Individuals in the Operating Room: data extraction and appraisals

Search results for 2019 International Pressure Injury Guideline: Individuals in the Operating Room


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=3,029

Identified as providing direct or indirect evidence related to topic and critically appraised
n=15

- 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=41

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: Individuals in the Operating Room © EPUAP/NPIAP/PPPIA Page 1
## 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.


### Ref
Lin et al., 2017

### Type of Study
Retrospective cohort study investigating risk factors for pressure injury in people undergoing posterior lumbar and/or thoracic surgery

### Sample
Participants were recruited in one spine service in Singapore (n=209)

**Inclusion criteria:**
- Adults having posterior lumbar and/or thoracic spinal surgery on a Jackson table

**Exclusion criteria:**
- Sedation or local anaesthesia for procedure
- Existing pressure injury

**Participant characteristics:**
N/A

### Intervention(s)

- Pressure injury Stage 1 or greater assessed using NPUAP staging system
- Skin assessments conducted at immediate postop, 24 hours postop, 48 hours postop
- Daily Braden scale score
- Multivariate logistic analysis
- Risk factors collected: (n=27) including gender, smoking, diabetes, cancer, antipatelet use, previous skin problems, Braden scale score, myelopathy, radiculopathy, non-specific numbness, spinal deformity, lumbar prolapse, cervical myelopathy, lumbar spinal

### Outcome Measures & Length of Follow-up
Pressure injury incidence
- 23% (48 Category./Stage I PU and 2 Category/Stage II pressure injuries)

### Multivariate analysis (5 factors significant)
- Previous skin problems OR not reported, p=0.034
- Myelopathy, OR 4.79, p=0.013
- Spinal deformity, OR 3.31, p=0.010
- Operative time >300 mins, OR 8.12, p=0.005
- Levels of surgery > 4, OR 9.10, p=0.006

### Results
- Included in risk chapter, only consider factors specific to operating room
- Insufficient number of events
- Cutoffs and categorical factors not clearly defined
- Unclear if full sample included in analysis

### Limitations and comments
- Level of evidence: 3 (prognostic)
- Quality: low

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### Individuals in the Operating Room: data extraction and appraisals

