Technology for Early Detection of skin and tissue damage

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Objectives:

1. Identify key parameters of a visual skin assessment for pressure induced tissue damage.
2. Compare and contrast new approaches for assessment of pressure related skin damage.
3. Discuss the current state of evidence for early detection of pressure related skin damage.

1. Identify key parameters of a visual skin assessment for pressure induced tissue damage.

How do we currently detect damage?

we *routinely visually observe…*

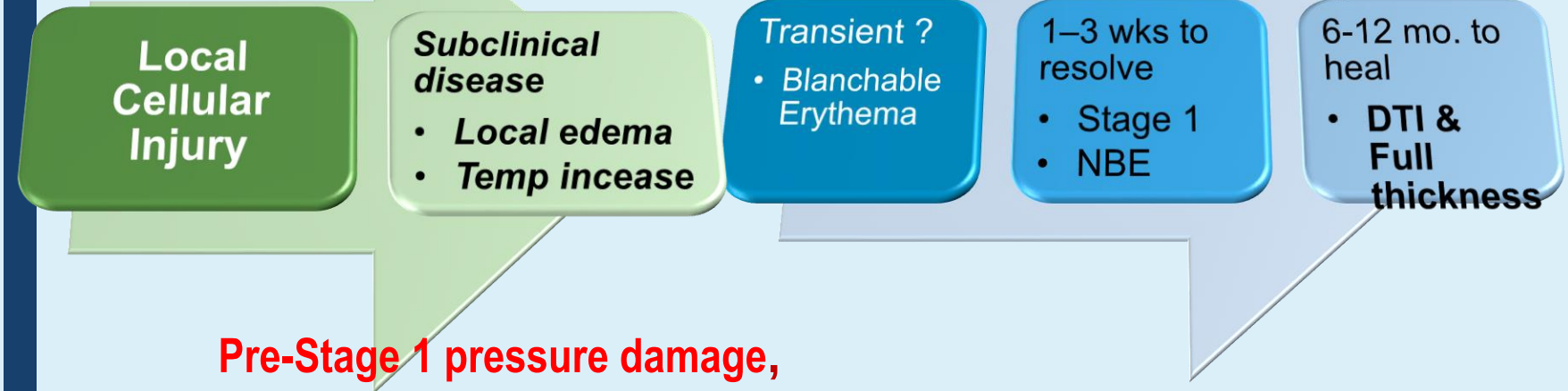
Bony prominences for signs of early damage:

- Erythema & Stage 1 PrI (Non-blanchable **redness**)
- Deep Tissue Injury (**Purple or maroon discolored intact skin** or blood-filled blister) ***BUT***
- By the time skin color changes some damage has already occurred… ***AND this does not work well for medium and dark skin tones***

Spectrum of Pressure Damage

This is what biophysical measures detect

We all observe for this clinically…



Pre-Stage 1 pressure damage,
INVISIBLE on skin

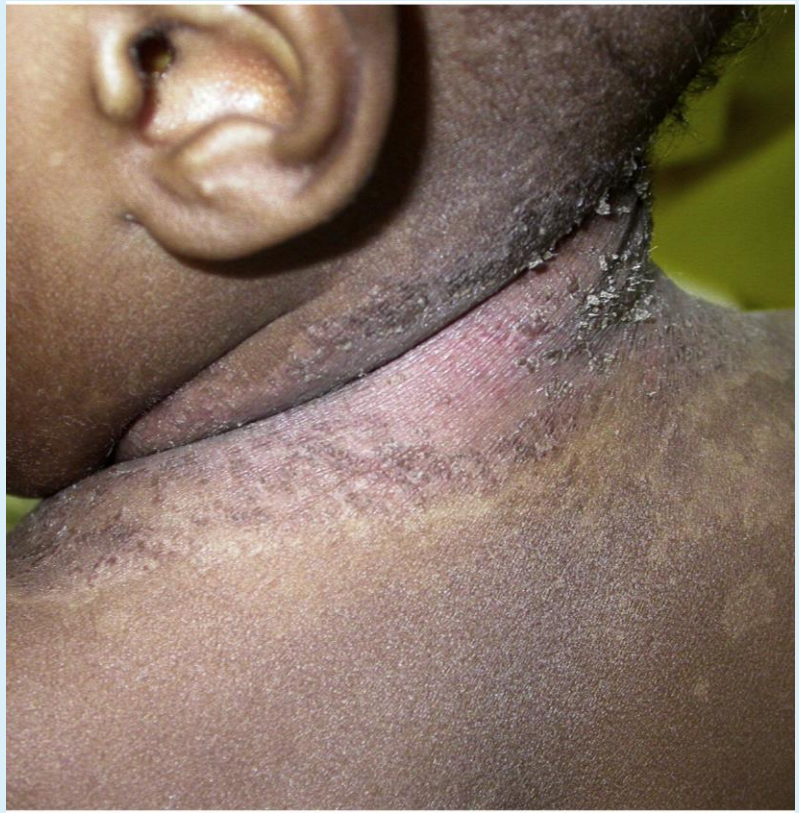
Skin health assessment:

1. Location of damage?
2. Is there a break in skin integrity?
3. Skin Discoloration?
4. Other indicators? (e.g., history, pain, induration or edema?)

