EXPLORING PRESSURE INJURIES IN THE CRITICAL CARE POPULATION

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Describe current clinical challenges in pressure injury risk assessment in the critical care population.

Describe current pressure injury risk factors that confront the critical care population.

Describe current clinical challenges in pressure injury prevention in the critical care population.
Circa 1955

"Special unit saves lives"

Circa 1980
27% of all hospital admissions involve ICU stay

2.5 times more costly than other hospital admissions

ICUs led by critical care specialists (intensivist)
SNAPSHOT OF CRITICAL CARE PATIENTS: UNITED STATES

**Diagnoses:**
- Acute Respiratory Failure
- Acute MI
- Intracranial hemorrhage
- C-V procedure
- Septicemia

**Common Comorbidities:**
- DM
- C-V Disease
- Obesity

**Patients are sicker and surviving once fatal acute illnesses!**

**Average LOS:**
- 3.8 days

**Mortality Risk:** 10-29%
- MOSF
- C-V Event
- Sepsis

**Monitoring Equipment**
- Pharmaceutical Agents
- Invasive lines
- Treatment Modalities

**Source:** SCCM
- CDC
Why study pressure injuries in ICU patients?
Sickest patients in our healthcare system
Highest Prevalence Rates
Ground Zero for PI development among hospitalized patients.
SNAPSHOT OF CRITICAL CARE PATIENTS WITH PRESSURE INJURIES

Top Comorbidities
- Diabetes
- C-V Disease

Age
60-73 years

Top ICU Diagnoses
- Respiratory Failure
- Cardiac Related Events
- Trauma
- Sepsis/Septic Shock

Treatment Associated Factors
- Mechanical Ventilation
- Vasopressor Agents
- Immobility

Average LOS
≥ 9 days

Mortality/Severity Of Illness
APACHE II: 9.5-22
(8%-40%) mortality risk
Pressure Injury Characteristics

Epidemiology: 5%-45% Highly Variable!

Most Common Stages: Stage 2
Recent studies: DTPI

Location: Sacrococcygeal

Days into the ICU Admission HAPI developed: First Week
A PRESSURE ULCER TOOK DOWN SUPERMAN!!

DID YOU KNOW........
94% of patients admitted into the ICU are at risk for pressure ulcers (as measured by the Braden Scale)

EVERY MONTH IS ICU PRESSURE ULCER AWARENESS MONTH!

OUR JOURNEY (2006-PRESENT......)

- Compliance to PI Risk Assessment
- Tracked compliance to PI prevention strategies
- Pressure Injury Prevention Awareness Campaigns

STILL HIGH PI RATES!
Can we truly **capture PI risk** in critical care patients using current risk assessment tools?

What are the **risk factors contributing to PI** development that need greater consideration in the critical care population?

Do current **prevention strategies mitigate PI risk** or could these risk factors be non-modifiable?
Risk Assessment in the Critical Care Population
CURRENT RISK ASSESSMENT
SCALES USED IN THE ICU SETTING

- Braden Scale - United States
- Jackson-Cubbin Scale: Europe
- Waterlow Scale: Europe
Bergstrom et al (1987): 60 ICU patients

Conclusions from initial study:

- *The critical cut-off point at which the patient could be judged to be at risk for pressure sore formation was a Braden Scale score ≤ 16.*

- *Less tendency to overpredict than Norton scale*
Most widely used RAS in the U.S.
Provides uniformity to risk assessment
Structured reminders for staff
Defined risk factors
Easy to complete
ELEMENTS OF PREDICTIVE VALIDITY

- **Sensitivity**: what % of patients who developed a PI were classified as at risk?
- **Specificity**: what % of all patients who remained PI free were classified as not at risk?
- **Predictive Value of Positive Test (PVP)**: How well does the scale prospectively predict who will develop a PI?
- **Predictive Value of a Negative Test**: (PVN): How well does the scale prospectively predict who will not develop a PI?
- **Receiver Operating Characteristic Curve (ROC)**: Balance of Sensitivity/Specificity