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<tr>
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</thead>
<tbody>
<tr>
<td>Chen, Zhu, Wei, &amp; Zhou, 2018</td>
<td>Retrospective cohort study exploring pressure injury risk factors in people undergoing surgery for hip fracture</td>
<td>Participants were recruited in a tertiary hospital in China (256 (21 missing data) 235 pts study population)</td>
<td>N/A</td>
<td>• Skin inspections</td>
<td>Pressure injury incidence 31 pts with 37 (13.2%) Stage ≥1 PU MV analysis Only Braden scale was a significant risk factor Length of surgery, haemoglobin and albumin were not significant</td>
<td>• Included in risk chapter • Insufficient number of results • Unclear risk factor measurement methods</td>
<td>Level of evidence: 3 (prognostic) Quality: low</td>
<td></td>
</tr>
<tr>
<td>Shaw, Chang, Lee, Kung, &amp; Tung, 2014</td>
<td>Prospective cohort study Exploring risk factors for pressure injury in people having surgery</td>
<td>Participants were recruited in a surgical department in Taiwan (n=297)</td>
<td>N/A</td>
<td>• Logistic regression</td>
<td>Pressure injury incidence • Immediately post-operative, incidence was 9.8% • (29 Stage 1 PU) • 30 minutes post-operative, incidence was 5.1% (15 Stage 1 PU) MV analysis • Significant factors: Age, type of anaesthesia (general anaesthesia or not), operation position (nonsupine vs supine), type of surgery (orthopaedic vs general), admission Braden score, number of nursing interventions</td>
<td>• Included in risk chapter • Inadequate number of events. • Some PUs resolved within 30 mins</td>
<td>Level of evidence: 3 (prognostic) Quality: low</td>
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<tr>
<td>Yoshimura et al., 2015</td>
<td>Retrospective cohort study exploring pressure injury risk factors in people have neurosurgery</td>
<td>Participants were recruited in a neurosurgery department in Japan (n=277) Inclusion criteria: Adults undergoing elective surgery in park bench position who had no pressure injury prior to surgery, with written informed consent Exclusion: repeated surgery or missing risk assessment</td>
<td>N/A</td>
<td>Multivariate logistic stepwise regression</td>
<td>Pressure injury incidence • Incidence was 11% (29 PU Grade 1 and 1 PU Grade 2) MV analysis • Presence of perspiration was significant • Surgery length &gt; 6 hours / Core temperature &gt; 38.1°C as a hybrid factor was significant (OR 8.45, 95% CI 3.04 to 27.46 p&lt;0.001)</td>
<td>• Not significant: Gender, Heat Lung machine use, Type of surgery (cardiac vs general), Type of surgery (neuro vs general) • Included in risk chapter • Timing of development of perspiration and PU during surgery is unclear • few risk factors • poor definition of perspiration • data derived cut points</td>
<td>Level of evidence: 3 (prognostic) Quality: low</td>
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</tr>
<tr>
<td>Chen, Shen, Xu, Zhang, &amp; Wu, 2013</td>
<td>Retrospective cohort study exploring relationship between perioperative corticosteroids as a risk factor for pressure injuries</td>
<td>Participants were consecutive cardiac patients over one year at one hospital in China (n=286) Inclusion criteria: Adults and children undergoing cardiac or aortic surgery Exclusion criteria: Not admitted to a cardiac ICU post surgery Participant characteristics: • Mean age 46.9±22.1 years (range 2 to 84) • 55.9% male • People who developed pressure injuries were older (p=0.017)</td>
<td>N/A</td>
<td>Record review, does not report how pressure injuries were assessed • Used NPUAP classification Logistic regression model</td>
<td>Pressure injury incidence • Surgical related pressure injury incidence was 16.4% (95% CI 12.3 to 21.2%) • Category/Stage I pressure injuries 97.9%, Category/Stage II pressure injuries 2.1% • 14.9% developed more than one pressure injury • Most common locations sacrum/coccyx 50.9%, heels 22.8%, tuberosities 910.5%</td>
<td>• Not eligible for risk section due to study including children • Insufficient events • Unclear numbers with missing data • Method of assessment not reported</td>
<td>Level of evidence: 3 (prognostic) Quality: low</td>
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<tr>
<td>Magny et al., 2017</td>
<td>Retrospective study exploring risks for pressure injury and pressure injury prognostic value</td>
<td>Participants were recruited in a post-operative unit in France (n=567)</td>
<td>• N/A</td>
<td>• 6.month mortality  • Admission until death or 6 months after surgery  • Routine consultation or contacted and interviewed by phone  • Secondary endpoints: in hospital mortality and 30 days mortality, LOS and complications  • Missing patients were tracked through health care providers, GP</td>
<td>Pressure injury incidence  • 11.8% pressure injuries, mostly heels (60%) and sacrum (39%).  • Severity of the pressure injuries: Category/Stage I (34%), Category/Stage II (49%), Category/Stage III (9%) and Category/Stage IV (7%).  • Risk factors for pressure injuries  • Low serum albumin, chronic atrial fibrillation, coronary artery disease and diabetes  • 30 days’ mortality (4.1%) and 6 months (14.4%)  • Survival rate decreased in the pressure injury group</td>
<td>• Not eligible for risk chapter, no MV analysis  • No evaluation of interventions to prevent pressure injuries  • No data on the surgery/OR experience</td>
<td>Level of evidence: 3 (prognostic)</td>
<td>Quality: low</td>
</tr>
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<td>Shen, Chen, Xu, Zhang, &amp; Wu, 2015</td>
<td>Retrospective study exploring relationship between pressure injuries and length of surgery</td>
<td>Participants were recruited in an operating suite in China (n=286)</td>
<td>Any Category/Stage II pressure injuries were treated with a hydrocolloid dressing</td>
<td>Pressure injuries measured and recorded using a tracking and NPUAP staging  • Length of surgery defined as time of first incision to wound closure  • Demographic data collected from records  • Risk factors were documented including medications such as steroids, vasoactive drugs</td>
<td>Pressure injury incidence 16.4% (95% CI 12.3%-21.2%) 97.9% of pressure injuries were Category/Stage I  Most common locations were sacrum and coccyx (50.9%), heels (22.8%), ischial tuberosities (10.5%)</td>
<td>Covariate analysis for factors associated with pressure injuries  • Higher mean age (pressure injuries 53.9±16.3 vs no pressure injury 45.5±22.8, p=0.17)  • Length of surgery (pressure injuries 259.7±108.9 mins vs no pressure injury 182.6±98.8, p=0.00)  • Taking corticosteroids (p=0.46)</td>
<td>• Risk study not eligible for risk section due to no multivariate analysis  • Retrospective study relying on medical records  • Important risk factors (e.g. Braden Scale) not accessible for some patients</td>
<td>Level of evidence: 3 (prognostic)</td>
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<tr>
<td>Sasabuchi, Matsui, Lefor, Fushimi, &amp; Yasunaga, 2018</td>
<td>Retrospective observational study evaluating influence of surgical timing on adverse outcomes including pressure injuries</td>
<td>Participants were records extracted from a national database spanning 4-year period in Japan (n=208,936)</td>
<td>N/A</td>
<td>Review of records</td>
<td>Disease category (p=0.013) Non-significant factors were gender, weight, length of cardiopulmonary bypass, intraoperative vasoactive agents, postoperative vasoactive agents No significant effect for length of surgery in pediatric patients Author conclusions: for adults, length of surgery is a risk factor for pressure injuries</td>