1. Location of damage?

Should trigger potential diagnosis:

- Over bony prominence?
  Pressure injury
- Under medical device:
  Pressure injury
- In perineal area?
  IAD
- Under skin folds?
  Intertriginous dermatitis (ITD)

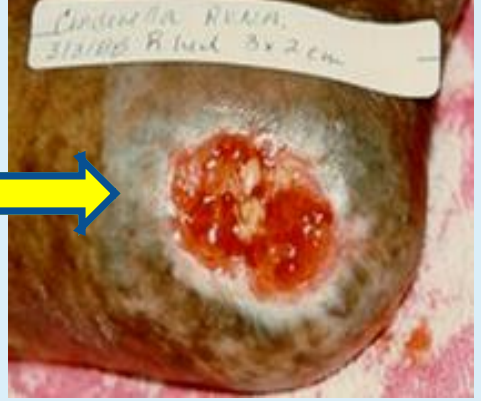


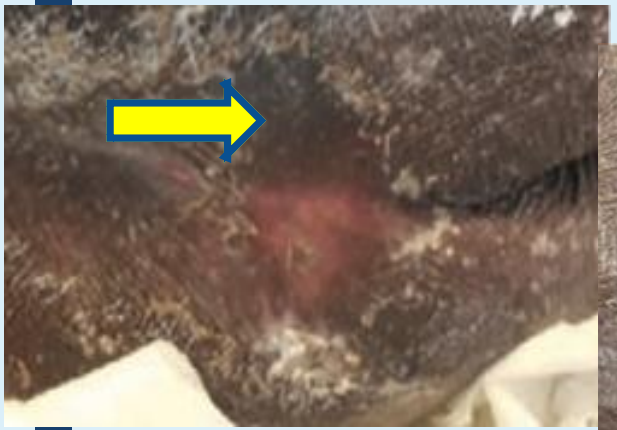
2. Break in skin integrity?

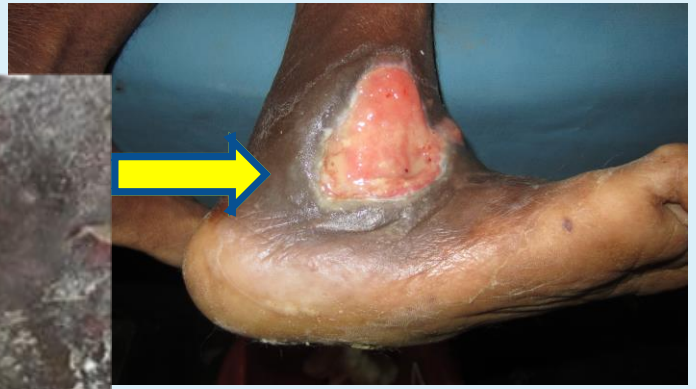
- **YES: Assess Wound**
  - *Shape*
  - *Depth*
  - *Size*
  - *Edges*
  - *Necrotic tissue presence & characteristics*
  - *Exudate presence & characteristics*
  - *Surrounding skin & tissue*
  - *Granulation tissue & Epithelialization*
- **NO:**
  - *assess for skin discoloration*
  - ***Use biophysical measures***

3. Skin discoloration?

- Appears differently in medium, dark skin tones
- Difficult even for experts to see
- Appears differently on various anatomic sites



