Clinical Aspects of Clinical Tissue Load

Virginia Capasso, APRN, PhD, CWS, FACCWS
Clinical Nurse Specialist – Wound Healing
Massachusetts General Hospital
Instructor in Surgery
Harvard Medical School
Boston, MA
Objectives

• List three clinical findings heralding risk of acute pressure injury (PI)
• Identify three clinical findings associated with chronic risk of PI
• Propose one of three bedside technologies that enhance early detection of evolving PI
• Delineate evidence-based strategies to prevent, halt, or minimize PI
Acute Clinical Manifestations of PI

- Pain
- Skin discoloration
- Variation in skin temperature
- Changes in texture of affected skin
Acute Clinical Manifestations: Pain

Capasso VA, Watkins MT, Mahoney EK, et. al

*Pre-Clinical Markers of Impending Pressure Ulcer Formation: Pilot Study (2007-2012, unpublished, N=10)*

**Inclusion criteria:** adults > 40 years, elective total hip replacement

**Measures:** Pre-op, PACU (4 hr), Day 1, Day 2, Day 3

- Blood for cytokines (IL-8, TNF-alpha)
- Sweat pads for transcutaneous lactate randomized for chemical analysis vs. mass spectrometer
- Four 3-D ultrasound images of both heels (Episcan-200, Chadd Ford, PA: Longport Inc.)
Acute Clinical Manifestations: Pain

Capasso VA, Watkins MT, Mahoney EK, et. al

*Pre-Clinical Markers of Impending Pressure Ulcer Formation: Pilot Study (2007-2012, unpublished)*

Subject # 7

- complaint of severe pain on posterior heel
- 3-D ultrasound image suggestive of subcutaneous inflammation / pressure injury
High Resolution, High Frequency Diagnostic Ultrasound Images

Figure 1.
EXAMPLES OF THICK AND THIN SKIN

1A. Thin skin, iliac crest. Note sharp border between the dermis and the subcutaneous tissue.

1B. Thick skin, lateral heel. Note thicker epidermis and dermis and the nondistinct border between the dermis and subcutaneous tissue.

High Resolution, High Frequency Diagnostic Ultrasound Images: Subcutaneous Edema Associated with Pressure and Friction

Figure 2.
HIGH-RESOLUTION ULTRASOUND IMAGES OF DEEP EDEMA VERSUS SUPERFICIAL EDEMA

2A. Pattern 1. Example of deep edema extending from the bone and extending upward, most likely caused by pressure.

2B. Pattern 2. Example of superficial edema, most likely caused by friction or incontinence.

PCMIPUF, Subject # 7 Right Posterior Heel

Subject # 7,
Time 5 (POD 1),
Right Posterior Heel

Subject # 7,
Time 7 (POD 2),
Right Posterior Heel

Subject # 7,
Time 8 (POD 3),
Right Posterior Heel
Acute Clinical Manifestations: Skin Discoloration

• Blanchable erythema
  – Visible skin redness that becomes white when pressure is applied and reddens when pressure is relieved
  – May result from normal reactive hyperemia that should resolve in several hours
  – Also may result from inflammatory erythema with intact capillary bed (Prevention & Treatment of pressure Ulcers: Clinical Practice Guideline, 2014, p. 63)
Acute Clinical Manifestations: Skin Discoloration

- Blanchable erythema
  - Presence of blanchable erythema or changes in sensation, temperature, or firmness may precede visual changes.
  - Color changes do not include purple or maroon discoloration; these may indicate deep tissue pressure injury

Acute Clinical Manifestations: Skin Discoloration

- Nonblanchable erythema
  - Visible skin redness that persists with application of manual pressure.
  - Indicates structural damage to capillary bed / microcirculation.
  - Indication of Stage I pressure ulcer (Sterner, et. al, 2011)
  - Independent predictor of Stage II PU development (Nixon, et. al., 2007)

