfactant
- Sharp/ surgical or mechanical
- Autolytic or enzymatic
- Biological/ larval

I — Infection and/or inflammation[1–2]

1. IDENTIFY THE BARRIERS TO WOUND HEALING



Infected



Deep infected cavity wound

Suspected biofilm

3. WOUND MANAGEMENT OUTCOME

Viable healthy wound bed

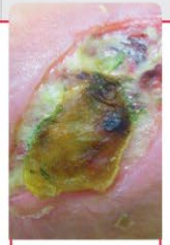
2. SELECT PRIMARY & SECONDARY INTERVENTIONS

Manage bioburden

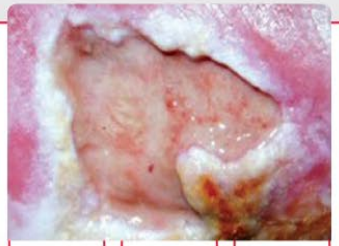
Antimicrobial* (topical antiseptic and/or antibiotic therapy)

M — Moisture imbalance[1–2]

1. IDENTIFY THE BARRIERS TO WOUND HEALING



Dry



💧 💧💧 💧💧💧

2. SELECT PRIMARY & SECONDARY INTERVENTIONS

Restore moisture balance

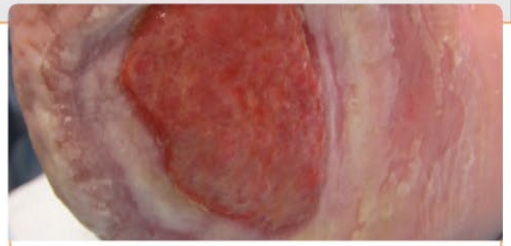
- Hydrogel*, Hydrocolloid
- Foam, superabsorbent, gelling fibre, NPWT
- Hydrocolloid, Alginate
- Alginate

3. WOUND MANAGEMENT OUTCOME

Optimal moisture balance

E — Edge of wound non-advancing[1–2]

1. IDENTIFY THE BARRIERS TO WOUND HEALING



Non-advancing or abnormal wound edge

2. SELECT PRIMARY & SECONDARY INTERVENTIONS

Promote epithelialisation and healthy periwound skin

NPWT, atraumatic wound contact layer, growth factors, cell or tissue products and skin care

3. WOUND MANAGEMENT OUTCOME

Advancing edge of wound

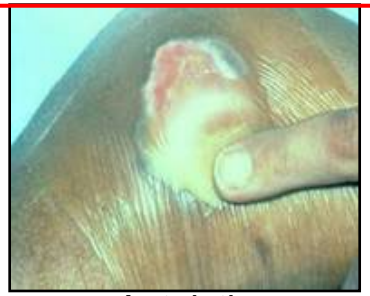
(Moore et al, 2019)

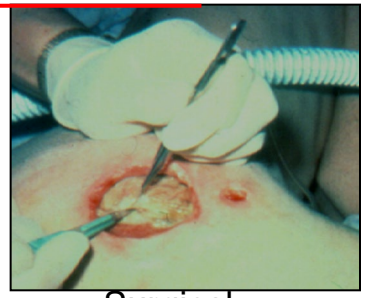
"T" – Tissue Debridement Remove Non-Viable or Deficient Tissue

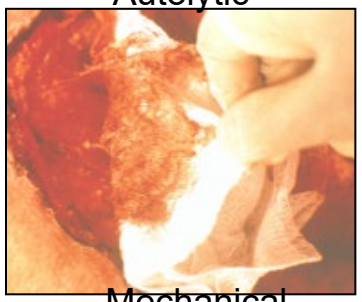
Goal: remove necrotic tissue, micro debris, reduce bacterial burden, decrease biofilm development

