Search results for 2019 International Pressure Injury Guideline: Critically Ill Individuals


Identified in pressure injury searches
- n=11,177

Excluded after screening title/abstract
- Duplicate citations
- Included in previous guideline
- Not related to pressure injuries
- n=8,128

Identified citations
- n=3,085

Excluded based on key word searches
- Not related to the topic-specific questions
- n=3,050

Critical care keywords
- Critical, critically ill, intensive care, ICU, CCU, prone, respiratory distress, ARDS, coronary care, resuscitation, acute care

Identified in topic-specific key word searches for full text review and critical appraisal
- n=35

Excluded after review of full text
- Not related to pressure injuries
- Not related to the clinical questions
- Citation type/research design not meeting inclusion criteria
- Non-English citation with abstract indicating not unique research for translation
- n=29

Identified as providing direct or indirect evidence related to topic and critically appraised
- n=6

Additional citations
- Identified by working group members
- n=36

Additional citations
- Identified as providing direct or indirect evidence related to topic and critically appraised
- n=6

Additional citations
- Appraised for previous editions
- n=N/A*

Total references providing direct or indirect evidence related to topic
- n= N/A*

* Recommendations related to all special populations are included in the topics to which the recommendation relates (e.g. support surfaces), and the references supporting these recommendations are included in the search reports for those topics.


Data Tables: 2019 Guideline Update: Critically Ill Individuals
Critically Ill Individuals: data extraction and appraisals

Articles Reviewed for International Pressure Injury Guideline

The research has been reviewed across three editions of the guideline. The terms pressure ulcer and pressure injury are used interchangeably in this document and abbreviated to PU/PI. Tables have not been professionally edited. Tables include papers with relevant direct and indirect evidence that were considered for inclusion in the guideline. The tables are provided as a background resources and are not for reproduction.


<table>
<thead>
<tr>
<th>Ref</th>
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<tr>
<td>(Cox &amp; Roche, 2015)</td>
<td>Retrospective cohort study exploring association between vasopressor use and development of pressure injuries in intensive care unit (ICU) patients</td>
<td>Participants were in two medical-surgical and cardiothoracic ICUs in the US (n=306)</td>
<td>All participants received a low-air-loss mattress</td>
<td>Pressure injury incidence determined through retrospective record review</td>
<td>Pressure injury incidence: 13% (n=41)</td>
<td>Statistical power for multivariate analysis was achieved</td>
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<td>Of pressure injuries, 39% were suspected deep tissue injury (DTI), 37% Category/Stage II, 12% Category/Stage I and 12% Unstageable.</td>
<td>Only considers pressure injuries that developed in participants who took vasopressors so it is unknown how this compares to patients who did not take vasopressin</td>
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<td>56% sacral, 34% buttocks, 5% heel, 5% other</td>
<td>Unclear how pressure injuries were identified and by whom</td>
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<td>Significant variables in logistic regression analysis</td>
<td>Relied on records – length of follow up is not clear</td>
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<td>Cardiac arrest; odds ratio [OR] 3.894, 95% CI 0.998 to 15.118, p=0.05</td>
<td>Relied on records – length of follow up is not clear</td>
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<td>mechanical ventilation longer than 72 hours: OR 23.604, 95% CI 6.427 to 86.686, p&lt;0.001</td>
<td>Statistical power for multivariate analysis was achieved</td>
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<td>hours of MAP &lt;60mmHg while receiving vasopressors: OR 1.996, 95% CI 1.020 to 1.178, p=0.01</td>
<td>Unclear how pressure injuries were identified and by whom</td>
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<td>administration of vasopressin OR 4.816, 95% CI 1.666 to 13.925, p=0.004</td>
<td>Relied on records – length of follow up is not clear</td>
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<td>Cardiac diagnosis at time of ICU admission; OR 0.035, 95% CI 0.002 to 0.764, p=0.03</td>
<td>Relied on records – length of follow up is not clear</td>
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<td>Level of evidence: 4 (prognostic)</td>
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(C) EPUAP/NPIAP/PPPIA Not for Reproduction
### Critically Ill Individuals: data extraction and appraisals

