Wound Management Considerations for Critical Care & End of Life Populations

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Objectives

• Interpret clinical information to correctly identify wound etiology in the critical care/end of life patient population.
• Compare and contrast findings associated with acute skin failure vs. skin changes at life's end.
• Examine different off-loading devices for features especially beneficial in the critical care/end of life population.
• Relate available technologic advances to their clinical usefulness for patients in critical care/at end of life.

What Do We Know?

• Examples of patients at high risk for pressure injury (PI) development:
  — Older adults
  — Those who have experienced trauma
  — Patients with spinal cord injuries
  — Patients with hip fractures
  — Patients in long-term or community care
  — The acutely ill
  — Those with diabetes
  — Those in critical care settings
• Almost 6 million people across the United States are admitted into intensive care units annually.
• PI prevalence in the ICU population is the highest among hospitalized patients at 13%-45.5%
• Over 17,000 lawsuits related to PI's are filed annually – second only to wrongful death & more common than patient falls.
What Do We Know?

• Risk Factors for PI in Critically Ill Adults:
  – 7 PI risk factors were significant across multiple studies
    • Age
    • Length of ICU admission
      – 1st week most vulnerable timeframe
    • Diabetes mellitus
    • Cardiovascular disease
    • Hypotension
    • Mechanical ventilation
    • Vasopressor agents

Do Our Current Risk Assessments Account for These Factors?

• Braden
  – No
  – Likely need to manage to subscales vs. cumulative score
  – Retrospective chart review showed that patients with cumulative & subscale scores of intermediate risk (13-14) had HIGHEST likelihood of developing a PI among all subscale categories except friction/shear subscale
  • Need to consider level of prevention interventions

• Jackson/Cubbin and modified Jackson/Cubbin risk scales
  – More intensive care specific but limited adoption in US

What Additional Tools Might Help?

• Sequential Organ Failure Assessment (SOFA):
  – Validated tool with 6 assessment categories – serum bilirubin concentration, platelet count, renal dysfunction, nervous system status via Glasgow Coma Scale (GCS), hypotension, presence of respiratory disorder
  – Each scored 0 (low risk) to 4 (high risk) for range of 0 to 24
    • Higher the score, the more severe the patient’s condition and the higher the mortality risk
SOFA & PI Prediction
Retrospective Cohort Study

• Included Stage 1-4 and unstageable PI’s
  – No mention of DTPI
• 4784 study participants
• Average ICU length of stay = 3.6 days (range 1-60)
• Data from cardiovascular and respiratory SOFA categories were the most reliable indicators of PI risk
• May be used as an adjunct to other risk assessment tools

Perfusion/Oxygenation & PI Development

• One third of the body’s circulating blood volume supplies the skin
• Dysfunction of tissue perfusion can create tissue compromise

Perfusion/Oxygenation & PI Development

• Assessment of perfusion/oxygenation is difficult due to varied descriptors and direct/indirect measures used by researchers

• Examples:
  – DM
  – CVA
  – Renal disease
  – Cardiac disease
  – Vascular disease
  – PVD
  – Cardiovascular instability
  – Norepinephrine use
  – Pulse pressure
  – Cyanosis
  – Low diastolic BP/High systolic BP
  – Decreased ABI
  – Hypotension/Hypertension
  – Inotrope administration
Perfusion/Oxygenation & PI Development

- Significance of perfusion/oxygenation measures:
  - Vascular disease – 4 of 6 studies
  - Blood pressure alterations (low or high) – 8 of 13 studies
  - Diabetes – 7 of 14 studies
  - Circulation – 5 of 10 studies
  - Smoking – 2 of 5 studies
  - Edema – 1 of 5 studies

Perfusion/Oxygenation

- Participants used as their own control & effects of MAP on wound healing were analyzed for at least 4 weeks of serial measurements
  - Cessation in wound healing discovered across the sample when MAP < 80 mmHg
- Subsequent analysis separated truncal wounds (sacrum, ischium, hips, buttocks) from lower extremity (LE) wounds (lower legs & feet)
  - No correlation between LE wound healing and a MAP > 80 mmHg
  - Suggests that peripheral artery disease is likely an independent intrinsic wound healing factor

Perfusion/Oxygenation

- Data suggests that for truncal wounds, a MAP of at least 80 mmHg is required for wound healing
  - How many patients in critical care meet this requirement?
  - General consensus is that a mean arterial pressure (MAP) of greater than 60 mmHg is necessary to maintain organ viability
Hematological Measures & PI Development