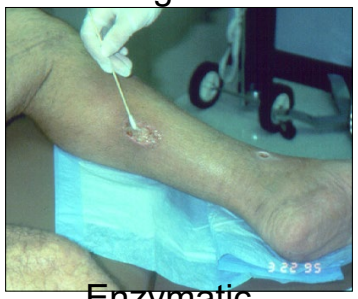
Debridement Types

Autolytic
Surgical/sharp
Mechanical
Enzymatic
Biological
Hydrosurgery
Ultrasonic

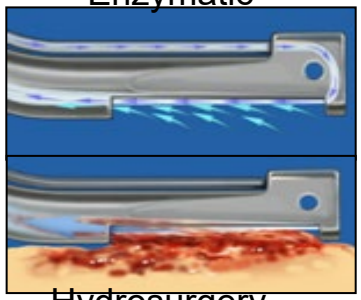

Autolytic


Surgical


Mechanical


Enzymatic


Biological

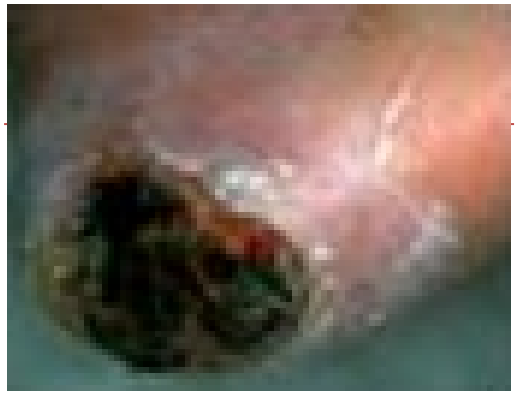

Hydrosurgery

WHS Guideline

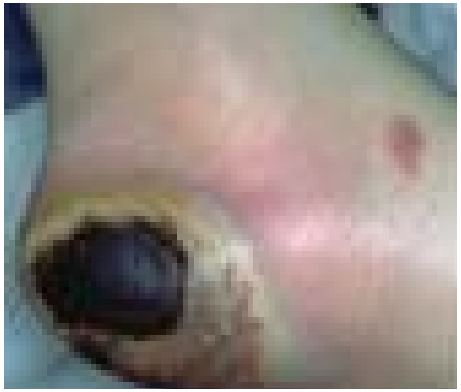
Debridement

- Less costly to use combination debridement
- Adding collagenase (CCO) vs selective debridement alone for stage 4 PrIs:
- CCO:
  - lower costs-$11,151 vs $17,596
  - greater benefits-34 vs 17 ulcer-free weeks,
- economically dominant ICER (incremental cost effectiveness ratio) of -$375 per ulcer
- **Perform maintenance debridement until wound bed clean and covered with granulation tissue**

Heels with hard dry eschar



- inspect daily if pathology, debride;
- if no s/s pathology, no debridement
- check collateral flow
  - **Vascular doppler studies--standard**
  - Ankle/brachial index (ABI)
    - 1.0 normal ≤ 0.8 arterial disease
- Diabetes may distort ABI
  - Only 30% have compressible posterior tibial artery allowing for ABI calculation as measure of heel perfusion



"I" -- Infection or Inflammation

Reduce Microorganisms & Inflammatory Cells

Superficial pseudomonas infection

Infection & inflammation lead to increased cytokines, proteases and reactive oxygen species in the wound

Pressure injury & infection

- Contaminated with skin flora
  - Enterococcus, Staphylococcus, Bacillus
  - Heal in presence of bacteria
- More likely to develop MRSA
  - Treat with Bactroban or silver dressings topically
- **Signs of infection:**
  - Increasing pain, friable, edematous granulation, odor, breakdown, pocketing, or delayed healing
- ***More likely to develop BIOFILMS which can delay healing***

Topical Antimicrobial Cleansers

Biofilms

- Polyhexamethylene Biguanide (PHMB)-disrupts biofilm
- Octenidine dihydrochloride (OCT)-inhibits biofilm growth x 72 hours
- Hypochlorous acid-penetrates and kills biofilm
- Povidone iodine-inhibits biofilm development
  - Cytotoxic above 0.05%

Necrotic, infected wounds--Antiseptics10-14 days

- hypochlorite (Dakin's)--staph, strep, dissolves necrosis, controls odor
- acetic acid--pseudomonas aeruginosa in superficial wounds

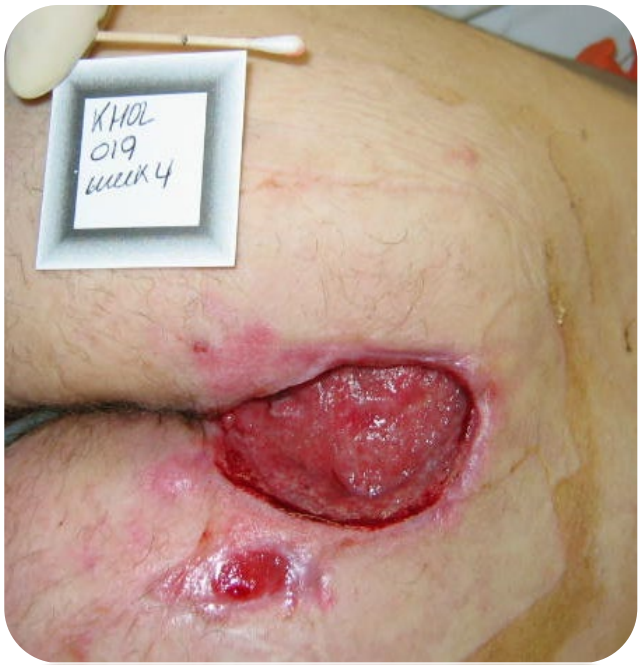
Topical Antimicrobial Dressings

- Cadexomer Iodine
  - Non-cytotoxic antimicrobial control
  - Slow release of iodine into wound bed
  - Broad spectrum of effectiveness
- Silver Release Dressings
  - Possible cytotoxicity
  - MRSA, VRE, broad spectrum effectiveness
  - Decrease infection, wound contamination, & resistant bacteria
- Medical-grade Honey
  - Inihibits biofilm growth & colony formation
  - Leptospermum species more effective
  - Should be gamma irradiated

Wound Cleansing

- At dressing changes, with low pressure
- ***What to clean with?***
- Clean wounds
  - Normal Saline
  - Sterile Water
  - Tap water/potable water
  - Surfactant wound cleansers

'M' Moisture Balance 'E' Epithelial Edge



- Moist wound healing dressings instead of any form of dry gauze (e.g., wet to dry or dry gauze dressing, impregnated gauze dressing, gauze packing)

  WHY?