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| mass index (BMI) on interface pressure and tissue reperfusion in individual with high Sequential Organ Failure Assessment (SOFA) scores compared to those with low SOFA scores and healthy people | volunteers (n=9) | foam.  
• Participants placed in 2 positions:  
  o semi-recumbent supine with HOB at 30° and bed knee elevation at 10°  
  o quarter lateral turn position  
• Measures in each position were repeated pressure mapping sensor 20 minutes  
• Tissue perfusion (measured as peak time (PT); settled time constant (STC) and normalized hyperemic area (NHA) using Doppler Laser blood perfusion monitoring for 5 minutes  
• Other measures: SOFA score, body and room temperature, Braden scale, APACHE II scale.  
Patients were analyzed in 3 groups based on SOFA score:  
  o Healthy adults  
  o Low acuity critically ill patients (mean SOFA score 2.9±1.8)  
  o High acuity critically ill patients (mean SOFA score 8.0±1.9) | Factors associated with PPI  
• Age was significantly associated with PPI at the sacrum and greater trochanter (p=0.008), older adults having higher PPI when controlling for body position and patient type  
• No significant associations were found between PPI and body type, patient type, Braden scores, APACHE 2 scores. | Factors associated with tissue reperfusion  
Using 5 different multivariate models, no factors were found to be significantly associated with tissue reperfusion (body position, body temperature, Braden score, APACHE II score, BMI, age) | identified with the use of pressure mapping device in the ICU (difficult to roll under participants)  
Pressure mapping and tissue reperfusion measures were not completed in all patients (e.g. pressure mapping was only available in 1/6 high acuity ICU patients) and repeat measures not reported  
Non-blinded outcome measurement |
| (Nowicki et al., To assess the clinical) Participants were those who were recorded in the incident | N/A  
• Data for ICU | Facility acquired pressure injury incidence change over time | Single centre study  
use of different | Level of evidence:  
High |

**Data Tables**: 2019 Guideline Update: Critically Ill Individuals  
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## Data Tables: 2019 Guideline Update: Critically Ill Individuals

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<td>2017</td>
<td>characteristic and outcomes of critically ill patients compared to ward patients with a hospital-acquired pressure injury</td>
<td>reporting system in one Australian hospital as having a facility acquired pressure injury over a 8.5 year period (n=3,860 patients with n=5,280 reports)</td>
<td>participants (n=726) was compared to data for general ward participants (n=4,554)</td>
<td>different incident reporting systems used in the facility during data collection period • The pressure injury staging system post-2012 was the NPUAP system, for pre-2012 the system is not reported • Pressure injuries were categorized as severe (Category/Stages III, IV and sDTI) and non-severe Category/Stage I, II, mucosal and unstable</td>
<td>• Pressure injury incidence increased in ICU by mean 2.9/100 separations (95% CI 1.3 to 4.5/100, p=0.0006) • Pressure injury incidence decreased in general ward by mean 2.1/1000 (95% CI 0.9-3.2/1000, p=0.001) • Rate of severe Pressure injury i</td>
<td>reporting systems over time • changes in definitions of pressure injury during the study • Voluntary reporting systems • Does not report how pressure injury assessment was conducted in the facility • Reports that 22 ICU participants had severe pressure injuries, but data only presented for 13</td>
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<tr>
<td>(Catala Espinosa et al., 2014)</td>
<td>Case control study to evaluate the association between body mass index (BMI), incidence and severity of pressure injuries in the ICU</td>
<td>Number of participants: Case: 77 with PI Control: 231 w/o PI with mechanical ventilation • Clinical setting: ICU • Country: Spain • Inclusion criteria: adults admitted on ICU</td>
<td>N/A</td>
<td>Pressure injuries measured on admission and during hospitalization and ICU period of observation15 months Risk factors measured: age, sex, comorbidities, dependency level (Barthel index), BMI, nutritional status, severity on admission (APACHE II and SAPS 3), reason for admission, treatment done, complications, length of stay, use of special</td>
<td>Pressure injury incidence 77/1424 = 5.41% • Stage 1 – 29 (37.7%); Stage 2 – 34 (44.2%); Stage 3 – 10 (13%); Stage 4 – 4 (5.2%)</td>
<td>• Study done in one ICU only • Case control study</td>
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<td>4</td>
<td>Quality: Low</td>
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Level of evidence: 3 (prognostic) Quality: Moderate

Data Tables: 2019 Guideline Update: Critically Ill Individuals

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## Critically Ill Individuals: data extraction and appraisals

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<td>mattress.</td>
<td>Multivariable analysis</td>
<td>Author conclusions on modeling: PI development and maximum stage are not associated with a worse prognosis</td>
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<td>• Association between PI and length of mechanical ventilation (MV) (p = 0.013, OR 1.08, CI95% 1.01-1.16)</td>
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<td>• Association between PI and kidney replacement therapy (p = 0.013, OR 3.55 CI95% 1.31-9.64).</td>
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<td>• BMI ≥ 40 was a confounding factor</td>
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### Clinical question two: What are the unique pressure injury prevention strategies for individuals in critical care?