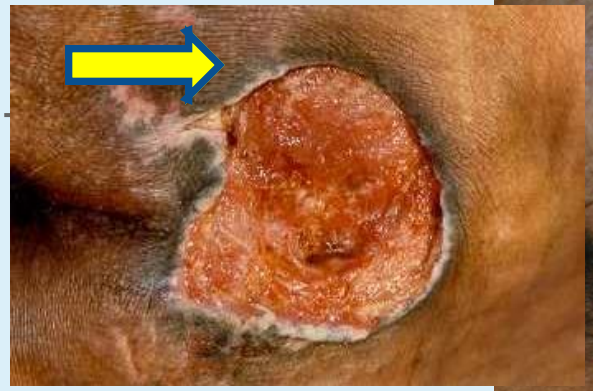


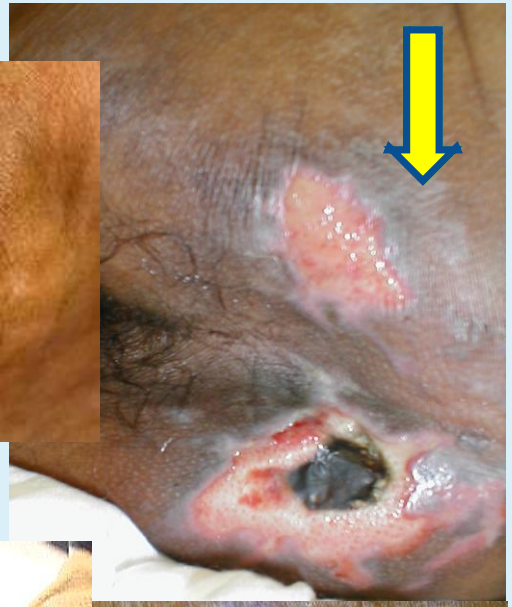


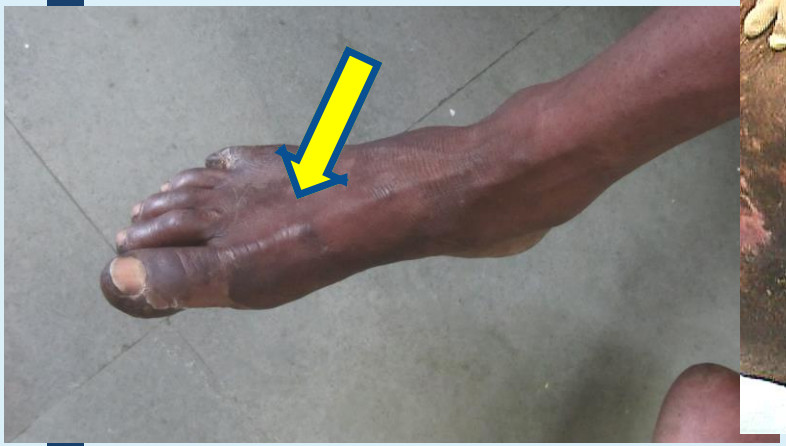
Kathleen Francis, DNP, FNP-BC, CWOCN

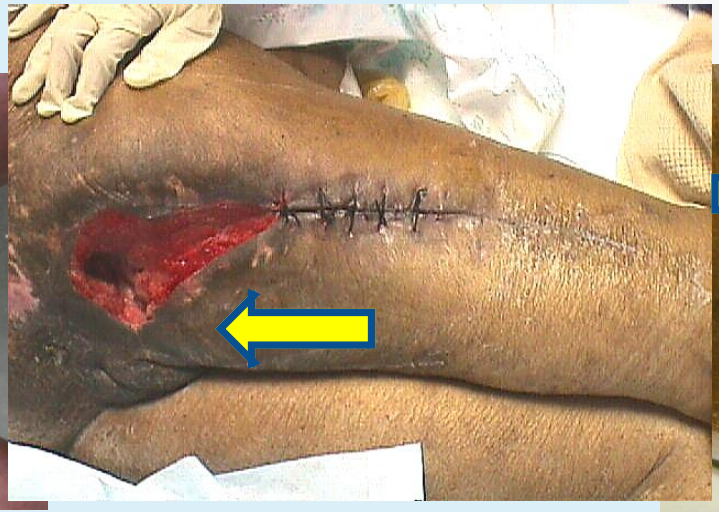
Look for:

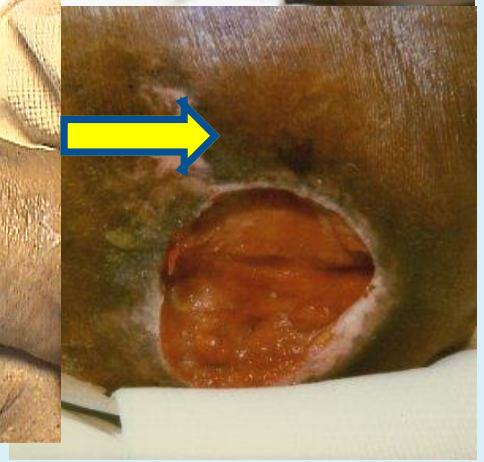
- White or gray discoloration or hypopigmentation
- Deepening of normal skin color
- Gray, blue discoloration



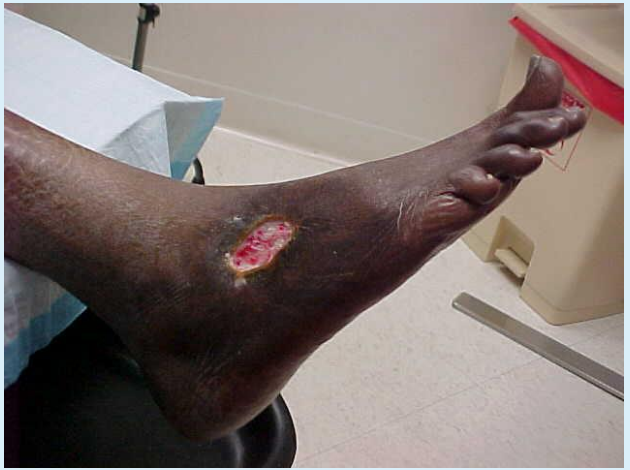








4. Other indicators?



- History
  - *What is the story behind the wound?*
- Pain
  - *May be first indication of damage but limited data to support*
- Induration
  - *Signals some damage already present*
- ***Edema***
  - *Inflammatory response to injury*

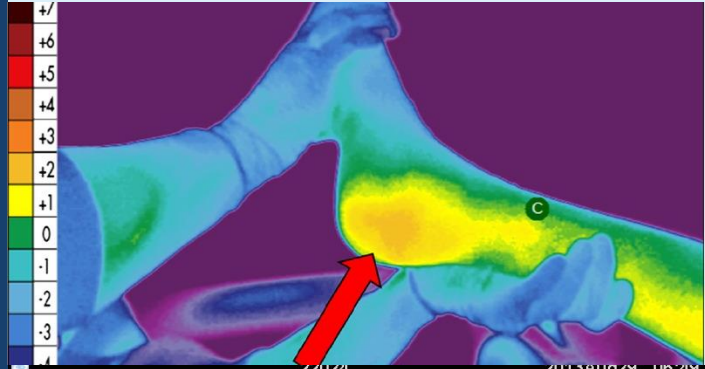
Is there a better approach?