  - Physiologically favor cell migration, matrix formation
  - Accelerates healing by promoting autolytic debridement
  - Reduces pain
  - Cost effective

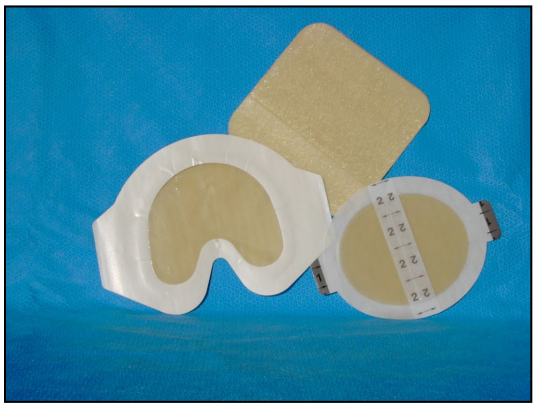
Topical therapy: Stage 2

- **Moist wound healing dressings less expensive, increased benefit vs moist gauze dressings**

- Hydrocolloid, Hydrogel, Polymeric membrane dressings for non-infected stage 2 PrI with minimal exudate
- Foam dressings for stage 2 PrI with moderate to heavy exudate

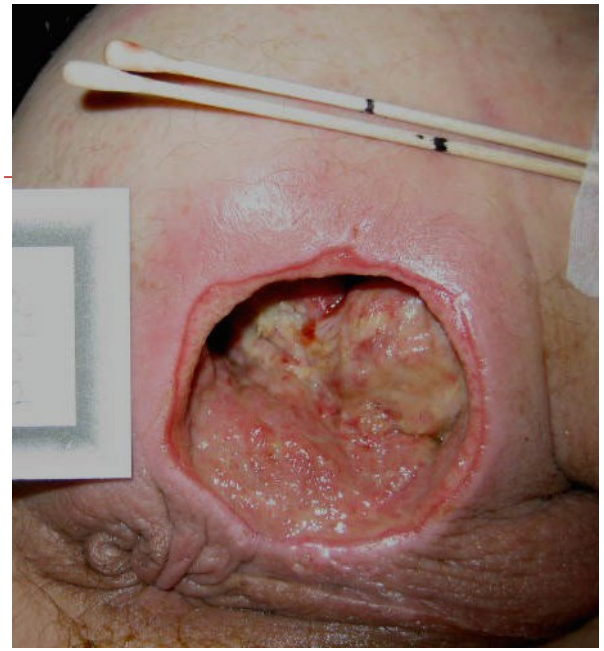
Topical therapy: Stage 3, 4

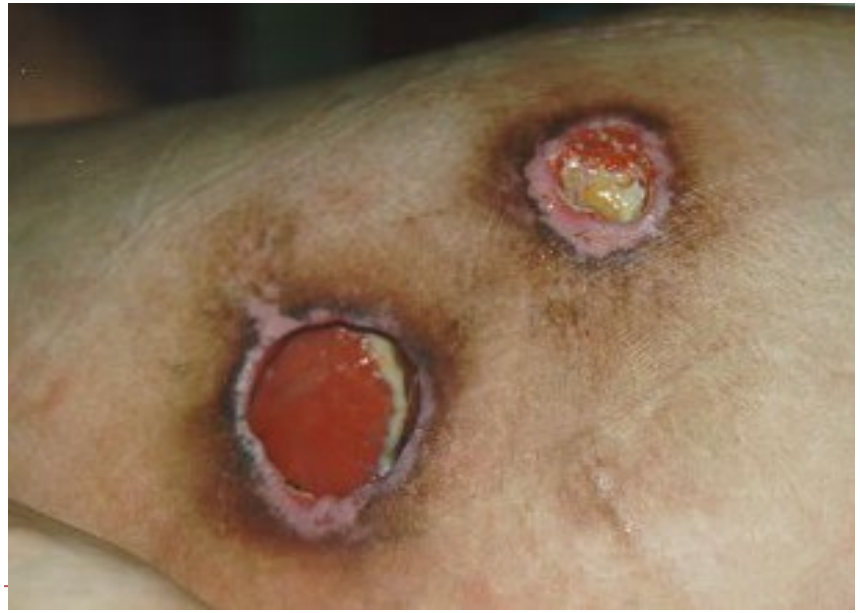
- Foam dressings for shallow stage 3, 4 PrI
  - Similar clinical performance for foam dressings
- Hydrogel dressings for stage 3,4 minimal exudate
- Hydrocolloid & Alginate dressings for stage 3, 4 moderate exudate
  - Sequential use of alginate followed by hydrocolloid more effective than continued use of hydrocolloid alone
- Super absorbent dressings for heavy exudate



Dressing Dead Space

- Light packing
- Prevent abscess formation
- Treatment of choice
  - Calcium alginates
  - Negative pressure wound therapy





My Rules for Therapy

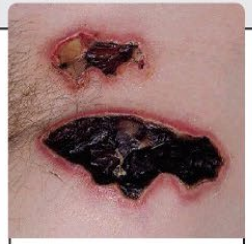
- If it's dirty; clean it,
- If there's a hole; fill it,
- If it's flat; protect it
- If it's healed; prevent it!

Resources:
A VERY Quick tour through Some Common wound dressings

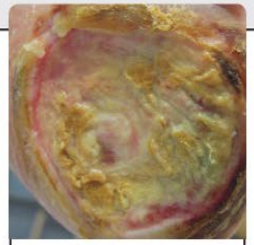
Decide appropriate treatment

T — Tissue non-viable[1–2]

1. IDENTIFY THE BARRIERS TO WOUND HEALING



Necrotic



Slough

3. WOUND MANAGEMENT OUTCOME

Viable healthy wound bed

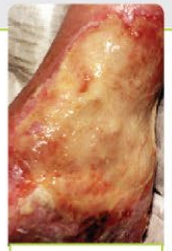
2. SELECT PRIMARY & SECONDARY INTERVENTIONS

Cleansing and debridement

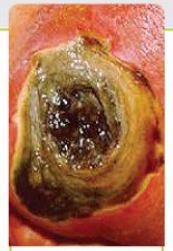
- Surfactant
- Sharp/ surgical or mechanical
- Autolytic or enzymatic
- Biological/ larval