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<td>Inclusion criteria:</td>
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<td>• Does not state how pressure injuries were identified or categorized, or timing of their development</td>
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<td></td>
<td>• Surgery for hip fracture</td>
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<td>Pressure injury incidence</td>
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<td></td>
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<td>• Aged &gt; 65 years</td>
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<td>• More people had pressure injuries in the group that had delayed surgery versus early surgery (1.6% versus 1%, p&lt;0.001) Early surgery (within 2 days) was significantly associated with pressure injury during hospitalization (odds ratio 0.56, 95%CI: 0.33 to 0.96, p = 0.035)</td>
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<td>Exclusion criteria:</td>
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<td>• Surgery on day 30 or later</td>
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<td>• Aged &lt;65 years</td>
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<td>Participant characteristics:</td>
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<td>• 22.5% had surgery within 2 days of admission and 77.5% had delayed surgery</td>
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<td>Hayes et al., 2014</td>
<td>Retrospective case control study to determine the relationship between time in the OR and hospital-acquired</td>
<td>Participants were people discharged from surgical services over a 3 year period in a hospital in US (eligible population 33,725 n=931 surgical patients with hospital acquired pressure injuries, all cases matched to 4 controls for total of 4652 participants)</td>
<td>N/A</td>
<td>Date and time pressure injury first documented</td>
<td>Pressure injury incidence 2.8% Operating room time</td>
<td>Not a prognostic study Unclear how pressure injuries were assessed Possibly includes pre-surgery pressure injuries No other risk factors for pressure injuries were included in modelling</td>
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<td>Inclusion criteria:</td>
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<td>Time in the OR in the 24, 48, and 72 hours prior to incident pressure injury Braden scores on admission and most</td>
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<td>Braden scores on admission and most</td>
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| pressure injuries | Case inclusion: (n=931) Documented pressure injuries | Controls matched for age, sex, surgery and comorbidities | recent prior to pressure injury documentation  
- American Society of Anesthesiologists (ASA) score, sex, age, patient weight, year of study  
- odds ratios for HAPU occurrence (compared to patients who were not in the OR in the 24 hours prior to a documented pressure injury) were:  
  - 1.1 for <2 hours operating time,  
  - 1.2 for >2 but <4 hours,  
  - 1.6 for >4 but <6 hours  
  - 6.4 for >6 hours in the OR | Author conclusions: Extended surgery is a risk factor for pressure injury | • Unable to correlate pressure injury location with surgical position  
• Significant difference in admission Braden score  
• Did not consider other risk factors |
| Case exclusion: Pressure injury documented within 24 hours of admission  
Control inclusion: (n=3721) Matched to hospital length of stay at time pressure injury documented | Characteristics:  
- Primarily trauma or cardiac surgery  
- Case patients more likely to be male, older, lower admission Braden scores, and more likely to die during admission or be discharged to long-term acute care hospital. | Controls matched for age, sex, surgery and comorbidities | Method of assessing pressure injuries not reported | Incidence  
- Category/Stage 2 or greater pressure injuries was 1.7%  
- 79% coccyx; 9% heel; 7% occiput; 5% back | Multivariable analysis  
- Preoperative albumin (g/dl) OR 0.21, 95% CI 0.05 to 0.82, p=0.025  
- Preoperative lactate (mmol/L) OR 1.70, 95% CI 1.07 to 2.71, p=0.026  
- Packed RBC transfusion (units) OR 0.99, 95% CI 1.92 to 1.06, p=0.772  
- Braden score OR 0.88, 95% CI 0.64 to 1.21, p=0.421 | • Not eligible for risk chapter due to study design  
• Some variables (e.g. Braden scale score) were only measured post-operative  
• Pressure injuries identified through medical records | Level of evidence: 3 (prognostic)  
Quality: low |
| Kim, Lee, Ha, & Na, 2018 | Case control study identifying perioperative risk factors for post operative pressure injuries | Participants were recruited over 12 months in a hospital in South Korea. Each case was matched to two controls from the same cohort (2,498 eligible population, n=43 cases, n=86 controls)  
Inclusion criteria:  
- Adults undergoing major surgery  
Exclusion criteria:  
- Pressure injury on admission  
- Children | Case inclusion: (n=931) Documented pressure injuries  
Case exclusion: Pressure injury documented within 24 hours of admission  
Control inclusion: (n=3721) Matched to hospital length of stay at time pressure injury documented | Categories/Stage 2 or greater pressure injuries was 1.7%  
- 79% coccyx; 9% heel; 7% occiput; 5% back | Multivariable analysis  
- Preoperative albumin (g/dl) OR 0.21, 95% CI 0.05 to 0.82, p=0.025  
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<tr>
<td>Wright, Van Netten, Dorrington, &amp; Hoffman, 2014</td>
<td>Study exploring risk factors for longer length surgery of the head/neck</td>
<td>Participants were recruited over 3 year period in an Australian hospital (n=88)</td>
<td>Participant characteristics: • Mean age 61 years • Mean BMI 22-23kg/m² • Primarily organ transplantation patients • Operative position was primarily supine</td>
<td>• Ventilator care OR 0.14, 95% CI 0.10 to 1.92, p=0.140</td>
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<tr>
<td>Wright, Van Netten, Dorrington, &amp; Hoffman, 2014</td>
<td>Study exploring risk factors for longer length surgery of the head/neck</td>
<td>Participants were recruited over 3 year period in an Australian hospital (n=88)</td>
<td>Participant characteristics: • Mean age 61.84 years (range 35-85) • Mean operation time 10.67 hours (5.05-19.33) • People who developed a pressure injury were older (p&lt;0.01) and had longer surgery times (p=0.02)</td>
<td>Incidence 14.7% (n=13/88) MV analysis • Gender OR 1.08 95% CI 0.25 – 4.73, p=0.914 • Age OR 0.91, 95% CI 0.84 to 0.98, p=0.009 • Systemic disease OR 0.32, 95% CI 0.08 to 1.4, p=0.131 • Operative duration, OR 1.007, 95% CI 1.002 – 1.013, p=0.011</td>
<td>Includes a relevant MV analysis • Ineligible for risk section • Insufficient cases • One center</td>
<td></td>
</tr>
<tr>
<td>Schoonhoven, Defloor, van der Tweel, Buskens, &amp; Grypdonck, 2002</td>
<td>Prospective cohort study</td>
<td>Surgical patients admitted to a teaching hospital in Netherlands (n=208)</td>
<td>Participant characteristics: • Primarily males • Mean age 61.84 years (range 35-85)</td>
<td>Incidence stage 1-4 was 21.2% (44/208) in the first 2 days after surgery. PU incidence stage 2-4 was 10.1% (21/208)</td>
<td>Included in risk chapter • Time limit for intraoperative PU imposed was based on ‘best guess’. Some pressure injuries may have been missed.</td>
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Participant characteristics:
- Mean age 61 years
- Mean BMI 22-23kg/m²
- Primarily organ transplantation patients
- Operative position was primarily supine