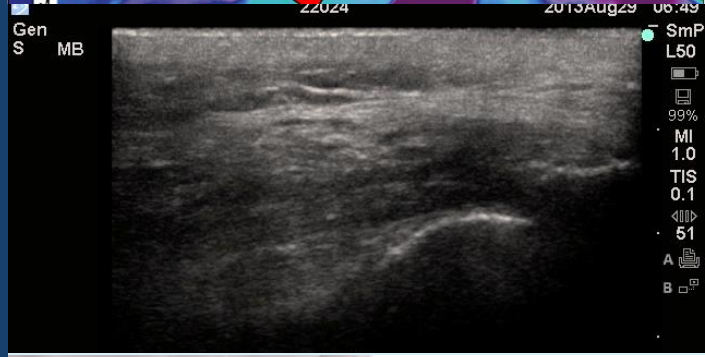
- We all agree skin health is difficult to assess in persons with medium and dark skin tones and there are challenges in this area…
- What else can we do to decrease the disparities in skin health related to detection of damage among persons of color?
- ***Ignore skin color and use technology to interrogate tissues below skin surface!***

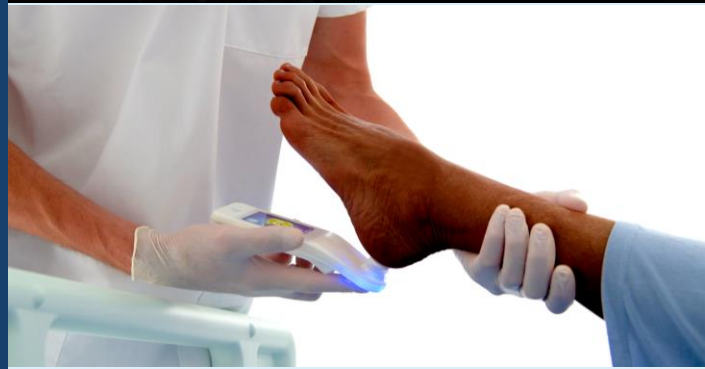
2. Compare and contrast new approaches for assessment of pressure related skin damage.

Technology to interrogate tissues below the skin surface

- Thermography
- Ultrasound
- Subepidermal moisture (SEM)







Thermography

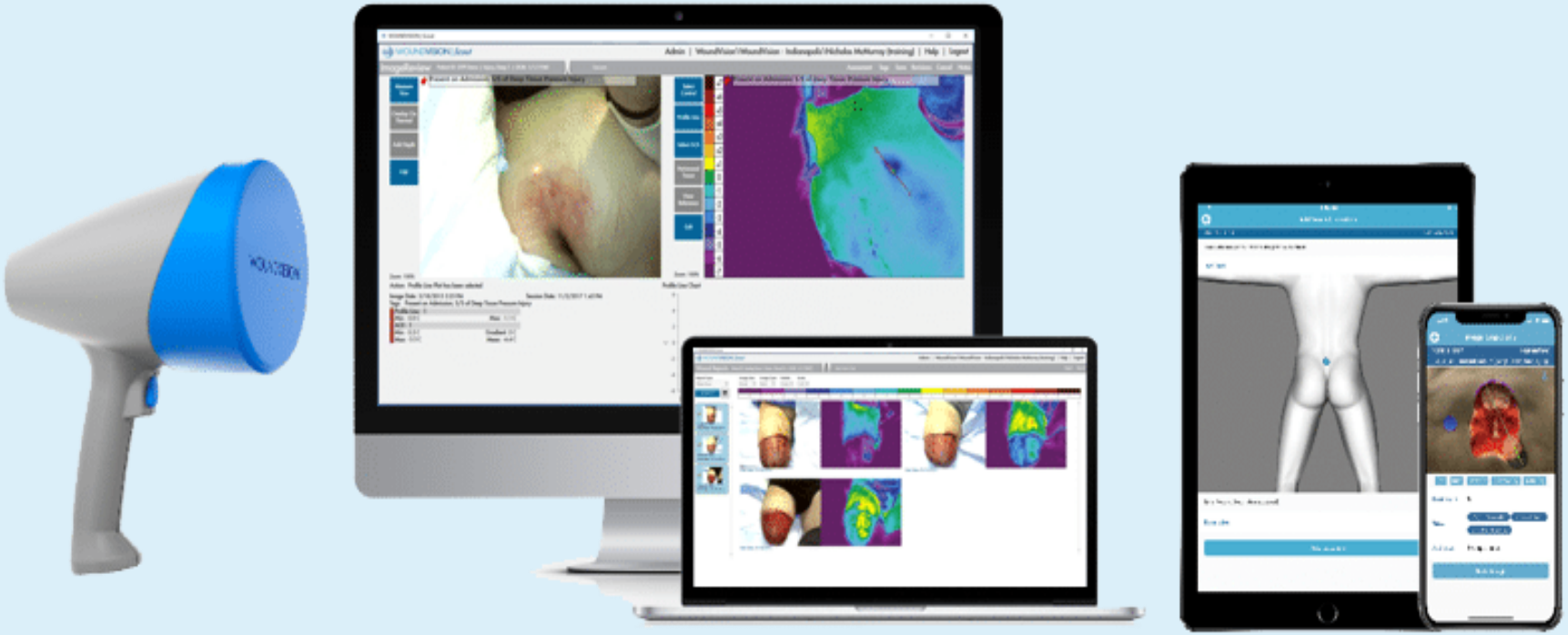
- Temperature as indicator of tissue perfusion
- Long-wave infrared thermography (LWIT) measures radiant heat from body surface
- Can capture a picture of the area of concern and detect tissue temperature relative to the level of tissue perfusion