<table>
<thead>
<tr>
<th>Study</th>
<th>Cut-off Score</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PVP</th>
<th>PVN</th>
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<tbody>
<tr>
<td>Bergstrom et al.</td>
<td>16</td>
<td>83%</td>
<td>64%</td>
<td>61%</td>
<td>85%</td>
</tr>
<tr>
<td>Garcia-Hernandez</td>
<td>ND</td>
<td>87%</td>
<td>38%</td>
<td>49%</td>
<td>81%</td>
</tr>
<tr>
<td>Cox</td>
<td>18</td>
<td>100%</td>
<td>7%</td>
<td>20%</td>
<td>100%</td>
</tr>
<tr>
<td>Hyun</td>
<td>18</td>
<td>97%</td>
<td>16%</td>
<td>10%</td>
<td>98%</td>
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IS THE BRADEN SCALE PREDICTIVE IN THE CRITICALLY ILL POPULATION?

- Total Braden Scale Score: Mixed in ICU Studies
- Low Specificity/Low PVP = High False Positive Rate

Overprediction

Need to consider PI prevention strategies in place with assessment of RAS Predictive Validity!
PREDICTIVE VALIDITY-SUBSCALES

- Sensory Perception
- Moisture
- Activity
- Mobility
- Nutrition
- Friction /Shear

Green check marks indicate validity, while red Xs indicate lack of validity.
QUESTIONS TO PONDER IN PI RISK ASSESSMENT IN CC PATIENTS

- Are we capturing true risk in this population?
- Are RAS better than clinical judgment?
  - Survey of Critical Care Nurses:
    - *My clinical judgment is better than any assessment scale for risk for pressure ulcers available to me.* (n = 330)
      25% agreed; 45% disagreed; 30% neither agree/disagree (Cox & Schallom, 2017)

Studies are mixed (NPUAP, 2014)

Can we measure PI risk using a more efficient method?
Pressure Injury Risk Factors in Critical Care: What do we know today?
TOP 7 PRESSURE INJURY RISK FACTORS

- Age
- Cardiovascular Disease
- Perfusion (hypotension)
- Vasopressor Agents
- Length of ICU admission
- Diabetes Mellitus
- Mechanical Ventilation
CATEGORIES

Demographic Variables
- Age
- Prolonged ICU admission

Comorbidities
- C-V Disease
- DM

Iatrogenic Factors
- Vasopressors
- Mechanical Ventilation

Intrinsic Factors
- Hypotension
<table>
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<th>Age: #1</th>
<th>Length of Stay: #2</th>
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<td>Most frequently reported predictor.</td>
<td>PI free: 3-14 days</td>
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<td>Mean age across studies:</td>
<td>PI Positive: 9-24 days</td>
</tr>
<tr>
<td>55-69: all patients</td>
<td>Factor of time?</td>
</tr>
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<td>60-73: PI + patients</td>
<td>Proxy for overall severity of illness?</td>
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<tr>
<td>Older, but not elderly!</td>
<td>Time to PI development:</td>
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<td>First week of ICU stay</td>
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Diabetes Mellitus
Prevalence of DM on the rise!

Microvascular changes:
capillary damage from oxidative stress/free radicals, poor perfusion

Macrovascular changes:
PAD, CAD, CVA

Cardiovascular Disease
CAD risk ↑ with DM
Atherosclerotic plaques

Impaired tissue oxygenation and perfusion
Hemodynamic instability - a primary reason for ICU admission!

Defined: Systolic < 90 mmHg; MAP < 60-70 mmHg; or ↓ in systolic BP of 40 mmHg

Poor perfusion - circulation shunted from periphery to preserve vital organs affecting tissue tolerance
- Increase MAP to improve tissue oxygenation and perfusion
- Administered in profound hypotension unresponsive to fluids - shock states

Empirical Evidence:
- Vasopressor agents predictive (no specific agents)
- Norepinephrine and Vasopressin → Predictive

Side effects: Inadequate perfusion of the extremities, mesentery, kidneys
VASOPRESSIN:
- Second line agent for refractory vasodilatory shock states (i.e. septic shock)
- Given with another vasopressor agent
- Does the addition of a second line agent create a “tipping point” that accelerates pressure injury risk?