#### Support surfaces

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<tr>
<td>(Black, Berke, &amp; Urzendo wski, 2012)</td>
<td>Participants were recruited from a cardiovascular surgical ICU in USA (n=52)</td>
<td>3 point interface sensor with three sensor mats positioned along an air mattress designed to all</td>
<td>Pressure injury incidence Participants on a low air loss bed had significantly less PUs (0% versus 18%, p=0.046)</td>
<td>No randomization, blinding, study power calculation Limited baseline demographics Concurrent management unclear Short study period No interrater reliability</td>
<td>Level of evidence: 2 Quality: Low</td>
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#### Repositioning

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<tr>
<td>(Tsuchiya et al., 2016)</td>
<td>Participants were healthy females (n=9)</td>
<td>3 point interface sensor with three sensor mats positioned along an air mattress designed to all</td>
<td>Significant pressure decreased (p&lt;0.05) by 1.3 to 3.9mmHg in 28 different positions</td>
<td>Healthy volunteers were all young females, which may</td>
<td>Indirect evidence (PU not an</td>
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|    | influence of small body changes on interface pressure and blood flow. | Participant characteristics:  
- All aged 21-22 years  
- Height range 152.5 to 168.5 cm  
- BMI 17.7 to 22.1 kg/m² | small postural changes (e.g. change degree tilt in lateral) rather than large ones (e.g. change from supine to lateral). Changes were similar to using a small pillow to provide support at different anatomical places. Small change air mattress had 6 cell components, each with two compartments. Small change mattress was located underneath a standard alternating air mattress. | arc.  
- Interface mats had a precision of 4mmHg  
- Measured interface pressure an contact area on pad.  
- Lateral alignment measured using stickers and angular calculation to determine angles of greater trochanter, head of fibula and lateral malleoli  
- Physical sensation during inflation and deflation of small change cells measured as yes or no by respondents | Contact area  
Median contact area with sensor increased significantly in 17 combinations of cells  
Physical sensations  
Minimal uncomfortable detection of movement by participants  
Author conclusions: Small changes in body positioning can alter interface pressures and contact area with the support surface that may influence the risk of PU. Small changes at the buttock region reduced disruptions in body alignment. | influence alignment factors  
- PU was not an outcome measure  
- No safety considerations of use of mattress were explored (e.g. height under another mattress) |
|    | Case series investigating the effect of prone positioning ventilation and reporting pressure injuries as an adverse effect of positioning | Participants were recruited from an ICU in Chile (n=15)  
Inclusion:  
- aged over 18 years  
- severe Acute Respiratory Distress Syndrome (ARDS)  
- ventilation >72hrs  
Exclusion:  
- contraindications to prone positioning ventilation  
- hemodynamic disorders  
- chronic respiratory insufficiency  
- likelihood of death within 24hrs  
Characteristics:  
- Mean age 46±17 years (range | Prone position ventilation for 48 hours or until the oxygenation index was 10 or less (extended PPV) | Primary:  
- Barotraumas and/or monobronchial incursion of the orotracheal tube  
- Artierial and venous blood gas results  
Secondary:  
- Development of a new pressure injury as assessed using NPUAP staging  
- Prone position ventilation was continuously maintained for 55±7 hours  
- Two patients (13%) developed Category/Stage II pressure injuries (nasal septum, cheek)  
- All patients experienced facial edema  
- No patients experienced ventilation complications in prone position | No control group  
- Only 20% of the individuals were older than 60 years  
- Pressure injury risk factors not reported | Level: 4  
Quality: moderate |

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## Critically Ill Individuals: data extraction and appraisals

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| (Oertwich & Kindschu, 1995) | Observational experiment to determine in small body shifts influence interface pressure and blood flow | Participants were a convenience sample of older adults from 3 long term care facilities in US (n=50) | • Baseline measures taken with no loading  
• Participants had measurements taken on a standard flat mattress in two positions:  
  - Trochanter measure: lateral oblique position (side-lying with body plane at 45° to 75° angle to support surface with top leg posterior to midline)  
  - Sacrum measure: supine position  
• In each position, two small body shifts were obtained:  
  - by placing a towel beneath thigh  
  - by placing towel directly above waistline  
• Measurements in every position were taken at 5 minute intervals for 15 minutes | • Mini-Texas Interface Pressure Evaluator to measure interface pressure at sacrum and trochanter (interrater reliability was 0.95)  
• TSI ASERFLO Blood Perfusion Monitor used to measure capillary blood perfusion at trochanter and sacrum | Interface pressure  
• Significant main effect for small shift of body weight in the lateral oblique position: F(1.75, 85.79) = 5.36, p<0.01  
• Significant main effect for small shift of body weight in supine position: F(1.38, 67.64) = 3.90, p<0.05 | Did not establish if change was sufficient to prevent a pressure injury  
Indirect evidence (pressure injury not an outcome measure) |

### Reducing sedation

(Nedergaard, RCT to assess whether non...red. | Participants were recruited in mixed ICUs in three countries | • All participants placed on air-filled, pressure | • Occurrence of pressure injuries, Pressure injury development  
• There was no significant difference in | Level of evidence: |