I — Infection and/or inflammation[1–2]

1. IDENTIFY THE BARRIERS TO WOUND HEALING



Infected



Deep infected cavity wound

Suspected biofilm

3. WOUND MANAGEMENT OUTCOME

Viable healthy wound bed

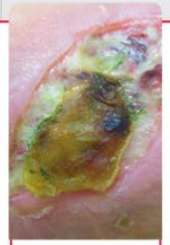
2. SELECT PRIMARY & SECONDARY INTERVENTIONS

Manage bioburden

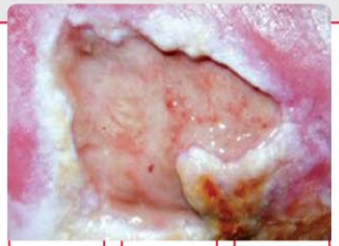
Antimicrobial* (topical antiseptic and/or antibiotic therapy)

M — Moisture imbalance[1–2]

1. IDENTIFY THE BARRIERS TO WOUND HEALING



Dry



💧 💧💧 💧💧💧

2. SELECT PRIMARY & SECONDARY INTERVENTIONS

Restore moisture balance

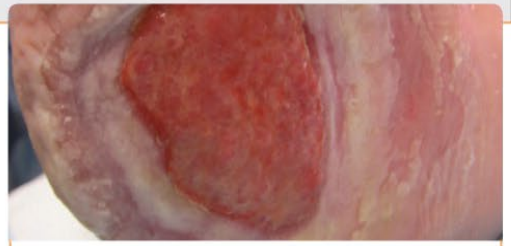
- Hydrogel*, Hydrocolloid
- Foam, superabsorbent, gelling fibre, NPWT
- Hydrocolloid, Alginate
- Alginate

3. WOUND MANAGEMENT OUTCOME

Optimal moisture balance

E — Edge of wound non-advancing[1–2]

1. IDENTIFY THE BARRIERS TO WOUND HEALING



Non-advancing or abnormal wound edge

2. SELECT PRIMARY & SECONDARY INTERVENTIONS

Promote epithelialisation and healthy periwound skin

NPWT, atraumatic wound contact layer, growth factors, cell or tissue products and skin care

3. WOUND MANAGEMENT OUTCOME

Advancing edge of wound

(Moore et al, 2019)

Electrical stimulation

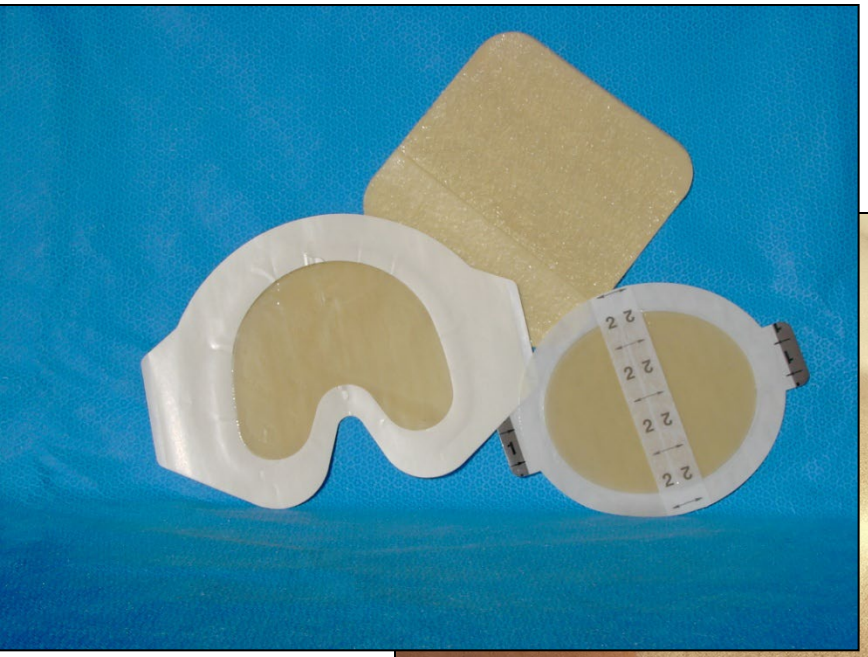
- High-voltage monophasic pulsed current (HVMPC) for stage 2-4 PrI meta analysis showed:
  - SA reduction per week
    - 12.39% for HVMPC vs 6.96% standard care/sham
    - Net effect of HVMPC 5.4%/week (78% > standard care/sham)
    - Level 1, 2 and 4 evidence studies consistently indicate HVMPC + standard care more effective than standard care/sham
- Electrical stimulation (50 min once a day/x 5 days/week)+ standard wound care for stage 2 & 3 PrI
  - At week 6, SA reduction: 80% ES vs 55% control group (P = .046)