- Hematological measures may affect physiology & repair as well as transport & thermal properties of the skin which can impact susceptibility and tolerance to load.
- Difficult to directly interpret and apply these results clinically.
- Significance of different hematological measures:
  - Lymphopenia – 2 of 2 studies
  - Albumin – 7 of 12 studies
  - Hemoglobin – 6 of 11 studies
  - Urea & Electrolytes – 2 of 4 studies
  - C-reactive protein – 1 of 3 studies

Mechanical Ventilation & PI Development

- Duration of mechanical ventilation (MV) impacts PI development
  - Series of 299 patients requiring MV for more than 24 hours assessed
  - PI (≥ Stage 2) reported in 2.8% of 181 patients with 7 days or less on MV
  - PI (≥ Stage 2) reported in 35.6% of 118 patients with more than 7 days on MV (P < .001)

Vasopressor Agents & PI Development

- Vasopressor agents:
  - Administered intravenously to increase blood pressure by vasoconstricting the arterioles
  - Over the last decade used as important first line drugs for critically ill patients in shock states
  - Norepinephrine, epinephrine, phenylephrine, vasopressin, dopamine
- Literature review of 10 studies:
  - Vasopressor agents a significant predictor of PI development in critical care patients – 4 studies
  - Significant associations with PI development and vasopressor use in univariate analyses – 3 studies
  - Still don’t know effects of specific vasopressors, dosing, duration of use, use of multiple concomitant vasopressors
So... which came first?

- When a critically ill patient requiring vasopressor use develops a PI →
  - Was it from the hypotension necessitating the use of the vasopressor medication(s) OR
  - Was it from the vasoconstricting properties of the medication?

Repositioning Critically Ill Patients

- In the critical care population, hospital-acquired pressure injury (HAPI) prevalence rates have been reported to be as high as 42%
  - Sacrum & buttocks most common locations
- Several factors may limit optimal repositioning in these patients:
  - Delayed sternal closure
  - Head-of-bed elevation requirements for ventilator associated pneumonia (VAP)/aspiration prevention
  - Continuous pulmonary toileting
  - Cardiac assist devices

Repositioning Critically Ill Patients

- Need to insure that additional pressure injury prevention program elements are also being implemented
  - Pressure redistributing surfaces
  - Moisture management
  - Nutritional support
- Incremental positioning or weight shifts
  - Frequent, small repositioning shifts of 15° to 20°
  - Suggested each time a nurse enters the patient room
  - Limited evidence to support reduction in HAPIs currently but also no evidence of patient harm from this intervention
Head of Bed (HOB) Elevation & Critically Ill Patients

• Peak sacral interface pressures rose significantly when there was 30° or higher HOB elevation
• HOB elevation ≥ 45° significantly increased the interface pressures to the buttocks and sacrum
  — Increased area of skin also exposed to capillary closing pressure
• HOB elevation to 60° suggested a shift in weight distribution as interface pressures over the sacrum decreased slightly but interface pressures over the buttocks increased

How Does Standard of Care (SOC) Compare to Reality?

• Clinical practice guidelines for aspiration and ventilator-associated pneumonia (VAP) recommend head-of-bed elevation > 30°
• Backrest elevation over 45° makes effective lateral repositioning difficult
• Combination of HOB elevation & reverse Trendelenburg positioning may be an alternative
  — Equivalent of 45° HOB elevation with 20° HOB + 10° reverse Trendelenburg
  — Could achieve VAP/aspiration prevention with HOB elevation under 30° → allows for adequate lateral positioning
  — May increase shear

Palliative Care

• Shift in focus:
  — Caring for pressure injuries in palliative care is not “lack of care”
  — Care is focused on comfort & limiting the extent or impact of the wound.
  — Prevention of new pressure injuries remains important but during the period of active dying – comfort and/or the individual's preference may override use of active prevention strategies
What Don’t We Know?

What Am I Seeing?

Skin Failure?  Unavoidable PI?

DTPI?  TB-TTI?

SCALE?  Kennedy Terminal Ulcer?

MASD?