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| Haberlan dt, Toft, & Jensen, 2017 | sedation affects the occurrence of pressure ulcers | (n=205) | reliving mattresses.  
- All participants mobilized as early and as often as possible  
- Participants were randomized to receive either:  
  o Intervention: receiving no albumin, but bolus morphine for pain or pharyngeal discomfort (n=104),  
  o Comparison: continuous sedation to a target of RASS score of −2 to −3 (propofol for the first 48 hours, then midazolam with bolus morphine for pain and a daily interruption of sedatives(a wake up call) (n=101) | described by Category/Stage and location (using grades I to IV)  
- APACHE II, SAPS II  
- Follow up period not reported | pressure injury rate between sedated and non-sedated groups (43.5% versus 29.8%, p=0.08)  
- There were no significant differences in characteristics between people who developed pressure injuries within the two groups: (age, p=0.72; gender, p=0.28; BMI, p=0.55, APACHE II score, p=0.49; SAPS II, p=0.75)  
- Anatomical location of pressure injuries was significantly different between groups, with sedated patients having more pressure injuries on heels and sacrum and non-sedated participants having more pressure injuries related to equipment(p=0.03) | • How pressure injuries were evaluated is poorly reported (e.g. who conducted assessment, how often and whether interrater reliability was established)  
• Follow up period duration is not reported  
• Power calculation not reported  
• Retrospective data collection |

### Intravenous albumin

| (Serra et al., 2013) | RCT evaluating intravenous administration of albumin to reduce pressure injuries in patients admitted to the ICU | Participants were recruited in an ICU in Italy (n=21) | Participants were randomized to receive:  
- Intervention group: receiving 25g of albumin for the first three days of ICU stay (n=11), or  
- Comparator group received nothing (n=10) | Other variable identified: age, sex, LOS in ICU, LOS in hospital, comorbidities, chronic diseases  
- Both groups were followed for at least 7 days  
- Staging system NPUAP/EPUAP | Pressure injury incidence  
- Pressure injuries developed in 27.27% (4/14) of people who received albumin compared with 36.36% (4/11) in the control group (p=0.06) | • Does not report methods for randomization, allocation concealment or blinding  
• No mention of training or credentialing for pressure injury assessment |

| Level of evidence: | 1  
Quality: | Low |
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Multi-faceted interventions

(Swafford, Culpepper, & Dunn, 2016) Chart audit to determine the effectiveness of a facility-acquired pressure injury prevention program in an adult ICU

Participants were individuals admitted to a medical/surgical ICU in the USA over a period of 3 years (n=1458)

No inclusion or exclusion criteria reported

Participant characteristics:
- Mean age of participants per audit year ranged from 50.5 to 52.2 years
- Mean length of stay per audit year ranged from 14 days to 10.7 days

Pressure injury prevention program included:
- Revised skin care protocol
- Fluidized repositioners for individuals with Braden Scale score ≤14
- Silicone border wound dressings on pressure points for individuals with Braden Scale score ≤14
- Face to face staff education

Outcome Measures & Length of Follow-up
- NPUAP pressure ulcer staging system
- No follow up period stated
- Unclear how skin assessments were performed
- Costs of pressure injuries were based on an estimation from the National Database of Nursing Quality Indicators (NDNQI) based on $US 38,700 per facility-acquired pressure injury

Results
- Facility-acquired pressure injury incidence
  - There was a reduction of pressure injury incidence from 10% to 3% over 3 years
  - Estimated costs of pressure injuries decreased from $US 1.7 million to $US 0.66 million over the 3 year period

Limitations and comments
- Appears to rely on retrospective chart audit but reporting of data collection is limited
- No statistical analyses
- Unclear how skin assessments performed
- Unclear if there are significant differences in population demographics over time that confound results
- Quality improvement program with low quality reporting

(Kelleher, Moorer, Quality improvement) Carried out in a 17 bed surgical ICU (total n=180)