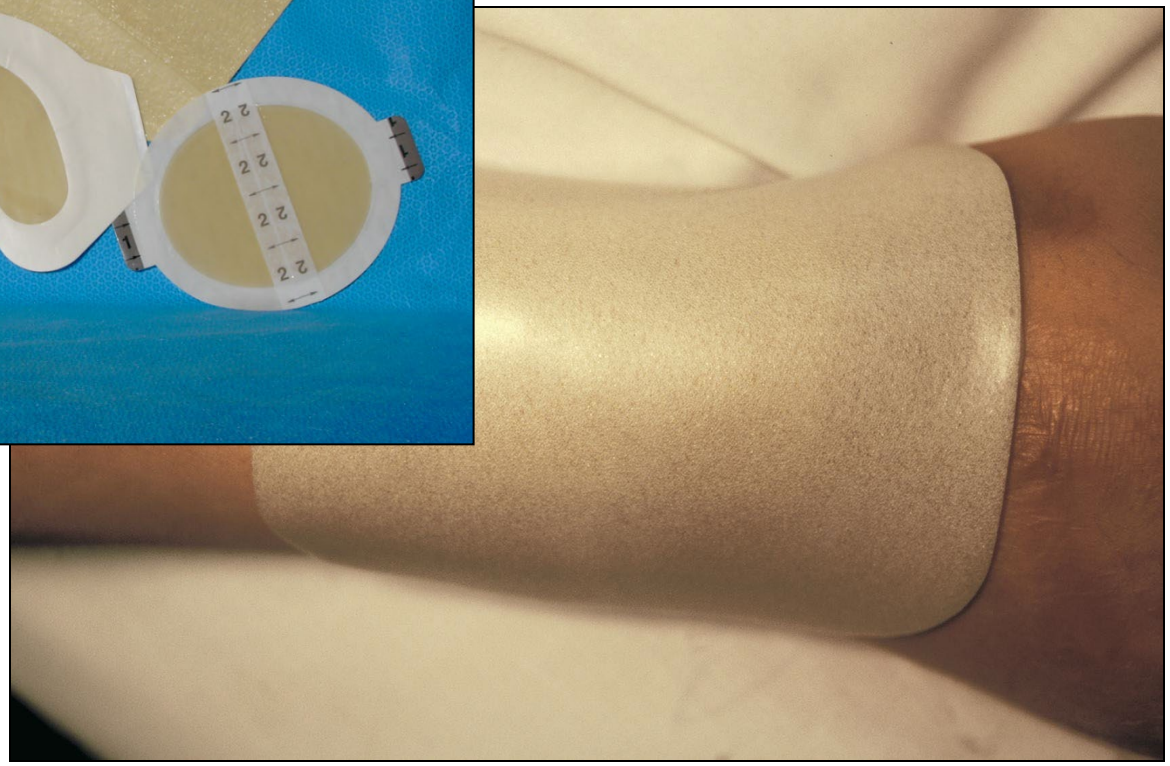
Girgis, B., et al. J Tissue Viability 2018 27(4): 274-284. Burdge, JJ, et al., Wound Management & Prevention, 2009; 55(8):

Hydrocolloids

- Hydrophilic colloid particles bound to polyurethane foam
- Impermeable to fluid and bacteria
- Can be used in all wounds
- Facilitates autolytic debridement
- Change every 3-7 days
- Not for draining wounds
- May be hard to remove and may leave a residue
- Normally develops a bad odor from occlusion