Do these all exist?
Timeline of Definitions

<table>
<thead>
<tr>
<th>Definition</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kennedy Terminal Ulcer</td>
<td>1989</td>
</tr>
<tr>
<td>Unavoidable Pressure Ulcer</td>
<td>2004</td>
</tr>
<tr>
<td>Skin Failure</td>
<td>2006</td>
</tr>
<tr>
<td>Skin Changes at Life’s End</td>
<td>2008</td>
</tr>
<tr>
<td>Trombley-Brennan Terminal Tissue Injury</td>
<td>2010</td>
</tr>
</tbody>
</table>

Kennedy Terminal Ulcer (KTU)

- “Shaped like a pear; always on the coccyx or sacrum. Red, yellow and black. Sudden onset. Death is imminent.”
- There is not an ICD-10 diagnosis for a KTU

Unavoidable Pressure Injury

- Can not be predicted – assignment of “unavoidability” can only occur AFTER the fact
- Physiologic definition vs. regulatory definition
- There is not an ICD-10 diagnosis for an unavoidable pressure injury
Unavoidable PI -- Physiology

- Severe anemia
- Severe nutritional depletion or weight loss/hypoalbuminemia
- Severe edema/anasarca
- Respiratory failure/life support measures
- Medication (steroids, vasopressors, immunosuppressants)
- Hypoperfusion/hypoxia from any cause (severe CHF, atherosclerosis, shock, blood loss, etc.)
- Pre-existing skin damage
- SIRS (Systemic Inflammatory Response Syndrome)
- Multi-Organ System Failure
- The dying process

Unavoidable PI – CMS Regulations

- “Unavoidable” means the resident developed a pressure ulcer/injury even though the facility had:
  - Evaluated the resident’s clinic condition and risk factors;
  - Defined and implemented interventions that are consistent with resident needs, resident goals, and professional standards of practice;
  - Monitored and evaluated the impact of the interventions; and
  - Revised the approaches as appropriate.

Skin Failure

- Primary pathophysiology associated with hypoperfusion
- No universally accepted definition or clinical criteria of skin failure currently exist
- There is not an ICD-10 diagnosis for skin failure
Skin Failure

- Initial Definition (2006)
  - “An event in which the skin and underlying tissue die due to hypoperfusion that occurs concurrent with severe dysfunction or failure of other organ systems.”
- Additional Definition (2009)
  - “Acute skin failure: pressure-related injury concurrent with chronic illness that is associated with progressive decompensation of major organ systems and/or functional decline.”
- Expanded Definition (2017)
  - “Skin failure is the state in which tissue tolerance is so compromised that cells can no longer survive in zones of physiological impairment that includes hypoxia, local mechanical stresses, impaired delivery of nutrients, and buildup of toxic metabolic byproducts.”

Skin Changes at Life’s End (SCALE)

- “Physiological changes that occur as a result of the dying process may affect the skin and soft tissues and may manifest as observable (objective) changes in skin color, turgor, or integrity, or as subjective symptoms such as localized pain.”
- There is not an ICD-10 diagnosis for SCALE

Trombley-Brennan Terminal Tissue Injury (TB-TTI)

- Spontaneously appearing skin alterations (rapid evolution, speed of enlargement and progression, appearance in areas of little to no pressure such as thighs and mirror imaging) found in patients at the end of life.
- There is not an ICD-10 diagnosis for TB-TTI
What's In a Name?

- Basic tenet of wound management is the need to treat the underlying etiology
- Pay for Performance
  - 2008 Hospital Acquired Conditions (HACs)
    - Stage 3 and 4 pressure ulcers acquired in the hospital considered "reasonably preventable"
  - 2010 Affordable Care Act
    - "Meaningful use" of EHRs includes standardization of terminology for accurate quality reporting
- How might regional or inter-facility differences in "operational definitions" impact this?

Potential Documentation Concerns

- Documented terminology not correlating to ICD-10 codes
- Conflicting documentation from different providers
  - EMR challenges
  - Teaching institution challenges
  - Need physician partners to make this successful

ACUTE SKIN FAILURE VS. SKIN CHANGES AT LIFE’S END
Factors Associated with Acute Skin Failure (ASF)

- Impaired nutrition
- Multisystem organ failure*
- Limited tissue perfusion
- Sepsis/severe sepsis/septic shock/MODS
- Prolonged mechanical ventilation
- Prolonged hypotension
- Diabetes
- Immobility
- Surgery > 3 hours
- Vasopressors
- Severe anemia

BUT... ?