(Prevention & Treatment of pressure Ulcers: Clinical Practice Guideline, 2014, p. 63)
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(Prevention & Treatment of pressure Ulcers: Clinical Practice Guideline, 2014, p. 63)
Acute Clinical Manifestations: Changes in Skin Temperature


N=65

80 paired sites in erythematosus tissue:
  - center and distant erythema
  - 50 cases: erythema was warmer
  - 18 cases: erythema cooler
  - 12 cases: temperature similar

Conclusion: Temperature not an indicator of tissue injury
Acute Clinical Manifestations: Changes in Skin Temperature


- Examined whether Pressure-Related Intact Discolored Areas of Skin (PRIDAS) correlated with the development of skin necrosis after 7 to 14 days
- N = 85
- 55 PRIDAS with a lower temperature at baseline than adjacent skin ("cool", average - 1.2 °C), 29 progressed to necrosis
Farid, et. al. cont. N = 85

- 29/55 PRIDAS with a lower temperature at baseline than adjacent skin ("cool", average -1.2 °C) progressed to necrosis
- 1/30 PRIDAS with a higher temperature than adjacent skin ("warm", average + 1.2 °C) (P <0.001)
- 0% of 26 patients with blanching erythema and warm PRIDAS versus 65% of 26 patients with a nonblanching and cool PRIDAS developed skin necrosis (P <0.001, Fisher exact test for the difference between the two combined values).
- Cooler may be ischemia vs. warmer re: O2 species
Acute Clinical Manifestations: Changes in Skin Temperature

Sae-Sia, et. al. Elevated sacral skin temperature ($T_s$): a risk factor for pressure ulcer development in hospitalized neurologically impaired Thai patients. Applied Nursing Research, 18(1), 29-35.

- Pressure ulcer incidence w/i 2 wks of admission 47%.
- Regardless of reclining position, mean sacral $T_s$ in subjects who developed a pressure ulcer was higher ($p < .01$) than those who did not develop an ulcer.
- $T_s$ may increase at least 1.2 °C 24–96 hr before sacral pressure ulcer development.
- Sacral $T_s$ may be an objective predictor of sacral pressure ulcer development.
Acute Clinical Manifestations: Changes in Skin Temperature


N=71

- Pressure ulcers and superficial skin changes were developed in 20 / 71 participants.

- Total mean difference in skin temperature was higher for patients with pressure ulcers and superficial skin changes (0.9 ± 0.6°C) compared with controls (0.6 ± 0.8°C) ($P = 0.071$).
Acute Clinical Manifestations: Changes in Skin Texture - Edema


- N = 66 residents in 4 US NH

- SEM threshold of 50 DPU was significant for detecting erythema/stage I PU in persons with dark skin tones (OR = 5.3, 95% CI, 1.87–15.11, P < .00)

- Higher SEM predicted greater likelihood of erythema/stage I PU and stage II+ PU in persons with dark skin tones the next week (OR = 1.88 for every 100 DPU increase in SEM, P = .004).
Findings Associated with Chronic Risk of PI

- Dry skin
- Thinning / atrophy of skin and muscle
Findings Associated with Chronic Risk of PI: Dry Skin


- Over-cleansing can cause the skin to become dry from removal of skin’s natural protective layers
- Avoid soap and water which has been associated with more erythema and broken skin
- Use pH balanced cleanser maintains slightly acidic to neutral pH, maintaining or improving skin integrity
Chronic Risk of PI: Case Study

- 60 yo white male who sustained a C6 spinal cord injury while playing football 43 years ago. Lives in his accessible family home with 24-7 personal care attendants. Wheelchair-bound, RoHo cushion, pressure-relief
- First episode of care for left ischial pressure ulcer in 12/2004. Treatment included topical wound care and sitting restricted to two 2 hour sessions per day. Healed in 32 weeks
Chronic Risk of PI: Case Study

- Presented for recurrent episode of care for left ischial pressure ulcer in 6/2015. Treatment included advanced wound therapy (NPWT, Cellular and Tissue Products) and restriction to bedrest 20 hour/day on fluid immersion simulation mattress.
- Much less enthusiastic and somewhat non-compliant (e.g. traveling 2 hr to casino or house at the shore with caregivers)
Chronic Risk of PI: Case Study