- Is it the pharmacodynamics of the vasopressors?
- Is it the hypotension that necessitates the use of the agent?
- Is it the overall burden of illness experienced by the critically ill patient who needs vasopressors?

Is it the perfect storm?

- New vasopressor agent - Angiotensin II (Giapreza)

Caveat: Can’t terminate these agents to mitigate PI risk!
Respiratory Failure: most common ICU admitting diagnosis.
Indications: Spontaneous respirations cannot sustain life → impaired tissue oxygenation and perfusion.

Considerations in PI Risk:
- Reflection of overall burden of illness
- Proxy for immobility
- Related to Shear - continuous HOB ↑

This is a life saving modality: non-negotiable to mitigate PI risk
WHAT ARE TWO COMMON ATTRIBUTES OF THESE RISK FACTORS?

Non-modifiable

Not included in current formal PI Risk Assessment
Ability to prevent some pressure injuries may be diminished in this population.

Strong potential for unavoidable pressure injuries exists in the critically ill population.
Despite best practice PIs do occur!!

Some situations favoring an unavoidable PI:
- Hemodynamic instability with repositioning
- Significant cardiopulmonary compromise → impaired tissue oxygenation and poor tissue perfusion
- Shock states
- Initiation of life-saving modalities when:
  - PI prevention strategies would be contraindicated
  - Take priority over PI prevention

All situations applicable to the Critical Care Population!
Unavoidable pressure injuries can only be determined if PI prevention strategies are consistently in use!
OR IS IT ACUTE SKIN FAILURE IN THE CRITICALLY ILL?

- If the heart and lungs can fail, why not skin?
- A hypoperfusion state that leads to tissue death that occurs simultaneously to a critical illness.
- Pressure-related injury concurrent with acute illness as manifested by hemodynamic instability and/or major organ system compromise.

Problem: No clear cut diagnostic criteria to validate acute skin failure or distinguish acute skin failure from a pressure injury. More work to be done!
PRESSURE INJURY STAGES
Stage 2

Partial-thickness loss of skin with exposed dermis. (NPUAP, 2016)

Considerations:
- Top down development
- May be a friction component
- May be related to moisture
- Factors that impair tissue tolerance
Intact or non-intact skin with localized area of persistent non-blanchable deep red, maroon, purple discoloration or epidermal separation revealing a dark wound bed or blood filled blister. NPUAP, 2016)

Rate: 9-12% nationally

- Tissue ischemia/tissue deformation
- Reperfusion Injury
- Shear injury- HOB elevation (MV; EN)
- Hypoperfusion states
  - Hypotension
  - Shock states
PRESSURE INJURY PREVENTION PRACTICES IN CRITICAL CARE WHAT’S THE EVIDENCE?
A change in position of the lying or seated individual performed at regular intervals with the purpose of redistributing or relieving pressure and enhancing comfort.” (NPUAP, 2014)

- Reposition all individuals at risk of, or with existing pressure injuries, unless contraindicated
  - Strength of the Evidence= A
Can critically ill, hemodynamically unstable patients be repositioned safely?
REPOSITIONING HEMODYNAMICALLY UNSTABLE PATIENTS

• Study in 4 ICUs in the U.S. (Mitchell et al, 2017)(AHRQ QI)(n=4075)
  • Studied frequency of inability to turn and reasons for not turning.

  Outcomes: 1 out of 6 deemed too unstable to be turned developed a PI after 8 hours.

  Clinical situations that resulted in inability to turn: hypoxia, BMI > 50, 2+ organs failing, vasopressors, hemodynamic instability, surgical procedure precluded turning

  Conclusion: Fewer than expected clinical situations resulted in inability to turn.