- Risk Factors for PI in Critically Ill Adults:
  - Age
  - Length of ICU admission
  - Diabetes mellitus
  - Cardiovascular disease
  - Hypotension
  - Mechanical ventilation
  - Vasopressor agents

- Factors Associated with ASF:
  - Multisystem organ failure*
  - Limited tissue perfusion
  - Sepsis/severe sepsis/septic shock/MODS
  - Prolonged mechanical ventilation
  - Prolonged hypotension
  - Diabetes
  - Vasopressors
  - Severe anemia

Delineation between skin disease and physical decline can be difficult to determine clinically because skin failure and pressure injuries can occur simultaneously.

Significant & Independent Predictors of ASF

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Regression Coefficient</th>
<th>Standard Error (SE)</th>
<th>P value</th>
<th>Odds Ratio</th>
<th>95% Confidence Interval (CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peripheral Artery Disease</td>
<td>1.33</td>
<td>0.42</td>
<td>.002</td>
<td>3.8</td>
<td>1.64-8.66</td>
</tr>
<tr>
<td>Mechanical ventilation &gt; 72 hrs</td>
<td>1.10</td>
<td>0.27</td>
<td>&lt;.001</td>
<td>3.0</td>
<td>1.78-5.05</td>
</tr>
<tr>
<td>Respiratory failure</td>
<td>1.15</td>
<td>0.28</td>
<td>&lt;.001</td>
<td>3.2</td>
<td>1.82-5.40</td>
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<tr>
<td>Liver failure</td>
<td>1.07</td>
<td>0.52</td>
<td>.04</td>
<td>2.9</td>
<td>1.05-8.08</td>
</tr>
<tr>
<td>Severe sepsis/septic shock</td>
<td>0.65</td>
<td>0.27</td>
<td>.02</td>
<td>1.9</td>
<td>1.14-3.20</td>
</tr>
</tbody>
</table>

Main analysis results in the final logistic regression model (N=450)
Validation Sample Results

<table>
<thead>
<tr>
<th>Observed ASF Present</th>
<th>Model Development Sample (N=450)</th>
<th>Validation Sample (N=102)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted</td>
<td>Predicted</td>
<td>Predicted</td>
</tr>
<tr>
<td>ASF Present Percentage</td>
<td>Correct</td>
<td>ASF Present Percentage</td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>ASF - Yes</td>
<td>222</td>
<td>78</td>
</tr>
<tr>
<td>ASF - No</td>
<td>41</td>
<td>109</td>
</tr>
<tr>
<td>Overall %</td>
<td>73.6</td>
<td>74.0</td>
</tr>
</tbody>
</table>

Cutoff value for the above classification tables is 0.33

Risk Factors, S/S of SCALE

- Weakness and progressive mobility limitation
- Decreased nutrition — loss of appetite, weight loss, cachexia and wasting, low serum albumin/pre-albumin, low hemoglobin, dehydration
- Diminished tissue perfusion, impaired skin oxygenation, decreased local tissue temperature, mottled discoloration, skin necrosis
- Loss of skin integrity
- Impaired immune function

Decreased Tissue Perfusion and SCALE

- Most significant risk factor for SCALE
  - Tends to occur in areas of the body with end arteries → fingers, toes, ears, nose
    - These areas may demonstrate early signs of vascular compromise such as dusky erythema, mottled discoloration, local cooling, progressing to infarcts and gangrene
    - Due to single vascular route these areas are more susceptible to critical decrease in tissue oxygenation due to vasoconstriction
  - Ability of tissue to tolerate pressure is limited in poorly perfused areas
Decreased Tissue Perfusion and SCALE

Keck is a tertiary care hospital but is affiliated with LA County Hospital (LAC-USC) so there are also a high number of trauma patients transferred in.

73 ICU beds

CASE STUDIES

Reference Point -- Case Mix Index

Keck Medical Center of USC

2.71

City of Hope

2.57

Moffitt Cancer Center

2.37

Cleveland Clinic

2.36

Univ. of Maryland Medical Center

2.28

Stanford Health

2.24

UCLA Health (Ronald Reagan)

2.09

Mayo Clinic

2.06

UCSF Medical Center

2.01

Johns Hopkins Medicine

1.84
What Am I Looking At?

• Need for clinical agreement in wound etiology and pressure injury classification amongst healthcare professionals
  – Most difficult for reliability:
    • Stage 3 PI's, Stage 1 PI's, MASD vs. PI, darker skin tones
    • What about the critically ill/those at end of life?
  – Drives treatment
  – Legal/reimbursement implications
  – How do we use photographs?
    • “Two eyes on” concept
HEEL OFF-LOADING DEVICES
Initial Concerns

- Standard boots used provided both heel off-loading as well as improvement in peripheral circulation
  - Due to the decreased distal perfusion of patients on ECMO, these boots were felt to be a good intervention for enhancing circulation but there was concern that they were not adequately off-loading the heels in patients that were sedated and minimally mobile for large parts of the day.