Hydrocolloid





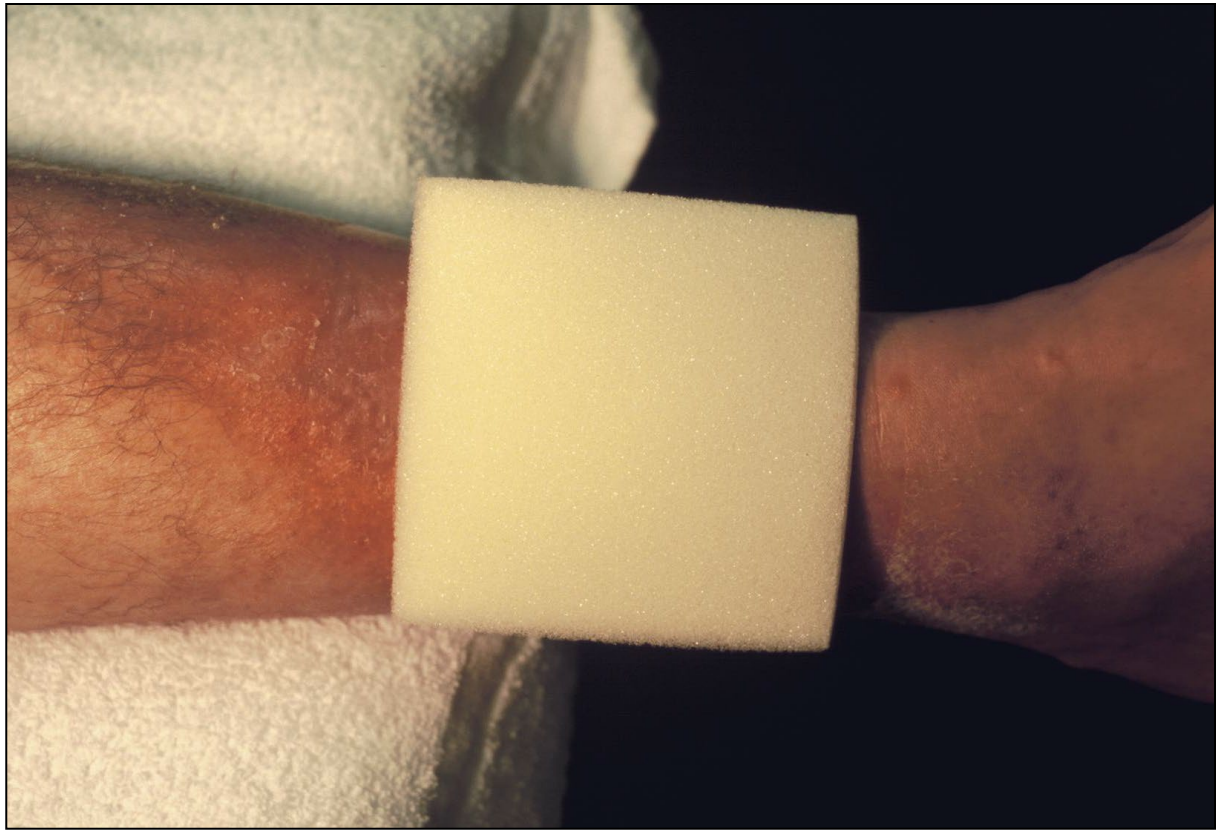
Hydrogel

- Water- or glycerin-based, non-adherent, polymer (contains 80% to 90% water)
- Comes as gel, wafers/sheets
- All full-thickness wounds
- Non-adherent
- Rehydrates wound bed; softens eschars
- Minimal absorption of exudate
- Can macerate skin if wound has moderate to heavy exudate
- Daily dressing changes may be needed

Foam

- Hydrophilic polyurethane/polymer or gel-film coated
- Non-occlusive, non-adherent, absorptive dressing
- Often combined with outer adherent layer (silicone, thin film)
- Silicone foam dressings recommended for prevention
- Use for all draining wounds
- Good under other dressings
- Not recommended for eschars and dry wounds
- Dressing change dependent on amount of drainage