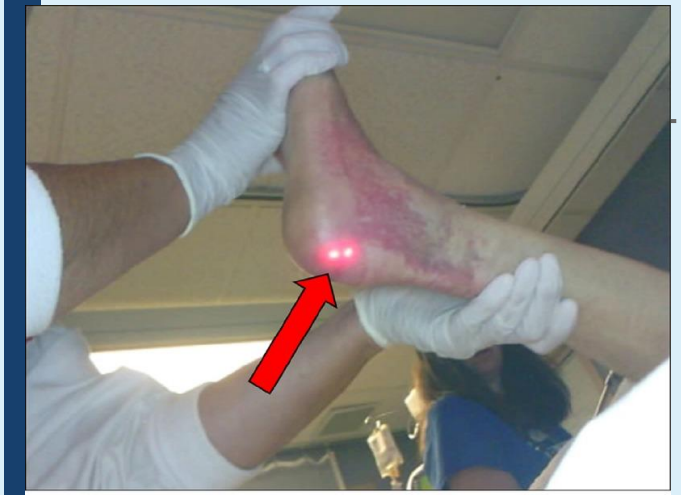
Thermography

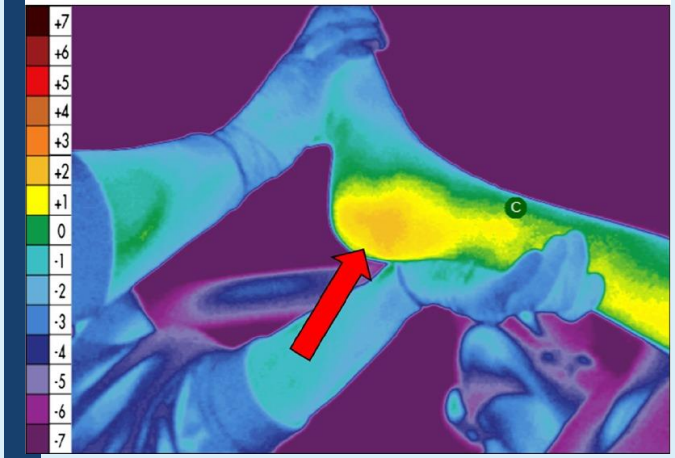
- LWIT devices can identify a pre-visual temperature anomaly before becoming a visually identifiable DTPI, stage 1 PrI
- Potential for detecting local hypothermia warnings of PrI before visual recognition