• Evidence Review (Krapfl et al, 2017)
  • Insufficient evidence at this time to conclude that incremental repositioning of hemodynamically unstable patients deemed to unstable to turn reduced PI rates in ICU population.
Team approach: adequate staff to assist

- Turning Trials every 8°
- Secure all lines
- **Slow incremental turns** to allow for the adjustment of the body to gravitational changes
  - 15° Pause 15 seconds
  - 30° Pause 15 seconds
  - 45° Pause 15 seconds
- Completion of turn and nursing tasks.
- Returned to 30° position using incremental shifts, wedges, pillows.
- Hemodynamics monitored for 10 minutes to determine if measures stabilize and patient recovers.
WHAT IS THE OPTIMAL TURNING FREQUENCY FOR CRITICAL CARE PATIENTS?

• Prospective, observational study: average time to turn in the ICU $\rightarrow 4.85$ hours (Goldhill et al, 2008)

• Prospective, observational study: mean time to repositioning for all ICU = 2 hours (+/- 30 minutes); Respiratory patients positioned more frequently in semi-Fowlers; Obese patients positioned most frequently in supine position. (Tayyib et al, 2013)

• RCT: No significant difference in PI rates when turning frequency $\downarrow$ to 4 hours vs. 2 hours in mechanically ventilated ICU patients on alternating pressure pad. Increase in adverse events noted with more frequent repositioning. (Manzano, et al 2014)
## Purpose

Investigate efficacy of a wireless patient monitoring system for optimizing delivery of patient turning and subsequent reduction of HAPUs

- Pragmatic, open-label, two-arm, prospective, RCT in two ICUs
- 1,226 patients (671 treatment & 555 control).

## Design

- 43% increase in q 2-hour repositioning compliance
- HAPU rates: Treatment = 0.7% Control = 2.7%

A decreased PI rate of 73% (OR=0.27, 95% CI [0.10, 0.75], p=0.01) (Pickham et al, 2018).
**SUPPORT SURFACES?**

- **RCT:** No significant difference in PU rates in ICU patients on 2 different types of viscoelastic foam. (Ozyurek et al, 2015)

- Prospective Observational: Lower incidence of PU in critically ill patients on **LAL support surfaces** with microclimate management as compared to integrated power air redistribution beds (Black et al, 2012)

- Quasi-experimental: **Alternating pressure mattresses were more effective** than alternating pressure air **overlays** in preventing PU in mechanically ventilated ICU patients. (Manzano et al, 2013)

- Pilot RCT: Lower PU rates in ICU patients placed on an active **alternating pressure surface** versus a manually inflatable static low pressure mattress. (Melbrain, 2010)
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<th>Turning/Positioning Devices</th>
<th>Conformational Positioners</th>
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<tr>
<td>↓ PI Rates</td>
<td>↓ Buttock PIs</td>
</tr>
<tr>
<td>↓ Time/Staff Utilization</td>
<td>↓↑ Patient comfort</td>
</tr>
<tr>
<td>↑ Staff Compliance</td>
<td>↓↑ ease of positioning obese pts.</td>
</tr>
<tr>
<td>■ Improved turning angles</td>
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Powers, 2016  
Hall et al, 2016  
Brennan et al, 2014
DO ASSISTIVE DEVICES REDUCE PRESSURE INJURIES?

Continuous Pressure Mapping
(Beherndt et al, 2014)

- Real time visual feedback regarding body positioning
- ↓PI rates

Non-invasive Perfusion Enhancement System
(Bharucha et al, 2018)

Goal: avoid prolonged vascular compression to the sacrum to improve tissue perfusion

- ↓Sacral PI as compared to alternating pressure surface
OTHER CLINICAL CONSIDERATIONS IN REPOSITIONING

Increase Nurses’ Knowledge of Proper Techniques
Presence of WOC Nurse
(Anderson et al, 2015)
Staff Education
(Tayib et al, 2016)

Human Resource Considerations
Turn Teams (2 trained PCAs) (Still et al, 2013)
RN to verbally cue staff
(Harmon et al, 2016)

HOB elevation: a competing strategy?
HOB elevation > 30° → No increase in PIs
(Schallom et al, 2015, Grap et al, 2018)
More research needed to determine optimal turning frequencies, positioning techniques and support surfaces.