Incidence:
- 14.7% (n=13/88)

MV analysis:
- Gender OR 1.08 95% CI 0.25 – 4.73, p=0.914
- Age OR 0.91, 95% CI 0.84 to 0.98, p=0.009
- Systemic disease OR 0.32, 95% CI 0.08 to 1.4, p=0.131
- Operative duration, OR 1.007, 95% CI 1.002 – 1.013, p=0.011

The authors provided recommendation that were not reflective of the study findings, although represent the literature overall
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<tr>
<td>Rademaker, Vainas, van Zutphen, Brink, &amp; van Helden, 2007</td>
<td>Retrospective cohort study exploring pressure injury risk factors in hip fracture patients undergoing surgery</td>
<td>Participants were recruited in a trauma centre in Netherlands (n=722)</td>
<td>N/A</td>
<td>multivariate logistic regression</td>
<td>Incidence of pressure injuries was 29.6%, 214 Stage ≥2 PU</td>
<td>Included in risk chapter, Large sample size but limited number of risk factors considered and not based on a conceptual framework (no nutrition or skin moisture factors). Inadequate measurement of risk factor. (Record review).</td>
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<td>Inclusion criteria: All hip fracture patients admitted to a level one trauma centre Having hip fracture surgery</td>
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<td>MV analysis</td>
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<td>Exclusion: age &lt;60 years, (multiple) high energy trauma (defined as a fall from higher than ground level, or road traffic accidents), initial conservative treatment, inter-hospital transfer, presence of PUs on admission, pathological fractures and recurrent fractures</td>
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- **Surgical specialties:** cardiac, GI, head and neck oncology, neuro, oncology, orthopaedics, plastics, urology and vascular.
- **Exclusion criteria:**
  - Expected to undergo surgery of >4 hours but actual procedure shorter than 4 hours
  - Surgical specialties: gynaecology and trauma
- **Participant characteristics:**
  - 72 female and 136 males, median age 61 years

- **Category/Stage 1-4 or closed pressure injury**
- **Risk indicators:** Body Mass Index (BMI), malnutrition, type of surgery, method of anesthesia.
- **Follow-up for 14 days or until discharge, whichever occurred first**
- **Discharge patients had follow-up telephone call on day 14.**

- Of a univariate analysis) indicated that only the length of surgery was significantly associated with the occurrence of PU stage 2-4 (OR 1.01, CI 1.004-1.009)

- **Post-operative care may have stopped pressure injury progression of biasing the result**
- **Insufficient number of events**
## Individu*als in the Operating Room: data extraction and appraisals

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| Nixon, Brown, McElvenny, Mason, & Bond, 2000 | Prospective sequential, double triangular, randomised, blinded, controlled trial | 446 general, vascular and gynaecological surgical patients | Participants were randomized to either:  
- Control group (224): Standard operating table mattress + heel pad.  
- Experimental group (222): Dry visco-elastic polymer pad (Action Products Inc.)  
- Warming mattress provision for both groups was standardized. | Pressure injuries Grade 1-5 (incidence (adapted version of Torrance classification))  
- General data, data on mobility, Braden Scale, equipment, pre-operative physiological measures, and intra-operative physiological measures.  
- Follow-up of 8 days | PU incidence was 15.6% (65/416).  
- 16% (9/56) were directly associated with the peri-operative period  
- Multivariate analysis showed the following prognostic factors:  
  - Increased number of hypotensive episodes  
  - Increased mean core temperature during surgery,  
  - Reduced mobility on Braden scale mobility Day 1 |  
- Not eligible for risk chapter  
- Results are limited by study design since the hypothesis and sample size were not determined by the prognostic factor study  
- Local variation in theatre practice  
- Use of a warm air over blanket for some patients classified as ‘big majors’  
- 30 patients dropped out. |
| Al-Ani et al., 2008 | Prospective cohort study comparing the incidence of PU in those who had delayed surgery to those who had surgery within 24 hours | Participants were recruited from two hospitals in Sweden (n=850, n=744 met inclusion) | Time to surgery defined as hours from admission to the ER to the time of operation. | Classification of PUs conducted by a specialist nurse according to EPUAP 1998 guidelines.  
Analysis included only grade II, III and IV PUs | Time to surgery  
- Median wait time to surgery was 24hrs (range 2.8 to 331 hrs)  
- 48% had surgery within 24 hours  
- 74% had surgery within 36 hours  
- 87% had surgery within 48 hours | Incidence of PU  
- Participants who had a >24 hr wait for surgery were more likely to  
- Not eligible for risk section  
- Modeling was based on establishing factors that increased risk of a negative outcome (i.e. not just pressure injuries) and did not include other risk factors |

**Level of evidence:** 2 (prognostic)  
**Quality:** low
### Individuals in the Operating Room: data extraction and appraisals