Use of thermography to detect tissue damage (infection and inflammation), PrIs

Example: Scout Mobile Wound Vision







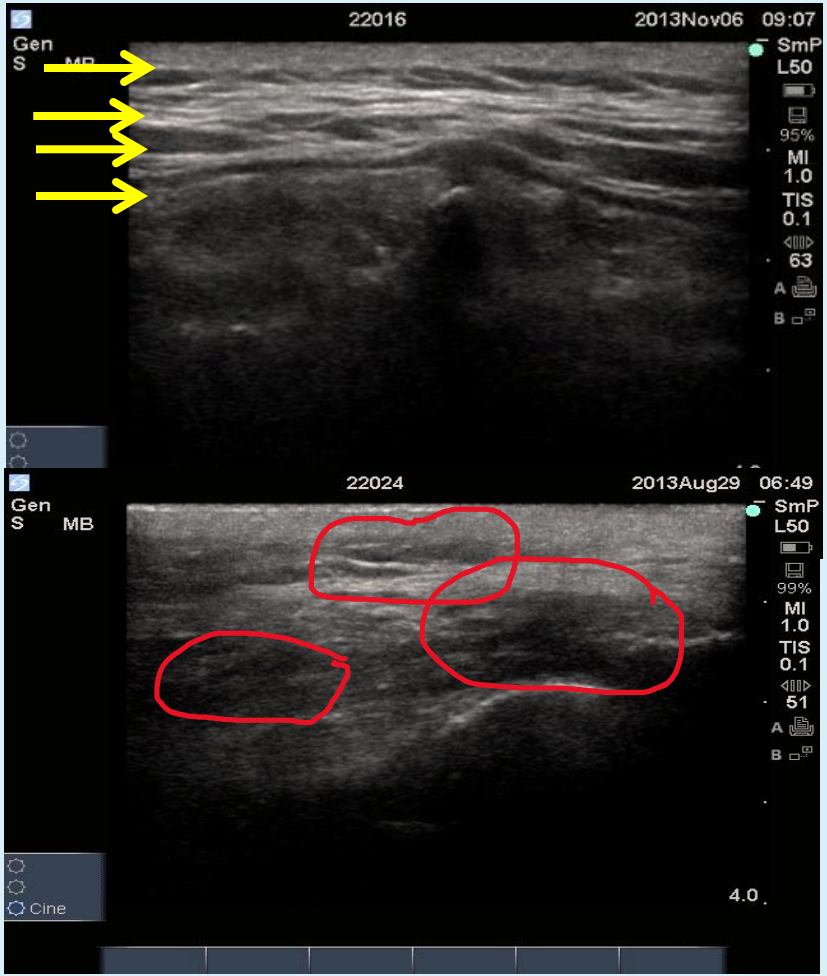
- Temperature difference between a chronically infected wound and normal tissue has a specific elevated thermal gradient range of 3°--4° C
- Elevated temperature of 1.2° C may predict impending PrI 24--96 hours before appearance on skin
- Delayed healing in PrIs with *'high temperature'*

Example: FLIR ONE smartphone thermography

- Miniature, smartphone-compatible thermal imaging camera
- Forward-looking infrared (FLIR) thermography technology uses handheld camera that measures skin infrared emissivity, captures photographs, and can be analyzed through specialized software.
- Used to assess inflammation in diabetic foot ulcers, locating perforators in flap surgery, and burn assessment
- Used to detect PrI prior to visual skin discoloraton

Ultrasound

- Detects macroscopic pockets of fluids (edema) that are visible to the radiologist
  - *present as*
  1. *hypoechoic lesions*
  2. *unclear layered structure*
  3. *discontinuous fascia*
  4. *heterogeneous hypoechoic areas*



Ultrasound

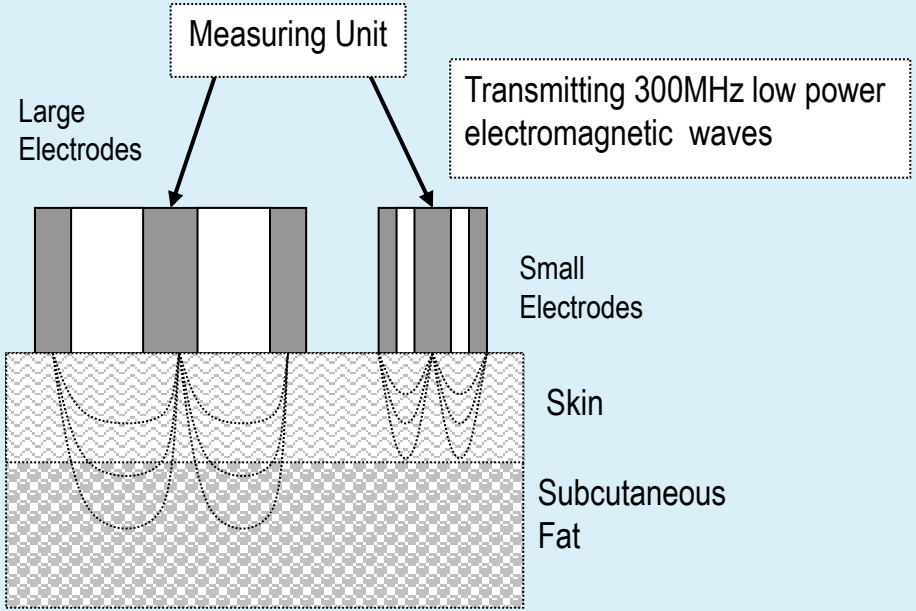
- Muscle layers become thinner, less clear with stage 1 PrI
- Specific patterns are associated with PrI severity:
  - PrIs with a cloud-like pattern show deterioration and size increase
  - *PrIs* showing a cobblestone-like pattern show stable wound characteristics and size decrease
- DTI may be better detected with both US and thermography:
  - *Higher temp plus heterogeneous hypoechoic areas*

Subepidermal Moisture

- Devices transmit high-frequency low power electromagnetic waves of 300 MHz or less via electrodes placed on skin with hand held devices,
- Measures ***surface electrical capacitance*** between 2 concentric circle electrodes
- In skin, electrical field interacts with water molecules
- Electromagnetic energy not absorbed by tissue water is reflected, measured, and displayed on the device

Depth depends on electrode size-2.5mm PrIs

- Inflammatory response initiated with cell injury,
- cell permeability & blood flow increases,
- action potential across cell membrane decreased, allowing quick/high electrical charges to pass through the tissues (e.g., SEM increases).