Nurse-led quality improvement program

Quarterly facility acquired pressure

Facility acquired pressure injury incidence rate: 10.6% overall

Introduction of specialty

Level of evidence: 3

Quality: Low
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| & Makic, 2012 | project investigating bedside rounds in the ICU to decrease pressure injury incidence | Average number of patients per quarterly prevalence survey was 15 | • All nurses received a education resource on pressure injuries.  
• Main intervention:  
  o Weekly bedside rounds by nurse managers and WOCNs to engage nurses in discussion on pressure injury risk factors, Braden score subscales and prevention plans  
  o Bed side rounds used question format to guide discussion (included in article) and focused on patient specific issues | injury incidence rates were tracked from January 2008-December 2010  
• Prevention measures in use commenced in Q6  
• Validation of pressure injury staging systems not reported | • Pre-intervention facility acquired pressure injury incidence rate (over 5 quarters, 1 to 5): 0% to 26.7%  
• Post-intervention facility acquired pressure injury incidence rate (over 7 quarters, 6 to 12) ranged from 0% to 27.1%  
• From quarters 9 to 12, the highest prevalence was 6.3%  
• Observations of the following prevention strategies improved with 100% compliance observed from Q 9 to Q 12:  
  o Use of a prevention surface  
  o Repositioning  
  o Nutrition  
  o Moisture Management | beds/mattresses and wicking under-pads during the study period may have affected the HAPU rate  
• Small number of patients per quarter |
| (Gray-Siracusa & Schrier, 2011) | Descriptive study reporting on a multifaceted quality improvement (QI) intervention in the ICU to prevent pressure injuries | QI project in a 27-bed cardiovascular and coronary care ICU in USA  
Participants in pre-QI intervention stage (2007 to 2008)(n=554)  
Mean age 69.3±21.97  
61.9% sample male  
Participants in post-QI intervention stage (2008 to 2009) (n=645)  
Mean age 66.8±19.10  
56.4% sample male | • Introduced a pressure injury bundle (PIB) including:  
  o Risk assessment conducted every 12 hours  
  o Mobility – lighting and chimes every 2 hours to indicate repositioning time  
  o Minimal head of bed elevation  
  o Heel elevation  
  o Nutritional screening on admission and daily  
  o Skin assessment using NPUAP staging  
  o Sacral cleanse and moisturize | fCility acquired pressure injuries identified through skin assessments and using EPUAP staging system | • No significant difference between pre-PIB and post-PIB for facility acquired pressure injury incidence rates (p=0.11)  
• Comparison of quarterly rates showed decreasing trend:  
  o Pre-PUB quarterly facility acquired pressure injury incidence rates:  
    Q1 5.7%  
    Q2 0%  
    Q3 5.2%  
    Q4 0%  
  o Post-PUB quarterly facility acquired pressure injury incidence rates:  
    Q1 0%  
    Q2 ~0.8%  
    Q3 0%  
    Q4 0% | • Small number of participants each quarter  
• Only one site | Level: 3  
Quality: low |
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| (Dibsie, 2008) | Descriptive study reporting on a QI project aimed at standardising skin and wound care products | QI project commenced in the adult surgical ICU and expanded to multisite (2) academic medical centers | • Nurse driven protocol to improve skin and wound care within a Standardization of all products related to the prevention of skin breakdown and care of partial-thickness wounds based on nurse recommendations
• Consistent and correct completion of order sets, education provided on new products and skin care, identification and staging of pressure injuries, assessment and treatment.
• Electronic reporting of all skin issues and PUs
• Daily reminder systems for use of reporting system
• Weekly evaluation of wounds and skin by clinical specialists
• Management support and funding for the project
• Organizational support including financial reward associated with strategic goals | • Prevalence of pressure injuries quarterly over 2 years
• Pressure injuries validated by wound care nurses | Prevalence data reflect steady decreases in the rate of facility acquired Category/Stage II or greater pressure injuries
Data from surgical ICU showed:
• ~16.5% at baseline (Q4 2005)
• ~6% at second measure (Q4 2006)
• ~12.5% at third measure (Q1 2007)
• ~6.5% at fourth measure (Q2 2007)
• ~6% by fifth measure (Q3 2007) | • Interventions might be specific to organizational structure and culture of study site, and might not be generalizable.
• No statistical analysis
• No reporting of baseline education level, experience of nursing staff | 3 | moderate |

**Clinical question three: What are the unique pressure injury treatment strategies for individuals in critical care?**

No studies
# Additional data: Assessing pressure injuries in critical care settings

(Ranzani, Simpson, Japiassu, & Noritomi, 2016)

<table>
<thead>
<tr>
<th>Ref</th>
<th>Type of Study</th>
<th>Sample</th>
<th>Intervention(s)</th>
<th>Outcome Measures &amp; Length of Follow-up</th>
<th>Results</th>
<th>Limitations and comments</th>
</tr>
</thead>
</table>
|     | Prospective cohort study to validate the Braden scale in critical care and determine appropriate cut off score | Data was collected in 12 ICUs in Brazil over a 12-month period (n=9,605) | All ICU nurses received training prior to study commencement on risk screening, PU classification and PU prevention. Preventive equipment including protective cushions, translucent film dressings, dynamic support surfaces were provided to ICU and 2 hour repositioning was reinforced. | ~Daily collection of PU development | - PU incidence: 157 PUs developed, incidence rate of 3.3/1,000 patient-days.  
- 28.7% Stage 1, 66.2% Stage II, 3.2% Stage III, 0.7% Stage IV, 1.2% unstageable/DTI.  
- Mean time to first PU 9±8 days.  
- 58% coccyx/sacrum, 10.2% buttocks, 8.9% heels.  
- Characteristics between PU and no-PU cohorts: 
  - PU cohort were significantly older (65.7±18 vs 59.6±20 years, p<0.001).  
  - PU cohort more likely to be male (60% vs 49%, p=0.008).  
  - PU cohort more likely to have admission for emergency surgery (p=0.0076).  
  - PU cohort more likely to have higher Charlson score (p<0.001) and be more dependent (p<0.001).  
  - PU cohort more likely to have chronic kidney disease (p=0.005), chronic heart disease (p=0.006), COPD (p=0.004), chronic arterial disease (p=0.019).  
  - PU cohort more likely to be admitted for cardiovascular reason (p<0.001) or sepsis (p<0.001).  
  - PU cohort more likely to require mechanical ventilation (p<0.001), vasoactive drugs (p<0.001) and renal replacement therapy (p<0.001).  
  - PU cohort more likely to have ICU or hospital death both (p<0.001).  
  - Braden scale: PU cohort had significantly lower mean. | Participants with PU within 48 hours were excluded as the cause may have originated external to the ICU.  
- Braden score was conducted on admission to ICU and not updated thereafter, even if clinical condition altered.  
- No interrater reliability for PU assessment was conducted. |