<table>
<thead>
<tr>
<th>Ref</th>
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<th>Results</th>
<th>Limitations and comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stahel et al., 2013</td>
<td>Cohort study comparing an early spinal surgery protocol versus delayed surgery</td>
<td>Participants were those undergoing spinal surgery in a US hospital (n=112)</td>
<td>• Early spinal surgery group (ESG, n=42): surgery performed within 24 hours</td>
<td>• Method and frequency of assessment of PU was not reported.</td>
<td>• Pressure ulcers occurred less frequently in the participants who had early surgery (2.4% versus 8.6%, p&lt;0.05)</td>
<td>• Presence of PU on admission to ER was not reported on considered</td>
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<td></td>
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<td>• Delayed surgery group (DSG, n=70): surgery for spinal fixation delayed by at least 24 hours</td>
<td>• Grade/stage of PU was not reported</td>
<td>• Other factors that may have influenced findings (e.g. duration of surgery) were not included in a correlational analysis</td>
<td>• Unclear if PU assessments were conducted by nurses blinded to surgery time</td>
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<td></td>
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<td></td>
<td>• Not eligible for risk section, not a prognostic study</td>
<td>• Small numbers in the group who waited longer for surgery</td>
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<td>• Does not report method or frequency of assessment of PU</td>
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<td>• Other factors that may have influenced findings (e.g. duration of surgery) were not included in a correlational analysis</td>
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<td>• No confidence intervals</td>
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</table>

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<tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>• arrived at hospital &lt;24 hrs after fracture occurred</td>
<td></td>
<td>• Pressure ulcers occurred less frequently in the participants who had early surgery (2.4% versus 8.6%, p&lt;0.05)</td>
<td>• Presence of PU on admission to ER was not reported on considered</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Characteristics:</td>
<td></td>
<td>• Other factors that may have influenced findings (e.g. duration of surgery) were not included in a correlational analysis</td>
<td>• Unclear if PU assessments were conducted by nurses blinded to surgery time</td>
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<tr>
<td></td>
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<td>• Mean age 81 years</td>
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<td>• No confidence intervals</td>
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<td>• 73% sample were female</td>
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<td>• 28% of sample had dementia</td>
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<td>• 49% cervical fracture, 43% trochanter fracture, 8% subtrochanter fracture</td>
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<td></td>
<td>• Demographics were not significantly different between time-to-surgery groups</td>
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Data Tables: 2019 Guideline Update: Individuals in the Operating Room © EPUAP/NPIAP/PPPIA Page 11
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</table>
| Smektala et al., 2008 | Prospective cohort study investigating impact of delayed surgery in older adults with hip fracture | Participants were recruited from 2002 to 2003 in 268 acute care hospitals in Germany (n=2,916) | Time to surgery classified as hours from time of fracture event to the time of operation.  
27.5% sample had surgery within 12 hours of fracture  
40.8% had surgery within 12 to 36 hours  
31.7% waited > 36 hours | The occurrence of a post-operative complication or patient death with one year follow up, of which pressure ulcer was one complication reported  
Assessment or classification of PU is not reported | Incidence of PU was 1.4%  
In all patients multi-variate adjusted hazard ratio for PU was 2.08 (95% CI 1.20 to 3.58, p=0.009)  
Time to surgery was not significantly associated with PU developed: Multivariate-adjusted OR as a function of time-to-surgery OR=1.33 (95% CI 0.96 to 2.05, p=0.201) | Not eligible for risk section  
Modeling was based on establishing factors that increased risk of a negative outcome (i.e. not just pressure injuries) and did not include other risk factors for pressure injuries  
Only patients with comprehensive records maintained for 12 months were included  
Method and timing of PU assessment not reported  
PU prevention strategies in OP and postoperative area not reported  
Does not report identification of PU on admission |
| Lefaivre et al., 2009 | Retrospective cohort study investigating effect of delay to surgery on incidence of PUs | Participants were admitted to trauma unit in Canada between 1998 and 2001 (n=607) | Time to surgery defined as hours from admission to the ER to the time of operation.  
Method and timing of assessing is not reported. Categories/staging of PU is not reported  
Delay in surgery was categorised as:  
< 24 hours | | Incidence of PU was 13.5% (82/607)  
Delay of 24 to 40 hours was not associated with a significant increase in risk of PU (OR 1.23. 95% CI 0.71 to 2.12, p=0.47)  
Delay >48 hours prior to surgery was associated with an increased risk of PU (OR 2.29, 95% CI 1.19 to 4.40, p=0.0128) | Not eligible for risk section  
Determination of time of discharge was a limitation  
Method of PU assessment and classification is not reported |

Level of evidence: 3 (prognosis)  
Quality: moderate
### Data Tables: 2019 Guideline Update: Individuals in the Operating Room

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</table>
| U. G. Nilsson, 2013 | Descriptive study reporting on association between postoperative pain and PU | Consecutive elective surgery patients at a hospital in Sweden (n=86) | None | • Pain located on heels, arms or overall, assessed in the post-anesthetic care unit (PACU) on a numerical rating scale (0 to 10)  
• Heel skin inspection and grading using four grades, conducted in the PACU by the nurse if the patient suffered heel pain | • 85% participants had a Tempur mattress and 15% had an air mattress  
• Four participants experienced heel pain (range 2 to 5 on NRS). 100% of these participants had a Tempur mattress.  
• 50% of participants experiencing heel pain had stage I heel PU. | • Repeat assessment of PU presence not reported  
• Blinded assessment is not reported or discussed |
## Individuals in the Operating Room: data extraction and appraisals