Do progressive mobility programs decrease PI occurrence in the ICU population?

There will always be critically ill patients that are too unstable to be turned- Document it!
Strengthening evidence to support this modality in ICU patients.

**Implementation Considerations:**

- **Strict criteria needed** to determine eligible patients to decrease overuse, misuse and associated costs.
- **Standardized Protocols** for assessment parameters, dressing change intervals, discontinuing dressings.

**More rigorous studies needed** to fully understand the role of prophylactic dressings in PI reduction in this population.
Due to insufficient evidence to support or refute the use of specific additional nutritional interventions in critical care patients, specific additional nutrition interventions are not recommended for routine use in the population. (NPUAP, 2014 Strength of evidence = C)

There is currently no clear evidence of a benefit associated with nutritional interventions for either the prevention or treatment of pressure ulcers. Further trials of high methodological quality are necessary. Cochrane Review, 2014

Difficult to measure nutritional status in CC patients

**WHY?**

Critical illness alters common nutritional markers → inaccurate diagnosis of malnutrition.

- Fluid shifts erroneously influence body weight
- Markers associated with inflammation, also associated with nutrition

UNDERSTUDIED thus UNDERAPPRECIATED!
Early feedings ideally within the first 24-48 hours after admission.

Preferred route for feeding= enteral route (lower infection rates)

Use of a feeding algorithm
Challenges in Practice Today

- Quality Indicators
- Legal Implications
- Regulatory/Financial Implications
<table>
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<th>Present on Admission Indicator</th>
<th>Mandatory State Patient Safety Reporting Requirements</th>
</tr>
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<tr>
<td>The Hospital-Acquired Condition (HAC) Reduction Program: pay-for-performance program</td>
<td>N.J. “Stage III or IV pressure ulcers acquired after admission... to a health care facility.”</td>
</tr>
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What about PIs that occur or worsen for which acute care clinicians believe they have little external control and cannot mitigate pressure injury development?
The National Database of Nursing Quality Indicators® (NDNQI®)
Hospital acquired pressure injuries are nurse sensitive quality indicators, linking PI occurrence to the quality of care delivered by nurses.

Is PI development a Nurse Sensitive Indicator or Patient Sensitive Indicator?

Are acquired PIs only a reflection of nursing care?

Currently even PIs which may have been unavoidable are counted in NDNQI reporting

PROBLEM

Potentially inflates the reported PI rate artificially, coupled with possible negative connotations regarding the nursing care delivered.
Over 17,000 lawsuits filed related to pressure injuries annually, second only to wrongful death, and more common than patient falls.\textsuperscript{37}

What about nurses and other caregivers who find themselves involved in litigation over HAPIs that were not the result of suboptimal care?
CONCLUSIONS
WHAT WE KNOW

- PI risk in the ICU population is multifactorial and complex!

- Some PIs cannot be prevented in the ICU population!

- Evidence base surrounding many PI prevention strategies is weak!
WHAT WE STILL NEED TO DO

- Improve Pressure Injury Risk Quantification in the ICU population.

- Substantiate the label of the "Unavoidable Pressure Injury" in the acute care setting.

- Continue to improve our evidence base surrounding PI risk factors and PI prevention.
LOOKING TOWARDS THE FUTURE: THE ICU IN 2050

WorldWide Critical Care Diagnostics and Therapeutics Center (WWCCDTC)

Biometrics Display

Holographic Interactive Display

Data outbound

Instructions inbound

Mattress, exoskeleton, 3D and infection controls
Diagnostics, imaging and laboratory systems
Therapeutics, mini-robotics
Environmental control, temperature and hibernation
Mobility system

J biosphere capsule. The ICU bed of the future will render care within a capsule that opens and closes and provides environment control.
WORLD WIDE PRESSURE INJURY PREVENTION DAY

NOVEMBER 15, 2018

STOP PRESSURE INJURIES
www.npuap.org
THANK YOU!
QUESTIONS?
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