What is Subepidermal Moisture or ***SEM***?

- Termed coined to describe “moisture” or edema within dermal tissues below epidermis; differentiates between surface moisture (e.g., IAD, skin surface moisture) and dermal edema
- SEM Scanner™ & SEM Provisio™(Bruin Biometrics) range 0-7 picoFarads
  - *Controls for user pressure when applying device*
- Higher values = more edema, inflammation
- ***FDA approved for PrI detection***

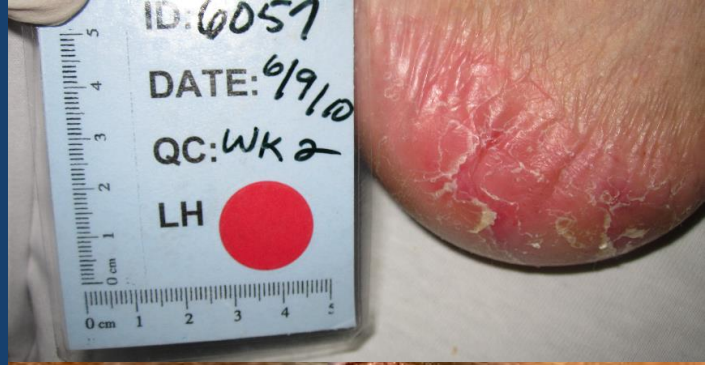
3. Discuss the current state of evidence for early detection of pressure related skin damage.

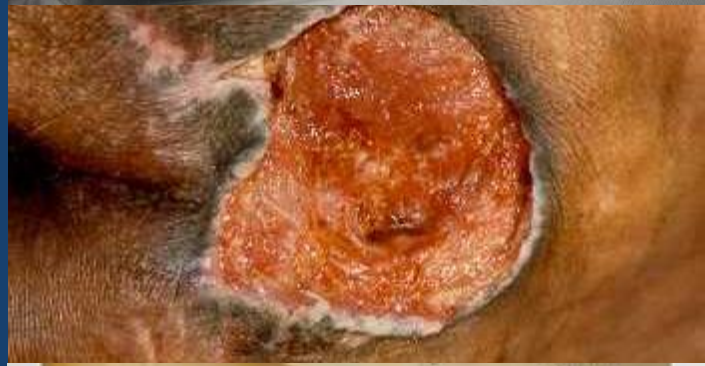
SEM & PrIs among NH residents:

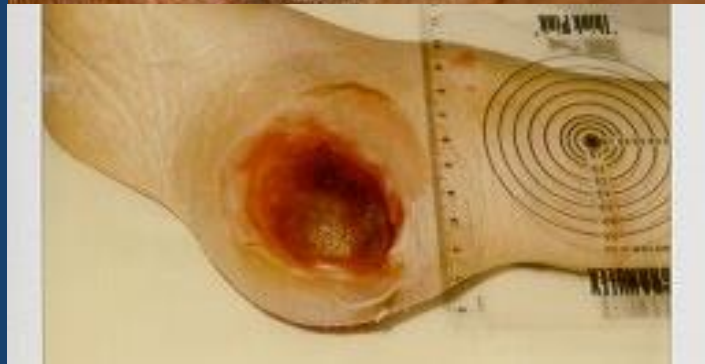
- SEM lowest for normal skin, higher for erythema/Stg 1 PrIs at all sites (P<.001);
- Responsive to skin changes
- Higher SEM predicted 26% of erythema/Stg 1 PrI the next week. N=34, weekly assessments X 52 wks
- SEM differentiated erythema & stg 1 PrI
- Higher SEM predicted 32% of sacral erythema/stg 1 PrI the next week. N=31, weekly assessments X 20 wks

Detection, prediction: Sacrum & Heels

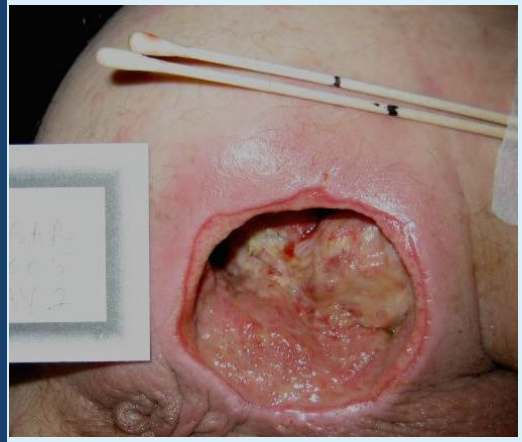
- PrI among 417 NH residents in 19 NHs over 16 weeks
- ***SEM associated with concurrent & 1 week later:***
- ***Heel PrI*** *adjusting for age, diabetes & function.*
- ***Sacral PrI*** *adjusting for age and risk*
- *SEM detected heel DTI, differentiated DTI that resolved, remained and deteriorated*