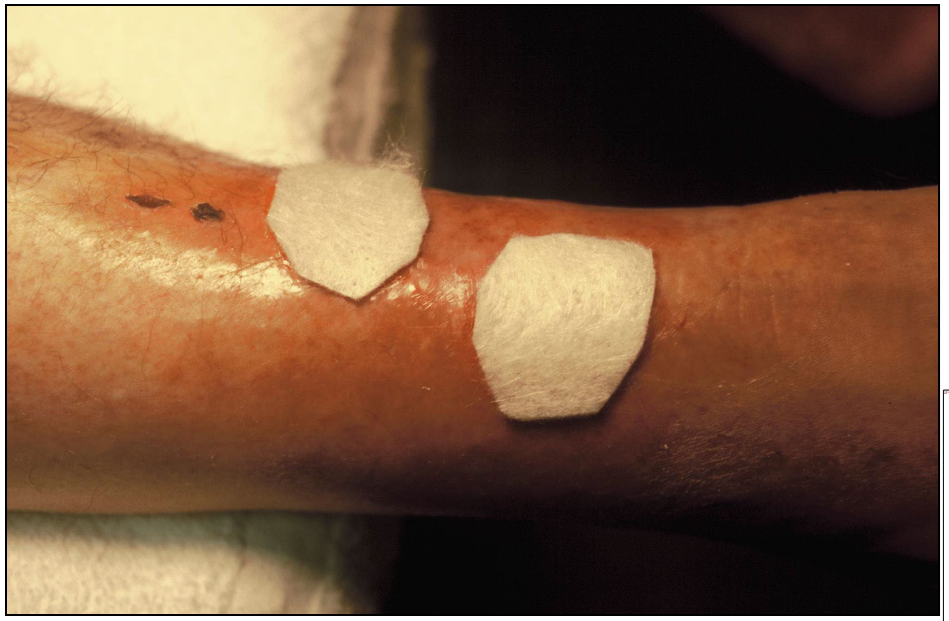
Foam Dressing



Calcium Alginate

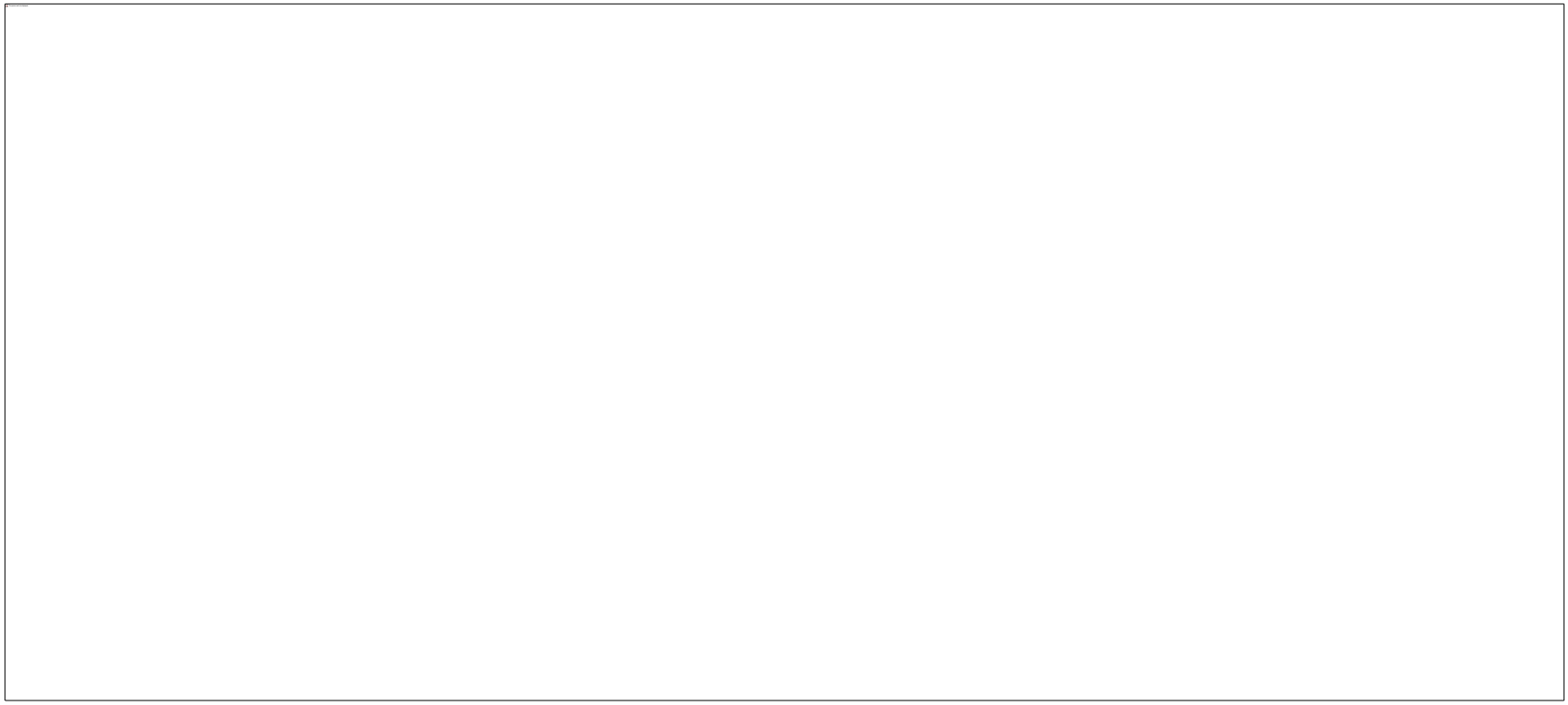
- Non-woven composite of fibers from calcium alginate (from brown seaweed)
- Forms soft gel when mixed with wound fluid
- Use in all wounds especially draining wounds; highly absorbent (can absorb 20 times their weight)
- Good for hemostasis
- Gel may have odor
- May make wound too dry if not changed appropriately
- Some forms may leave fibers in wound bed

Alginate Dressing



Honey dressings

- Alginates, gels, hydrocolloids impregnated with Manuka Honey

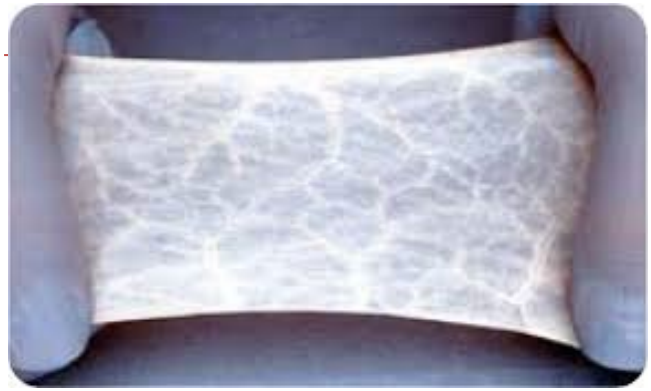


Collagens

- Used for all partial or full-thickness wounds
  - skin grafts and skin donation sites
  - second-degree burns
  - granulating or necrotic wounds
  - chronic nonhealing wounds
- Available in freeze-dried sheets, pastes, pads, powder, and gels, some require secondary dressing
- Some include alginates or even antimicrobial additives.
- The collagen source varies—bovine, porcine, or avian
- Replace from 1 to 7 days depending on drainage and infection, may require rehydration
- May be used in combination with topical agents

Collagens

Biologic Dressings: cellular or acellular



- Animal (bovine, porcine) collagen, Cadaveric skin, synthetic, plant based
- PrI should be free of necrosis prior to use
- Example: Extracellular matrix graft n=67, standard care n=63; 12 weeks follow up, weekly assessments,
- Proportion with complete healing:
  - 40% versus 29% standard care (p = 0.1)
- Participants with 90% surface area reduction:
  - 55% vs 38% standard care (p = 0.037)

References

- Li Z, Lin F, Thalib L, et al. Global prevalence and incidence of pressure injuries in hospitalised adult patients: A systematic review and meta-analysis. Int J Nurs Stud. 2020;105:103546.
- Tubaishat, A, et al. Pressure ulcers prevalence in the acute care setting: A systematic review, 2000-2015. Clin Nurs Res 2018.
- Chaboyer WP, Thalib L, Harbeck EL, et al. Incidence and Prevalence of Pressure Injuries in Adult Intensive Care Patients: A Systematic Review and Meta-Analysis. Crit Care Med. 2018;46(11):e1074-e1081.
- Jackson D, Sarki AM, Betteridge R, et al. Medical device-related pressure ulcers: A systematic review and meta-analysis. Int J Nurs Stud. 2019;92:109-120. doi:10.1016/j.ijnurstu.2019.02.006
- Anthony D, Alosoumi D, Safari R. Prevalence of pressure ulcers in long-term care: a global review. J Wound Care. 2019;28(11):702-709. doi:10.12968/jowc.2019.28.11.702
- Corbett, LO, et al. Pressure injury in a community population: a descriptive study, JWOCN 2017
- Gilligan, AM, et al. Cost effectiveness of Becaplermin gel on wound closure for the treatment of pressure injuries. Wounds. 2018 30(6): 197-204.
- Sanson G, et al.. Stage-related implications of community-acquired pressure injuries for the acute medical inpatients. J Clin Nurs. 2021;30(5-6):712-724. doi:10.1111/jocn.15598
- Singh C, Shoqirat N. Community-Acquired Pressure Injuries in the Acute Care Setting. Adv Skin Wound Care. 2021;34(3):1-4. doi:10.1097/01.ASW.0000732748.56041.cf