- Non-healing for 11 months
- Myocutaneous flap by Plastic Surgery (May, 2016)
- Bed rest x 6 weeks
- Hospital re-admission (August, 2016) for recurrent left ischial ulceration
  - Bedrest on air fluidized bed
  - Topical therapy with keratin gel / solid dressings every two days
  - Initial wound closure in 8 days
Chronic Risk of PI: Case Study

Discharge to home on bedrest for 14 days
Fluid immersion simulation (FIS) mattress for hospital bed at home
Chronic Risk of PI: Case Study

- Referral to seating clinic at rehab hospital:
- "Motor: UE strength= 3-/5 through C6, absent MMT below C6
- Tone: minimal increased tone both LE's
- ROM: wnl for wheelchair seating
- Sensation: Absent below C6
- Edema: N/A
- Wt= 145#
Chronic Risk of PI: Case Study

Referral to seating clinic at rehab hospital:

• Independent and functional in his current seating system
• Roho cushion was properly inflated
• Pressure mapping revealed low peak pressures
• Good pressure distribution with only slightly increased weight bearing right > left pelvis. Dispersion index= 22%.
• achieves complete pressure relief with full tilt
• Physiatrist / PT: Scar tissue more susceptible to trauma
Bedside Technologies to Detect PI

- High frequency 3-D ultrasound (Slide 6 & 7)
- “Moisture Meter” to detect subepidermal moisture (Bates-Jensen)
- Rubitect
  LED emission / reflection to detect changes in the chemical footprint
Bedside Technologies to Detect PI

• High frequency 3-D ultrasound
  20 – 50 MHz
Bedside Technologies to Detect PI: Moisture

- BBI's SEM Scanner™, a hand-held, portable device, interrogates the subepidermal moisture (SEM), a biophysical marker of damaged tissue. The SEM Scanner™ uses sensor technology to measure changes in tissue electrical capacitance through the low amplitude signals from electrodes placed on the patient's skin.

Bedside Technologies to Detect PI: Rubitect

LED Emission / Reflection

http://rubitection.com/
Strategies to Prevent, Halt, Minimize PI

• Reposition patient
  – Turn every two hours
  – Use ceiling lift
  https://www.youtube.com/watch?v=Of5DoVOISHA&feature=youtu.be
  – Reposition in chair every 15 minutes
    limit sitting to maximum of 2 hours per
Strategies to Prevent, Halt, Minimize PI

• Reposition patient
  – Turn every two hours
  – Use ceiling lift
  – Reposition in chair every 15 minutes
    limit sitting to maximum of 2 hours per session
Strategies to Prevent, Halt, Minimize PI

- **Support surfaces:**
  - Braden > 12
  - Standard General Care: Non-motorized
  - Rental: LAL with MCM
  - Standard Critical Care: IPAR
  - Braden Score < 12
  - Rental: Air Fluidized Bed
  - Selected Populations: Fluid Immersion Simulation
Strategies to Prevent, Halt, Minimize PI

- Support surfaces:
  - Chair pads
    - Air cushions
    - RoHo
Strategies to Prevent, Halt, Minimize PI

- Adjuncts:
  - Prophylactic foam dressings / tape
    - Sacrum, heels
    - Beneath CPAP / BiPAP masks
    - On boney prominences when patient is in prone position, Jackson frame for spine surgery
  - Boots to Relieve Heel Pressure
  - Tube holders (NGT, ETT, G-tube, urinary catheters, fecal incontinence devices)
  - Bridle to secure NGT
SKIN BUNDLE

Protect Your Patient’s SKIN

- Skin / Risk Assessment Surfaces
- Keep moving/turning
- Incontinence management
- Nutrition

Tissue injury can be more than skin deep

http://www.ascensionhealth.org/assets/docs/JCAHO_Eliminating_Facility_Acquired_Pressure_Ulcers_at_AH_shrink.pdf