Level of evidence: 1 (prognostic)  
Quality: High  
Note: This study also for review by risk SWG.
<table>
<thead>
<tr>
<th>Ref</th>
<th>Type of Study</th>
<th>Sample</th>
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</tr>
</thead>
<tbody>
<tr>
<td>(Delmore, Cox, Rolnitzky, Chu, &amp; Stolfi, 2015)</td>
<td>Retrospective case-control study exploring predictive factors for acute skin failure (ASF) and differentiating from pressure injuries</td>
<td>Cases were identified from review of admissions at two US hospitals in a two year period (validation set 102 participants of which 34 with PU; main analysis 450 participants of which 150 had PU) Patients with PUs were purposively selected and control patients without PUs were selected randomly. Inclusion criteria: • Aged ≥ 18 years</td>
<td>• N/A</td>
<td>• Variables considered in modeling: Tian. Impaired nutrition (BMI &lt; 18.5 kg/m², C-reactive protein &gt; 10mg/dl, unintentional weight loss before admission) © respiratory failure, renal failure, cardiac failure, and/or liver failure © limited tissue</td>
<td>Regression analysis to determine significant and independent predictors of acute skin failure • Peripheral arterial disease (PAD) odds ratio (OR) 3.8, 95% CI 1.64 to 8.66, p=0.002 • mechanical ventilation &gt; 72 hrs OR 3.0, 95% CI 1.78 to 5.05, p&lt;0.001 • respiratory failure OR 3.2, 95% CI 1.82 to 5.40, p&lt;0.001 • liver failure OR 2.9, 95% CI 1.05 to 8.08, p=0.04 • severe sepsis OR 1.9, 95% CI 1.14 to 3.20, p=0.02</td>
<td>• A 3-day length of stay was chosen, as time frame considered adequate to detect development of a new PU • Retrospective design relying on records</td>
</tr>
</tbody>
</table>

Author conclusions: Braden scale has good predictive ability in critical care, but a lower cut off score for risk is proposed

Braden scores (11.2±2.7 versus 15.1±3.5, p<0.001)
• Discrimination of Braden scale was 0.753 (95% CI 0.712 to 0.795)
• Discrimination of Braden scale was 0.642 (95% CI 0.591 to 0.689) for individuals with mechanical ventilation, 0.634 (95% CI 0.584 to 0.689) for individuals with vasoactives, 0.660 (95% CI 0.557 to 0.730) for individuals with renal replacement therapy, 0.697 (95% CI 0.558 to 0.842) for surgical patients
• Significant variables in multivariate analysis included age, gender, diabetes, hematological malignancy, PAD, Braden score ≤13, MAP < 60mmHg, mechanical ventilation and renal replacement therapy (subdistribution hazard ratio and p values provided)
• Cut off score for Braden scale in critical care proposed at ≤13
## Critically Ill Individuals: data extraction and appraisals