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</table>
| Primiano et al., 2011 | Prospective cohort observational study investigating risk factors associated with development of PU post-operatively | Participants were admitted to a trauma academic medical center in from June 2009 to Feb 2010 (n=258) | - average surgery duration 151 minutes (range 60 to 560)  
- 27% of participants experienced preoperative pain | - Duration of surgery  
- Observation of multiple intrinsic and extrinsic factors | - Presence of new PU within 72 hours of surgery  
- Assessment pre- intra- and post-operatively, using NPUAP classification system and daily Braden scales scores  
- Preoperative factors analysed:  
  - Age  
  - Weight  
  - Surgical procedure  
  - Incontinence  
  - ASA score  
  - Nutritional status  
  - Skin integrity including previous breakdown  
  - Alterations in sensation  
- Intraoperative factors analysed:  
  - type of anasthesia  
  - patient temperature  
  - temperature devices in OR  
  - length surgery | - Incidence of new PU was 8.1%  
- Variables significantly associated with PU development in chi-square analysis:  
  - type of positioning device used in OR ($\chi^2=7.897$, p=0.048)  
  - table surface used in OR ($\chi^2=15.848$, p=0.000)  
  - postanaesthetic care unit skin assessment score ($\chi^2=41.652$, p=0.000)  
  - female gender ($\chi^2=6.984$, p=0.030)  
- Variables significantly predicting PU development logistic regression multivariate analysis:  
  - use of a foam pad on OR table (OR=14.740, p=0.024)  
  - Braden score on day 1postoperative (OR=0.783, p=0.003)  
- 23% of participants who developed a PU (suggests primarily sacral) had their heels elevated (p=ns)  
- Closed cell foam pad was used for 29% of participants who developed a PU | - Not included for risk factors  
- single site  
- confidence intervals not reported  
- only included surgical procedures of > 3hr duration  
- Location of PU not stated  
- Selection of sample is not reported  
- Rater reliability and blinding of assessment is not reported | Level of evidence: 3 (prognosis)  
Quality: low |
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</table>
| Tschannen, Bates, Talsma, & Guo, 2012 | Retrospective cohort study investigating patient-specific and surgical factors in the development of PUs | Participants recruited from 5 units (3 ICUs; 2 intermediate care) from one hospital (n=3225 surgical patients) | Not reported | Outcome definition: development of ≥1 new Stage 1 or higher hospital-acquired PU. Skin inspected for PU not reported | N=383 developed hospital-acquired PUs (no. or grades not reported) | • Record review  
• Conceptual framework limited  
• Strategy for model building based on a restricted conceptual framework |
| | | | | • type of surgical pad/overlay  
○ hypotension, hypoxia  
○ medications | No. in final: not reported but assumed complete  
N=9 risk factors entered into MV analysis:  
• age; sex; BMI; Braden score at admission; history of diabetes; risk of mortality; use of vasopressors; number of surgeries; total operating room time | |
| | | | | | N=7 risk factors from final model:  
BMI: <.001; 0.97; 0.95-0.98  
History of diabetes <.001; 1.49; 1.14-1.96  
Use of vasopressors 0.03; 1.33; 1.03-1.73  
Number of surgeries <.001; 2.23; 1.45-3.44  
Total operating room time <.001; 1.07; 1.03-1.11  
Braden score at admission <.001; 0.89; 0.86-0.93  
Risk of mortality (score 2) <.001; 2.32; 1.49-3.62  
Risk of mortality (score 3) <.001; 5.50; 3.58-8.45  
Risk of mortality (score 4) <.001; 11.15; 7.1-15.5 | |
| | | | | | Characteristics:  
• n=1910 males; n=1315 females  
• mean age 58.9 yrs; range 18-96 yrs  
• lost to follow-up and baseline PU not reported | | |

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## Individuals in the Operating Room: data extraction and appraisals

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<th>Level of evidence</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connor, Sledge, Bryant-Wiersema, Stamm, &amp; Potter, 2010</td>
<td>Prospective cohort study examining perioperative factors predictive of PUs in patients undergoing urologic surgical procedure</td>
<td>Participants recruited from academic center with urologic-specific OR and inpatient urologic surgery unit (n=538)</td>
<td>When a patient arrived in the post-anesthesia recovery room (PAR), a data collector determined the manner in which patient positioning in OR and turned the patient away from the side that was dependent during surgery.</td>
<td>Outcome definition: development of new PU in the PAR.</td>
<td>N=25 (5%) developed Stage 1 PUs</td>
<td>Insufficient number of events</td>
<td>3 (prognosis)</td>
<td>low</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Inclusion:</td>
<td>Skin inspected for PU pre-operatively and post-operatively (PO) when patient arrived to PAR, and PO daily until PO day 3</td>
<td>N=498 (assumed)</td>
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<td>• English speaking adults</td>
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<td>Multivariate analysis</td>
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<td></td>
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<td>• Undergoing scheduled inpatient urologic surgical procedures</td>
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<td>N=8 risk factors entered into MV analysis:</td>
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<td></td>
<td>• Admitted for ≥24 hrs of post-operative care</td>
<td></td>
<td>• Braden scores (pre- and post-op); length of surgery; length of anesthesia time; time BP &lt;50 mmHg diastolic; BMI; position; type of fluids on table surface; type of support device used intra-operatively.</td>
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<td>Exclusion:</td>
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<td>N=2 significant risk factors from final model:</td>
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<td></td>
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<td>• Pre-existing PU or open skin wound on dependent areas subject to pressure during surgery</td>
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<td>BP &lt;50: 0.046; 1.007; 1.000-1.014</td>
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<td>Characteristics:</td>
<td></td>
<td>Perfusion time (anesthesia): 0.038; 1.005; 1.000-1.010</td>
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<td></td>
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<td>• n=379 (76%) males; n=119 (24%) females</td>
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<td></td>
<td>• mean age 58.9 (SD 12.66) yrs; range 20-89 yrs</td>
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<td>• N=40 enrolled patients excluded</td>
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<td></td>
<td>• Sample without baseline PU</td>
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</table>

### Clinical question 2: What are the unique pressure injury prevention strategies for individuals in the operating room?