Capasso, 5-19-2011
SKIN BUNDLE: “S”

S – Skin Assessment / Risk Assessment (Braden Scale)
- Admission, including provider documentation “present on admission”
- Daily

http://www.mnhospitals.org/inc/data/tools/SafeSkin-Toolkit/mha-welcome-apold.ppt#540,11,Save Our Skin Awards
http://www.ascensionhealth.org/assets/docs/JCAHO_Eliminating_Facility_Acquired_Pressure_Ulcers_at_AH_shrink.pdf
Capasso, 5-19-2011
Cardiac Surgical ICU Pressure Ulcer Prevalence
9/2012 – 12/2015

* No Stage III or Stage IV HAPU reported in these quarterly surveys

Legend: HAPU: Hospital-acquired pressure ulcers; CSICU-Cardiac Surgical Intensive Care Unit, DTI – Deep Tissue Injury U - Unstageable

<table>
<thead>
<tr>
<th>Survey Date</th>
<th>Patients Surveyed (N)</th>
<th>Hospital-Acquired Pressure Ulcers (HAPU) (N)</th>
<th>HAPU ≥ Stage 2 (%)</th>
<th>Patients Surveyed in CSICU (N)</th>
<th>Patients with HAPU in CSICU (N)</th>
<th>Stage</th>
<th>% of Total Patients with HAPU in CSICU (%)</th>
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<td>09/2012</td>
<td>800</td>
<td>18</td>
<td>1.9%</td>
<td>7</td>
<td>1</td>
<td>DTI</td>
<td>1/7 (14.0%)</td>
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<td>12/2012</td>
<td>791</td>
<td>22</td>
<td>2.7%</td>
<td>14</td>
<td>5</td>
<td>II(3) DTI(2)</td>
<td>5/14 (35.0%)</td>
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<td>03/2013</td>
<td>777</td>
<td>25</td>
<td>3.0%</td>
<td>14</td>
<td>1</td>
<td>DTI</td>
<td>1/15 (6.0%)</td>
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<td>06/2013</td>
<td>786</td>
<td>26</td>
<td>3.2%</td>
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<td>4</td>
<td>II(2) DTI(2)</td>
<td>4/12 (33.0%)</td>
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<tr>
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<td>16</td>
<td>2.1%</td>
<td>11</td>
<td>1</td>
<td>II</td>
<td>1/11 (9.1%)</td>
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<td>19</td>
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<td>1/12 (8.0%)</td>
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<tr>
<td>06/2014</td>
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<td>20</td>
<td>2.7%</td>
<td>14</td>
<td>4</td>
<td>II(1) DTI(2) U(2)</td>
<td>4/14 (28.0%)</td>
</tr>
</tbody>
</table>

|             |                       | Range: 1-5                                   | Mean: 15.5%       |                               |                               |       |                                         |
| 09/2014     | 814                   | 11                                          | 1.4%              | 10                            | 1                             | II(1) DTI(1) | 1/10 (10.0%) |
| 12/2014     | 795                   | 12                                          | 1.4%              | 8                             | 0                             |                   | (0.0%) |
| 03/2015     | 824                   | 14                                          | 1.7%              | 10                            | 1                             | DTI(2)      | 1/10 (10.0%) |
| 06/2015     | 800                   | 12                                          | 1.5%              | 15                            | 0                             |                   | (0.0%) |
| 09/2015     | 807                   | 16                                          | 2.0%              | 12                            | 0                             |                   | (0.0%) |
| 12/2015     | 829                   | 17                                          | 2.1%              | 11                            | 1                             | DTI(1)      | 1/11 (9.0%)   |
Pressure Injury Prevalence Rate in Cardiac Surgical ICU

- Intervention, Sept. 2013
  - ‘FIS Table Pads’ in CS ORs

- Intervention, August 2014
  - ‘FIS Beds’ in CSICU

Patients with Hospital Acquired Pressure Injury (%)

Prevalence Survey Data (Mo./Yr.)
Thank you!