Pressure Ulcers in the ICU
Incidence, Risk Factors & Prevention

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-
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Grading of pressure ulcers

**Grade 1**
Non-blanchable erythema (redness) of intact skin. Discolouration of the skin, warmth, oedema, induration or hardness may also be used as indicators, particularly on individuals with darker skin.

**Grade 2**
Partial thickness skin loss involving epidermis, dermis, or both. The ulcer is superficial and presents clinically as an abrasion or blister.

**Grade 3**
Full thickness skin loss involving damage to or necrosis of subcutaneous tissue that may extend down to, but not through underlying fascia.

**Grade 4**
Extensive destruction, tissue necrosis, or damage to muscle, bone, or supporting structures with or without full thickness skin loss.
Pathogentic mechanism of pressure ulcers

Microscopic view

• Several theories to explain the tissue necrosis
  o Localized ischemia
  o Sustained deformation of cells
  o Impaired interstitial fluid flow and lymphatic drainage
  o Reperfusion infusion

• Widely accepted
• Tissue ischemia induced by occlusion of blood vessels

Clinical view

• Mechanical loading of soft tissues (extrinsic factors)
  o Pressure forces
  o Shearing forces

• Damage might be facilitated by:
  o Intrinsic factors
    o Underlying disease
    o Malnutrition
    o Older age
    o Lack of mobility
  o Other extrinsic factors
    o Moisture
    o Friction
Risk factors for Pressure Ulcers in the ICU

• Any different from non-critically ill patients?
  (basic mechanism is the same)

• More risk factors present at the same time
• Risk factors present in higher degree of severity

→ Accumulated risk for pressure ulcers
<table>
<thead>
<tr>
<th>Author</th>
<th>Source, year</th>
<th>Study design</th>
<th>Patients</th>
<th>n</th>
<th>Pressure ulcer rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvey S</td>
<td>NEJM 2014</td>
<td>RCT, multicentric</td>
<td>Mixed ICU, unplanned admission</td>
<td>2388</td>
<td>15%</td>
</tr>
<tr>
<td>Manzano F</td>
<td>J Crit Care 2010</td>
<td>Prosp., observ., multicentric</td>
<td>General ICU; &gt;24 hrs. on mechanical ventilation</td>
<td>299</td>
<td>16% ≥2nd stage</td>
</tr>
<tr>
<td>Manzano F</td>
<td>J Eval Clin Pract 2014</td>
<td>Prosp., observ., single centre</td>
<td>General ICU; &gt;24 hrs. on mechanical ventilation</td>
<td>563</td>
<td>19.5%</td>
</tr>
<tr>
<td>Nijs N</td>
<td>J Clin Nurs 2009</td>
<td>Prosp., observ., single centre</td>
<td>General ICU; &gt;24 hrs. in ICU</td>
<td>520</td>
<td>20.1%</td>
</tr>
<tr>
<td>Terekeci H</td>
<td>Eur J Intern Med 2009</td>
<td>Prosp., observ., single centre</td>
<td>General ICU; all patients</td>
<td>142</td>
<td>9.8% on admiss.; 17.6% at discharge</td>
</tr>
<tr>
<td>Akbari Sari</td>
<td>Iran J Public Health 2014</td>
<td>Prosp., observ., multicentre</td>
<td>General ICU; all patients</td>
<td>90</td>
<td>26.7%</td>
</tr>
</tbody>
</table>
Pressure Ulcers in Burn Injury Patients
Pressure ulcers in Burn Victims

Risk profile:

- Bedridden
- Extensive wound dressings limits early mobilization
- If inhalation injury is present mechanical ventilation required for prolonged period of time
- Multiple surgical procedures (positioning problems in OR)
- Burn shock ➔ vasopressors
- Capillary leak
  - Edema formation
  - Excessive wound exsudate
- Damaged skin integrity
Pressure ulcers in Burn Victims

- Epidermis
- Dermis
- Fat
- Muscle

Types of burns:
- Superficial, 1°
- Intermediate partial thickness, 2°
- Deep partial thickness, 2°
- Full thickness, 3°
Pressure ulcers in Burn Victims

Complete destruction of the subcutaneous vascular plexus system in the burned skin.
Pressure ulcers in Burn Victims

Serious but incomplete damage of vascular structure; regeneration possible as some blood vessels remain functioning
Pressure ulcers in Burn Victims

Only epidermis affected; no direct damage to vascular structures; hyperemic status
How to tell a 1° burn from a 1° pressure ulcer?
How to tell a 1° burn from a 1° pressure ulcer?