**Support surfaces in the operating room**
## Individuals in the Operating Room: data extraction and appraisals

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<thead>
<tr>
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</tr>
</thead>
</table>
| Kirkland-Walsh, Teleten, Wilson, & Raingruber, 2015 | Aim of study was compare four different surfaces used in the operating room | Participants were healthy volunteers in US (n=49) | Four OR table surfaces were tested for pressure redistribution:  
  - standard three-layer viscoelastic memory foam surgical table  
  - air-inflated static seat cushion under the sacral area placed on standard surgical table  
  - a two-layer OR surface consisting of a top layer of nonpowered self-contouring copolymer gel and a bottom layer of high density foam, and 4  
  - a fluid immersion simulation surgical surface | Participants would lie flat on a surface being tested for 5 minutes before any pressure mapping measurements were taken.  
  - Measurements were then taken at 3 and 30 minutes | Outcomes of testing these surfaces revealed that fluid immersion surfaces provide the lowest interface pressure in sacral areas.  
  - Average sacral interface pressure was significantly lower with fluid immersion compared with other three surfaces (p=0.004)  
  - Average sacral interface pressure ranged from 23.9mmHg (air inflated) to 22.1 mmHg (fluid immersion) between the four surfaces  
  - All support surfaces had significantly different peak sacral interface pressures, except fluid immersion vs air inflated | Limitations=  
  - All recruits were healthy volunteers  
  - This study was limited to testing pressures and contact areas of the sacrum and not any other at risk areas of the body  
  - All surfaces tested were from different manufacturers and there is the potential that pressure redistribution properties may not be standard across different manufacturers  
  - Indirect evidence (PU not an outcome measure) |
| Grisell & Place, 2008 | Blinded RCT comparing different facial pillow position for prevention of pressure injuries in the OR setting | Participants were consecutive patients admitted for elective surgery requiring prone position at a surgery in the USA (n=66) | All participants were positioned using standard prone positioning:  
  - Patients were randomized to receive different facial pillows:  
    - Orthopedic Systems Inc (OSI) disposable polyurethane foam positioner (n=22)  
    - Dupaco Prone View® Protective Helmet System disposable polyurethane foam head positioner (n=22) | Facial tissue pressures were measured at the patient’s forehead and chin at time 0, 5, 15, and 60 minutes of positioning  
  - The integrity of skin was recorded and classified using NPUAP system staging at the end of surgery | 10 patients positioned on the OSI positioner developed PUs (eight stage I PUs and two stage II PUs)  
  - No patients from the other two groups showed any evidence of PUs  
  - The pressure measurements for the Dupaco Prone View® were lower at all of the time points for both the forehead and the chin in comparison to the OSI and the ROHO (p<0.05)  
  - Forehead pressures were significantly less for the ROHO compared with the OSI (p<0.05) | Level of evidence: 1  
  - Quality: low |
<table>
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| Nixon, McElvenny, Mason, Brown, & Bond, 1998 | RCT comparing a standard table mattress to a viscoelastic polymer pad | Individuals undergoing elective major general, gynecological, or vascular surgery in UK (n=446) | Participants received either: - a viscoelastic polymer pad or - standard table mattress | New pressure injuries | The pressure ulcer incidence in the viscoelastic polymer pad group (11%) was significantly lower than in the standard mattress group (20%) (OR = 0.46; 95% CI 0.26 to 0.82; p = 0.010) | Level of evidence: 1  
Quality: High |
| Feuchtinger, de Bie, Dassen, and Halfens (2006) | RCT comparing visco elastic foam overlay to a water-filled mattress in the OR | Participants recruited in operating room (n=175) | Participants received either: - 4 cm thermoactive viscoelastic foam overlay combined with a water-filled warming mattress during surgery, or - a water-filled warming mattress was used | New pressure injuries | non-significant increase in pressure ulcers in the intervention group compared with the control group (17.6% versus 11.1%, p = 0.22) | Level of evidence: 1  
Quality: moderate |
| Russell & Lichtenstien, 2000 | RCT comparing alternating air mattress to gel mattress in operating room | Participants recruited in operating room (n=198) | Participants received either: - alternating pressure air mattress (a multi-segmented pad with more than 2,500 air cells) | pressure ulcer incidence of 7% in the control group and 2% in the intervention group (p=0.17) (Level 2 study). | Level of evidence: 1  
Quality: Low |
## Individuals in the Operating Room: data extraction and appraisals

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</table>
| Aronovitch, Wilber, Slezak, Martin, & Utter, 1999 | RCT comparing alternating air mattress to gel mattress in operating room | Participants recruited in operating room (n=217) | Participants received either:  
• alternating pressure air mattress (a multi-segmented pad with more than 2,500 air cells enclosed in a waterproof cover) during and after surgery, or  
• gel mattress during surgery and a standard mattress after surgery | pressure ulcer incidence of 8.7% in the control group and no pressure ulcers in the intervention group (p < 0.005) | Level of evidence: 1  
Quality: Low |
| Wu, Wang, Lin, Liu, & Chao, 2011 | Quasi experiment investigating prone positioning as a risk for pressure injuries | Participants were recruited in a spinal unit in Taiwan (n=30) | Participants received either:  
• 10cm thick high density foam (HDF)  
• 2cm thick viscoelastic pads (VP) (high specification)  
Each participant had VP on the left side of the chest and iliac crest and HDF padding on the right side | Immediately after surgery 75% of participants had nonblanchable skin redness on iliac and chest pressure points (73% of VP pressure points, 77% of HDF pressure points).  
At 30mins post-operative overall incidence of PU was higher in HDF group, but not difference was not significant (10% versus 5%, OR=0.47, 95% CI 0.11 to 1.99, p>0.05)  
One stage II PU in VP group after 48 hrs  
Interface pressure was significantly lower (p<0.001) with VP pad  
Univariate analysis of risk factors for PU at 30mins | Level of Evidence: 2  
Quality: moderate |
### Individuals in the Operating Room: data extraction and appraisals