SEM & PrIs among Veterans with SCI

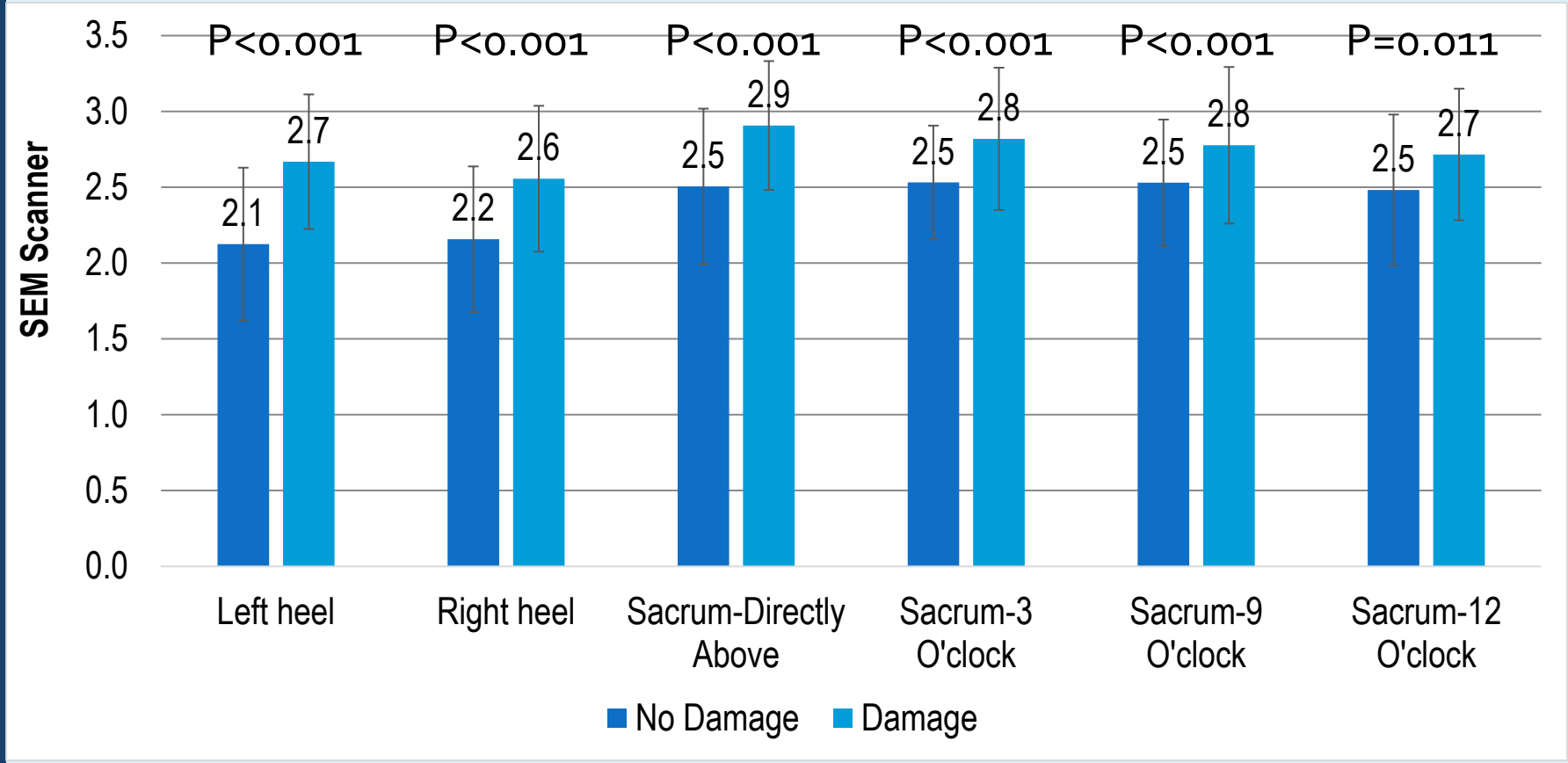


- Higher SEM at PrI vs controls for chronic non-healing stage 3,4 PrIs among Veterans with SCI,
  - *SEM differentiates PrIs from intact skin*
    - Harrow, Mayrovitz. J Spinal Cord Med. 2014 Nov;37(6):719-28.
- SEM lowest for normal skin (39.3), higher for erythema/stage 1 PrIs (40.8) at all anatomic sites
  - *n=34 Veterans; daily (n=12) or weekly (n=22) SEM and VSA*
    - Guihan M, Bates-Jensen BM, et al. J Spinal Cord Med, 2012; 35(1): 46-52

What are we actually finding with SEM?

- Small pilot study using ultrasound, thermography, SEM with **SEM Scanner**, VSA
  - *N=34, 2 NHs, weekly assessments x 16 weeks*
- Sacrum, Heels
- Sacral SEM, thermography, US at bony prominence, 9, 12, and 3-o-clock locations
- All US sagittal and transverse views

Mean SEM by Ultrasound category



Technology can detect damage below skin surface

- Best research evidence currently, SEM
- SEM has a relationship with PrI damage with several devices, across anatomic locations, among multiple patient populations and in various health care settings, FDA approved for detecting Sacral and Heel PrI

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