Proposed Interventions

- Discussions with the vendor resulted in a change in the structure of the boot -- including deepening the heel well and increasing the lining and foam density along the calf area to achieve better immersion and heel off-loading.

Financial Impact

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>$3,212</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 2</td>
<td>$1,606</td>
</tr>
<tr>
<td>CEIM</td>
<td>$84,487</td>
</tr>
<tr>
<td>Unstageable</td>
<td>$143,006</td>
</tr>
<tr>
<td>TOTAL COST</td>
<td>$232,311</td>
</tr>
</tbody>
</table>

I:\ 10/20/2017
Additional Impact

- Hospital “cost” for reportable pressure injuries.
  - Varies based on CDPH findings in each case, but always includes personnel costs associated with: the initial reporting process, reviewing/preparing the medical record for the CDPH on-site visit, staff time spent with surveyor reviewing case, time spent on required follow up items.
  - Affects quality markers for hospital.

CASE STUDIES
Medical-Device Related Pressure Injuries (MDRPI’s)

- Advancements in life-saving technology have significantly increased the number and type of medical devices our patients are exposed to—especially those in critical care environments.
- These patients often have lower “thresholds” for tolerating the forces generated by these devices.

MDRPI’s in Critical Care

- ALL devices create a risk
  - What do we need?
  - How long do we need it?
  - Assess fit frequently—especially for patients with edema (more than twice per day).
  - Reposition device frequently
  - Do we need to alter how we use it?
MDRPI’s in Critical Care

Graduated compression stockings in Johns Hopkins study had prevalence of 2.2% for SICU patients – 33% of all PI’s – 75% of all MDRPI’s

Using graduated compression stockings in critically ill patients who are also receiving better forms of venous thromboembolism prophylaxis might cause more harm than benefit.

MDRPI’s from Graduated Compression Stockings

- Graduated compression stockings in Johns Hopkins study had prevalence of 2.2% for SICU patients
  - 33% of all PI’s
  - 75% of all MDRPI’s
- Using graduated compression stockings in critically ill patients who are also receiving better forms of venous thromboembolism prophylaxis might cause more harm than benefit.

MDRPI’s from Respiratory Equipment

- 30-70% of MDRPI’s resulted from respiratory equipment
- Particularly prevalent in critical care units
- Common devices responsible – CPAP, BiPAP, nasal oxygen tubing, ET tubes, tracheostomy face plates and ties
Features of Support Surfaces

- Lateral Rotation
  - Provides rotation about a longitudinal axis as characterized by degree of patient turn, duration and frequency.

Clinical Usefulness of Lateral Rotation

- Prolonged bedrest can result in orthostatic tolerance or gravitational equilibrium
  - Patients that move too quickly from supine to side-lying or sitting could be mislabeled as hemodynamically unstable
  - Slower movement allows for better baroreceptor accommodation to the position change
- Patients identified as too unstable to turn may benefit from lateral rotation to gradually retrain them to tolerate turning
Supine
Low Air Loss Peak Pressure 28mmHg
Air Fluidized Peak Pressure 25mmHg

HOB at 30°
Low Air Loss Peak Pressure 37mmHg
Air Fluidized Peak Pressure 30mmHg

Edge of Bed Sitting
Feet on the Floor
Low Air Loss Peak Pressure 54mmHg
Air Fluidized Peak Pressure 107mmHg
Implications of this Technology in Critical Care

• Staff education
  – Effectiveness of off-loading
  – Timeliness of off-loading
  – Compliance
• Patient/family education
• Documentation assistance
• Resource utilization

References

References

• Cox J. Pressure ulcer development and vasopressor agents in adult critical care patients: A literature review. OWM. 2013; 59(4): 50-60.


• Federal Register, Vol 73, #161, August 19, 2008, pp 48471-48491.


References


References


References