1st stage pressure ulcer: non-blanchable erythema

1° burn: “blanching”; the more superficial the burn, the faster the capillary refill upon pressure relief
How to tell a 1° burn from a 1° pressure ulcer?
Pressure Ulcers and Risk Assessment in Severe Burns

• Cohort study, n=1489
• Pressure ulcer incidence: 1.3%
• Affected site: sacrum, lower extremity, occiput
• A majority of the PUs presented at stage 2 (33%), stage 3 (26%), and unstageable (30%).
• 90% of patients with PUs had Braden score of ≤16
• Multivariate analysis: Braden score not an independent predictor of PUs
• Most PUs acquired in acute phase

Relatively low occurrence rate despite high risk?

**Potential explanation:**

- More than the average critically ill patient, burn victims are cared for in specialized beds.
- Alternating mattresses are standard.
- Burn wounds at the back: low-air-loss bed or air fluidized therapy bed.
Smoking as a Risk Factor for Pressure Ulcers
Smokers have severely disturbed peripheral microcirculation

**Smoking**

→ morphological changes in microvascular structure
→ reduced blood flow

**Hypothesis**: decreased microvascular function decreases the skin’s natural defense and increases risk for pressure ulcers

Cigarette smoking and risk of pressure ulcer in adult intensive care unit patients

- Cohort study
- Setting: 20-bed MICU
- Inclusion criteria
  - Male patients
  - ≥18 yrs
  - ICU stay ≥24 hrs
  - Pressure ulcer-free on admission
- “Smoking” ≥5 cigarettes/day for the past 6 months

Cigarette smoking and risk of pressure ulcer in adult intensive care unit patients

Results

• Cohort:
  o 2046 admissions
  o 352 met inclusion criteria
    o 160 smokers
    o 192 non-smokers
Cigarette smoking and risk of pressure ulcer in adult intensive care unit patients

<table>
<thead>
<tr>
<th></th>
<th>Smoker</th>
<th>Non-smoker</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of ICU stay, days (Mean ± SD)</td>
<td>11.0 ± 12.3</td>
<td>10.4 ± 14.4</td>
<td>0.009</td>
</tr>
<tr>
<td>Reason of admission n (%)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Trauma</td>
<td>86 (53.8)</td>
<td>104 (54.2)</td>
<td>0.791</td>
</tr>
<tr>
<td>Postsurgical</td>
<td>30 (18.8)</td>
<td>35 (18.2)</td>
<td></td>
</tr>
<tr>
<td>CVA†</td>
<td>13 (8.1)</td>
<td>16 (8.3)</td>
<td></td>
</tr>
<tr>
<td>Unconsciousness</td>
<td>13 (8.1)</td>
<td>10 (5.2)</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>31 (19.4)</td>
<td>37 (19.3)</td>
<td></td>
</tr>
<tr>
<td>Anaemia n (%)</td>
<td>93 (58.1)</td>
<td>107 (55.7)</td>
<td>0.651</td>
</tr>
<tr>
<td>Diabetes mellitus n (%)</td>
<td>24 (12.5)</td>
<td>10 (5.2)</td>
<td>0.015</td>
</tr>
<tr>
<td>Hypertension n (%)</td>
<td>21 (13.1)</td>
<td>24 (12.5)</td>
<td>0.861</td>
</tr>
<tr>
<td>Faecal incontinency n (%)</td>
<td>64 (40)</td>
<td>38 (19.8)</td>
<td>&lt; 0.001</td>
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<tr>
<td>Level of consciousness n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>103 (64.4)</td>
<td>143 (74.5)</td>
<td>0.075</td>
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<tr>
<td>Moderate</td>
<td>31 (19.4)</td>
<td>24 (12.5)</td>
<td></td>
</tr>
<tr>
<td>Sever</td>
<td>26 (16.2)</td>
<td>25 (13)</td>
<td></td>
</tr>
</tbody>
</table>

Results

- 25.6% of patients developed PU
  - Smokers: 62/160 (38.8%)
  - Non-smokers: 28/192 (14.6%) (P<0.001)

- PU development associated with pack-year of smoking (p=0.003)
Cigarette smoking and risk of pressure ulcer in adult intensive care unit patients

Results – distribution of PU stage in smokers and non-smokers

<table>
<thead>
<tr>
<th>Ulcer stage</th>
<th>Smoker</th>
<th></th>
<th></th>
<th>Non-smoker</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>33</td>
<td>53.2</td>
<td>24</td>
<td>85.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>23</td>
<td>37.1</td>
<td>4</td>
<td>14.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>6</td>
<td>9.7</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>62</td>
<td>100</td>
<td>28</td>
<td>100</td>
<td></td>
<td></td>
</tr>
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</table>