- Woo, K, Kasaboski, J. A pilot retrospective study to evaluate two multi-layer foam dressings for the management of moderately exudative pressure injuries. Surg Technol Int. 2017 31: 61-65.
- Santamaria N, Gerdtz M, Liu W, et al. Clinical effectiveness of a silicone foam dressing for the prevention of heel pressure ulcers in critically ill patients: Border II Trial. J Wound Care. 2015; 24(8):340-5.
- The International Guideline, 2019. Prevention and treatment of pressure ulcers/injuries: Clinical practice guideline.
- AMDA—The Society for Post Acute and Long Term Care Medicine. Pressure Ulcers and Other Wounds in the Post-Acute and Long-Term Care Setting Clinical Practice Guideline. Columbia, MD: AMDA 2017.
- Galetto, SGDS, et al. Medical device-related pressure injuries: an integrative literature review. Rev Bras Enferm. 2019; 72(2):505-512.
- Moore, ZE, Webster, J. Dressings and topical agents for preventing pressure ulcers. Cochrane Database Syst Rev 2018 Dec 6;12CD009362.
- Cai, JY, et al. Use of a hydrocolloid dressing in the prevention of device-related pressure ulcers during noninvasive ventilation: a meta-analysis of randomized controlled trials. Wound Man Prev. 2019 65(2): 30-38.
- Bishopp, A, et al. The preventative effect of hydrocolloid dressing on nasal bridge pressure ulceration in acute non-invasive ventilation. Ulster Med J 2019 88(1): 17-20.

- Magny, E, et al. Pressure ulcers are associated with 6-month mortality in elderly patients with hip fracture managed in orthogeriatric care pathway. Arch Osteoporos. 2017 12(1): 77.
- Magny, E, Vallet, H, et al. Pressure ulcers are associated with 6-month mortality in elderly patients with hip fracture managed in orthogeriatric care pathway. Arch Osteoporos. 2017 12(1): 77.
- Meyers, T. Prevention of heel pressure injuries and plantar flexion contractures with use of a heel protector in high-risk neurotrauma, medical, and surgical intensive care units: A randomized controlled trial. J Wound Ostomy Continence Nurs. 2017 44(5): 429-433.
- Jin, Y, Jin, T, Lee, SM. Automated pressure injury risk assessment system incorporated into an electronic health record system. Nurs Res. 2017 66(6): 462-472.
- Doupe, MB, et al Pressure ulcers among newly admitted nursing home residents: measuring the impact of transferring from hospital. Med Care, 2016.
- Hajhosseini B, Longaker MT, Gurtner GC. Pressure Injury. Annals of Surgery. 2020;271(4):671–679.
- Bates-Jensen BM, et al. Subepidermal moisture detection of pressure induced tissue damage on the trunk: the Pressure Ulcer Detection (PUD) study outcomes. Wound Rep Reg, 2017: 25(3), 502-511.
- Smith G. Improved clinical outcomes in pressure ulcer prevention using the SEM scanner. J Wound Care. 2019;28(5):278-282.
- Santamaria N, et al. Clinical effectiveness of a silicone foam dressing for the prevention of heel pressure ulcers in critically ill patients: Border II Trial. JWC. 2015; 24(8):340-5.

- Bates-Jensen BM, et al. Subepidermal Moisture Detection of Pressure Induced Tissue Damage on the Trunk: The Pressure Ulcer Detection (PUD) Study Outcomes. Wound Repair Regen. 2017/ 25(3): 502-511.
- Bergstrom N, Horn SD, Rapp MP, et al. Turning for Ulcer ReductioN: a multisite randomized clinical trial in nursing homes. J Am Geriatr Soc 2013; 61(10): 1705-13.
- Hartmann CW, Shwartz M, Zhao S, et al . Longitudinal pressure ulcer rates since adoption of culture change in Veterans Health Administration nursing homes. JAGS 2016; 64(1): 151-155.
- Alderden, J, et al. s J WOCN 2017 44(5): 420-428.
- Bates-Jensen, BM, et al. Subepidermal moisture detection of heel pressure injury: the Pressure Ulcer Detection study outcomes. International Wound Journal. 2017; 15(2): 297-309.
- Bail, K, Draper, B, Berry, H, et al. Predicting excess cost for older inpatients with clinical complexity: a retrospective cohort study examining cognition, comorbidities and complications. PloS One, 2018. 13(2).
- Messinger-Rapport, BJ, et al. Clinical Update on Nursing Home Medicine: 2017. JAMDA, 2017.18(11): 928-940.
- Musa L, Ore N, Raine G, Smith G. Clinical impact of a sub-epidermal moisture scanner: what is the real-world use?. J Wound Care. 2021;30(3):198-208.
- Gershon S. Using Subepidermal Moisture Level as an Indicator of Early Pressure Damage to Local Skin and Tissue. Adv Skin Wound Care. 2020;33(9):469-475.
- Okonkwo H, Bryant R, et al. A blinded clinical study using a subepidermal moisture biocapacitance measurement device for early detection of pressure injuries. Wound Repair Regen. 2020;28(3):364-374.
- Mayrovitz, HN, et al. Sacral skin temperature assessed by thermal imaging: Role of patient vascular attributes. J Wound Ostomy Continence Nurs. 2018 45(1): 17-21.