<table>
<thead>
<tr>
<th>Ref</th>
<th>Type of Study</th>
<th>Sample</th>
<th>Intervention(s)</th>
<th>Outcome Measures &amp; Length of Follow-up</th>
<th>Results</th>
<th>Limitations and comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>• admitted into the critical care for at least 3-day ICU stay</td>
<td></td>
<td>perfusion (MI, severe anemia, vasopressor use resulting in peripheral necrosis, PAD, cardiac arrest)</td>
<td>Area under curve (AUC) 0.793 indicating good predictive accuracy</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Exclusion criteria:</td>
<td></td>
<td>o sepsis</td>
<td>Study conclusion: PAD, mechanical ventilation &gt; 72 hours, respiratory failure, liver failure, and severe sepsis/septic shock were significant independent predictors of ASF. Current pressure injury prevention/intervention strategies should be considered when diagnosing ASF. ASF cannot be accurately distinguished from pressure injuries if the standard of pressure injury prevention has not been maintained.</td>
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<tr>
<td></td>
<td></td>
<td>• preexisting PU</td>
<td></td>
<td>o diabetes</td>
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<td></td>
<td></td>
<td>• lack of PU prevention measures without justification for non-adherence</td>
<td></td>
<td>o immobility</td>
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<tr>
<td></td>
<td></td>
<td>• actively dying/end of life</td>
<td></td>
<td>o surgery &gt; 3 hrs duration</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Participant characteristics:</td>
<td></td>
<td>o hypotension &gt; 48 hrs</td>
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<tr>
<td></td>
<td></td>
<td>• Mean age 71 years (SD 15.6)</td>
<td></td>
<td>o vasopressors used in ICU</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Mean ICU stay 9.8 days</td>
<td></td>
<td>o mechanical ventilation &gt; 72 hrs</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Mean Braden score 14 (SD 3.5)</td>
<td></td>
<td>o baseline variables including age, race, gender, diagnosis, Braden score, APCHE score</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>• Most PUs were SDTI, most commonly on sacrum and majority occurred in first 7 days in ICU</td>
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</tr>
</tbody>
</table>
Critically Ill Individuals: data extraction and appraisals

<table>
<thead>
<tr>
<th>Table 1: Level of Evidence for Intervention Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level 1</strong></td>
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<tr>
<td></td>
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<tr>
<td><strong>Level 2</strong></td>
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<td><strong>Level 3</strong></td>
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<td><strong>Level 4</strong></td>
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<td></td>
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<tr>
<td><strong>Level 5</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2: Levels of evidence for diagnostic studies in the EPUAP-NPIAP-PPPIA guideline update</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level 1</strong></td>
</tr>
<tr>
<td><strong>Level 2</strong></td>
</tr>
<tr>
<td><strong>Level 3</strong></td>
</tr>
<tr>
<td><strong>Level 4</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 3: Levels of evidence for prognostic studies in the EPUAP-NPIAP-PPPIA guideline update</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level 1</strong></td>
</tr>
<tr>
<td><strong>Level 2</strong></td>
</tr>
<tr>
<td><strong>Level 3</strong></td>
</tr>
</tbody>
</table>

APPRaisal for studies providing direct evidence (i.e. Eligible for supporting an evidence-based recommendations)
Each criteria on the critical appraisal forms was assessed as being fully met (Y), partially met or uncertain (U), not met/not reported/unclear (N), or not applicable (NA). Studies were generally described as high, moderate, or low quality using the following criteria:

- High quality studies: fully met at least 80% of applicable criteria
- Moderate quality studies: fully met at least 70% of applicable criteria
- Low quality studies: did not fully meet at least 70% of applicable criteria
# Critically Ill Individuals: data extraction and appraisals

## RCTs

<table>
<thead>
<tr>
<th>Endnote ID</th>
<th>Author/year</th>
<th>Focused question</th>
<th>Assignment randomized using appropriate method</th>
<th>Adequate concealment method</th>
<th>Subjects and investigators blinded</th>
<th>Groups comparable at commencement</th>
<th>Only difference btw groups was</th>
<th>Valid, reliable outcome measure</th>
<th>Intention to treat analysis</th>
<th>Comparable results for multiple sites</th>
<th>Minimal bias</th>
<th>Reliable conclusions</th>
<th>Level of evidence</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>15073</td>
<td>(Nedergaard, Haberlandt, Toft, &amp; Jensen, 2017)</td>
<td>Y</td>
<td>N</td>
<td>U</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>U</td>
<td>1</td>
</tr>
<tr>
<td>1568</td>
<td>(Serra et al., 2013)</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>U</td>
<td>U</td>
<td>N</td>
<td>U</td>
<td>U</td>
<td>NA</td>
<td>Y</td>
<td>U</td>
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</tbody>
</table>

## Cohort Studies

<table>
<thead>
<tr>
<th>Endnote ID</th>
<th>Author/year</th>
<th>Focused question</th>
<th>Comparable source populations</th>
<th>States number invited participants</th>
<th>Likelihood of outcome at enrolment considered</th>
<th>Per cent drop out in study arms reported</th>
<th>Clear outcome measures</th>
<th>Valid, reliable outcome measurement</th>
<th>Confounders identified and accounted for</th>
<th>Provides confidence intervals</th>
<th>Minimal bias</th>
<th>Reliable conclusions</th>
<th>Level of evidence</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>15181</td>
<td>(Coyer et al., 2017)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>U</td>
<td>3</td>
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</tbody>
</table>