## Results – independent relationships with PU risk

<table>
<thead>
<tr>
<th>Variables</th>
<th>$\beta$ Coefficient</th>
<th>SE ($\beta$)</th>
<th>$P$-value</th>
<th>Odds ratio (OR)</th>
<th>95% CI for OR</th>
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</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.05</td>
<td>0.01</td>
<td>&lt;0.001</td>
<td>1.05</td>
<td>1.03–1.07</td>
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<tr>
<td>Length of ICU stay</td>
<td>0.17</td>
<td>0.03</td>
<td>&lt;0.001</td>
<td>1.19</td>
<td>1.13–1.25</td>
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<tr>
<td>Faecal incontinency</td>
<td>1.23</td>
<td>0.44</td>
<td>0.005</td>
<td>3.42</td>
<td>1.45–8.06</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>1.77</td>
<td>0.59</td>
<td>0.003</td>
<td>5.58</td>
<td>1.83–18.70</td>
</tr>
<tr>
<td>Anaemia</td>
<td>0.99</td>
<td>0.40</td>
<td>0.014</td>
<td>2.68</td>
<td>1.22–5.91</td>
</tr>
<tr>
<td><strong>Smoking</strong></td>
<td><strong>0.03</strong></td>
<td><strong>0.01</strong></td>
<td><strong>0.003</strong></td>
<td><strong>1.03</strong></td>
<td><strong>1.01–1.06</strong></td>
</tr>
<tr>
<td>Trauma</td>
<td>2.77</td>
<td>0.74</td>
<td>&lt;0.001</td>
<td>15.95</td>
<td>3.72–68.65</td>
</tr>
<tr>
<td>Constant</td>
<td>−9.47</td>
<td>1.3</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>
Vasopressor use and risk for pressure ulcers
Vasopressor use and risk for pressure ulcers

Vasopressor agents

- Increase SVR by vasoconstriction of smooth muscle cells in arterioles of non-vital organs
- Consequently: tissue perfusion is reduced
- Research question: is tissue perfusion sufficiently reduced to increase the risk of PUs?
Pressure Ulcer Development and Vasopressor Agents in Adult Critical Care Patients: A Literature Review

**Results**

- 10 studies (2000 – 2012)
  - 3 retrospective
  - 7 prospective cohort studies
  - 7 studies found **significant relationship** between vasopressor use and PU development
    - 4 multivariate analysis
    - 3 only in univariate analysis

**Overall evidence is rather low**

Cox J. Ostomy Wound Manag 2013
Problems

- Some studies: No difference between agents

- Problem of dosing
  - Most studies: vasopressor use registered as “Yes/No” without defining a threshold
  - What about low dose vasopressors that rather result in vasodilatation?

- Multivariate analysis identifies independent relationships, but accumulated effect of vasopressors above existing (intrinsic) risk factors is not assessed.
Vasopressor use and risk for pressure ulcers

Pressure ulcer risk

**Hypothesis:** identical dose might have higher impact on PU risk in the presence of intrinsic risk factors

Patient without risk profile

- **NOR dose xxx**
- **Diabetes**

Patient with risk profile

- **NOR dose xxx**
- **Obesity**
- **Incontinency**
- **Sedation**
Any new issues in prevention...?
A randomised controlled trial of the effectiveness of soft silicone multi-layered foam dressings in the prevention of sacral and heel pressure ulcers in trauma and critically ill patients: the border trial


Mepilex® Border Sacrum (5 layers)
Mepilex® Heel (3 layers)

Objective: to assess the effectiveness of the dressing to prevent pressure ulcers on sacrum and heels of ICU patients.

Methods: Patients were randomized in the ED. Patients allocated to the intervention group received dressing in the ED; dressings remained in place throughout the ICU course.
A randomised controlled trial of the effectiveness of soft silicone multi-layered foam dressings in the prevention of sacral and heel pressure ulcers in trauma and critically ill patients: the border trial

<table>
<thead>
<tr>
<th>intervention (n = 161)</th>
<th>control (n = 152)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>cases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>developed PU</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>incidence (%)</td>
<td>3.1</td>
<td>13.1</td>
</tr>
<tr>
<td>anatomical site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>developed PU</td>
<td>7</td>
<td>27</td>
</tr>
<tr>
<td>sacral PU</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>heel PU</td>
<td>5</td>
<td>19</td>
</tr>
</tbody>
</table>

PU, pressure ulcer.

Number needed to treat to prevent 1 PU: n=10
Conclusion

• Critically ill patients have a high risk for PUs because more risk factors are present in high degree of severity.

• The multifactorial aspect hampers the assessment of the contribution of an individual risk factor within the total risk profile.

• Pressure ulcers appears to remain an important source of morbidity in ICUs, however, large-scaled epidemiologic studies are lacking.
Decubitus in Intensive Care Units

- **Design:** multicenter, international 1-day prevalence study
- **Outcomes:** prevalence, risk factors, prevention measures, clinical & economic outcomes
- **Scale:** worldwide
- **Timing:** study day tbd (fall 2016)