## Cross Sectional/Survey/Prevalence Studies/Observational

<table>
<thead>
<tr>
<th>Endnote ID</th>
<th>Author/year</th>
<th>Focused question</th>
<th>Sampling method</th>
<th>Representative sample</th>
<th>States number invited participants</th>
<th>Clear outcome measures</th>
<th>Valid reliable outcome measurement</th>
<th>Confounders identified and accounted for</th>
<th>Provides confidence intervals</th>
<th>Minimal bias</th>
<th>Reliable conclusions</th>
<th>Level of evidence</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>13814</td>
<td>(Swafford, 2016 #13814)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>U</td>
<td>Y</td>
<td>U</td>
<td>NA</td>
<td>U</td>
<td>N</td>
<td>N</td>
<td>4</td>
<td>Low</td>
</tr>
<tr>
<td>15092</td>
<td>(Nowicki, 2017 #15092)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>U</td>
<td>Y</td>
<td>Y</td>
<td>NA</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>4</td>
<td>Low</td>
</tr>
</tbody>
</table>
## PROGNOSTIC STUDIES

<table>
<thead>
<tr>
<th>Author/year</th>
<th>Adequate description of baseline characteristics</th>
<th>Satisfactory study attrition</th>
<th>Clear outcome/ prognostic factors</th>
<th>Range of prognostic factors/confounders</th>
<th>Method of measuring prognostic factor</th>
<th>Same method of measuring factor for all</th>
<th>Continuous or variables or appropriate cut offs</th>
<th>Percent participants with complete data</th>
<th>Appropriate imputation method</th>
<th>Confounders/prognostic factors accounted for in analysis</th>
<th>Selective reporting avoided</th>
<th>Adequate sample size (10 PIs/factor)</th>
<th>Level of evidence</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>9509 (Delmore, Cox, Rolnitzky, Chu, &amp; Stolfi, 2015)</td>
<td>N</td>
<td>U</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>U</td>
<td>Y</td>
<td>U</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td>6497 (Catala Espinosa, 2014 #6497)</td>
<td>Y</td>
<td>NA</td>
<td>Y</td>
<td>Y</td>
<td>U</td>
<td>Y</td>
<td>Y</td>
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</tr>
</tbody>
</table>

## SYSTEMATIC REVIEWS FOR DISCUSSION

**RATING CRITERIA:**

1. Partial yes: states review question, search strategy, in/exclusion criteria and risk of bias were a-priori; full yes: meta-analysis/synthesis plan, investigation of heterogeneity and justification for protocol deviation
2. Partial yes: At least 2 databases, provides keywords and search, justifies publication restrictions; full yes: searched reference lists of included studies, searched trial registries, consulted experts in field, searched grey literature, within 24 months of review completion
3. At least two reviewers independently agreed on selection of studies to include or reviewers achieved 80% agreement on a sample of studies
4. Either two reviewers did data extraction and had >80% agreement, or two reviewers reached consensus on data to extract
5. Partial yes: list of all relevant studies that were read and excluded; full yes: every study that was excluded is independently justified
6. Partial yes: described populations, interventions, comparators, outcomes and research design; full yes: detailed descriptions of same plus study setting and timeframe for follow-up
7. For RCTs Partial yes: appraised risk of bias from uncontrolled allocation and lack of blinding; full yes: appraised risk of bias on true randomisation, selection of reported result from multiple measurements/analyses
   For non randomised studies: Partial yes: appraised confounding and selection bias; full yes: appraised methods to ascertain exposures and outcomes, selection of reported result from multiple measurements/analyses
8. Must include reporting of the source of funding of individual studies, or reports that the reviewers considered this even if individual funding sources aren’t listed in review

<table>
<thead>
<tr>
<th>Endnote ID</th>
<th>Author/year</th>
<th>PICO research and inclusion criteria</th>
<th>Rationale for selection of study designs</th>
<th>Duplicate study selection</th>
<th>Duplicate data extraction</th>
<th>Excluded studies listed</th>
<th>Adequate description of bias assessed</th>
<th>Source of funding reported</th>
<th>Appropriate meta-analysis including weighting and adjustment for heterogeneity</th>
<th>Meta-analysis considers risk of bias of studies</th>
<th>Discussion considers risk of bias of studies</th>
<th>Assessment of publication bias if quantitative analysis is done</th>
<th>Potential conflicts of interest of authors reported and managed</th>
<th>Review Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>8108</td>
<td>(Park et al., 2015)</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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<td>Y</td>
<td>Y</td>
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<tr>
<td>14657</td>
<td>(Tayib &amp; Coyer, 2016)</td>
<td>Y</td>
<td>N</td>
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<td>Y</td>
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</table>
References


Cox, J., & Roche, S. (2015). Differentiating a Pressure Ulcer from Acute Skin Failure in the Adult Critical Care Patient. [DE]. Adv Skin Wound Care, 28(11), 514-524. doi:https://dx.doi.org/10.1016/j.aswc.2014.03.002