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<td>Defloor &amp; De Schuijmer, 2000</td>
<td>Quasi experiment with healthy volunteers to measure interface pressure of different OR support surfaces</td>
<td>Healthy volunteers (n=36) BMI range 18.3 and 42.6 kg/m²</td>
<td>Four intraoperative positions Five operating table mattresses: A: gel mattress B: foam mattress 70-75g/m² C: polyester viscoelastic foam, 6cm thick D: polyester viscoelastic foam, 7cm thick E standard foam, 4cm thick</td>
<td>Interface pressure was higher on standard operating-table mattress than on the other types of mattresses for all positions (p&lt;0.01)</td>
<td>Female gender (OR=0.04, 95% CI 0 to 0.79, p&lt;0.05) BMI &lt; 18 (OR=21.40, 95% CI 4.11 to 111.51, p&lt;0.05) Body weight &lt;50kgs (OR=18.57, 95% CI 4.06 to 85.03, p&lt;0.05)</td>
<td>Indirect evidence: Interface pressure</td>
</tr>
<tr>
<td>Scott, Baker, Kelly, Stoddard, &amp; Leaper, 1999</td>
<td>Observation study exploring interface pressure for four different operating room mattresses</td>
<td>Participants were healthy volunteers (n=25) Participant characteristics: Mean age 35.5 years Mean BMI 25.9</td>
<td>Four foam mattresses: o A: 33-36km/m² foam density, hardness 190-160 Newtons, severe class rating, neoprene cover o B: 52-56kg/m³ foam density, hardness 210-260 Newtons, very severe class rating, nylon/polyurethane cover, convoluted structure o C: 46-50kg/m³ foam density, hardness 110-130 Newtons</td>
<td>Pressure map measuring sacral interface pressure Mean maximum pressure (mmHg) Positioning contributed to interface pressure, with Lloyd Davies position being 9.5% to 14.2% higher interface pressure Mattress A had significantly lower mean interface pressure (p&lt;0.001) In supine position, mattress D had the lowest interface pressure In Lloyd Davies position, mattress A had the lowest mean interface pressure Underweight individuals experienced significantly higher maximum interface pressures, but</td>
<td>Healthy volunteers</td>
<td>Indirect evidence: Interface pressure</td>
</tr>
</tbody>
</table>
## Positioning in the operating room

<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>Furuno et al., 2014</td>
<td>Retrospective case series investigating positioning related complications in patients undergoing surgery with cerebello-pontine angle lesions</td>
<td>Participants were individuals undergoing surgery for cerebello-pontine angle lesions over 7 years in one center in Japan selected by unspecified methods (n=71 participants)</td>
<td>Participants were placed in supine position then trunk rotated to lateral position on 30° to 60° angle toward unaffected side. In some cases (n=note reported) a low resilience foam was used to reduced interface pressure at axilla. In the last 4 cases a viscoelastic foam was used in the axillary region which provided additional support to axilla and low back</td>
<td>Pressure injuries were measured and assessed using the National Pressure Ulcer Advisory panel classification</td>
<td>Overall pressure injury incidence 34/71 (47.9%) 22 (30.98%) developed a Category/Stage I pressure injury and 12 (16.9%) developed Category/Stage II pressure injury Low resilience foam was associated with a 59% reduction in interface pressure at the axilla (116mmHg to 48.2 mmHg) No pressure injuries occurred when the viscoelastic foam was used (4 cases)</td>
<td>Level of evidence: 4 Quality: low</td>
</tr>
</tbody>
</table>

### Furuno et al., 2014

- Participants were individuals undergoing surgery for cerebello-pontine angle lesions over 7 years in one center in Japan selected by unspecified methods (n=71 participants).
- **Inclusion criteria:** Undergoing surgery for cerebello-pontine angle lesions
- **Exclusion criteria:**
  - None identified
  - Repeat surgeries excluded from analysis
- **Participant characteristics:**
  - Mean age 57 years (range 16 to 81)
  - Mean operative duration 608 minutes (range 210 to 1060)
- Participants were placed in supine position then trunk rotated to lateral position on 30° to 60° angle toward unaffected side.
- In some cases (n=note reported) a low resilience foam was used to reduce interface pressure at axilla.
- In the last 4 cases a viscoelastic foam was used in the axillary region which provided additional support to axilla and low back.
- Pressure injuries were measured and assessed using the National Pressure Ulcer Advisory panel classification.
- Interface pressure at axilla region and great trochanter.

### Results

- Overall pressure injury incidence 34/71 (47.9%)
- 22 (30.98%) developed a Category/Stage I pressure injury and 12 (16.9%) developed Category/Stage II pressure injury.
- Low resilience foam was associated with a 59% reduction in interface pressure at the axilla (116mmHg to 48.2 mmHg).
- No pressure injuries occurred when the viscoelastic foam was used (4 cases).

### Author conclusions

Positioning of the head using the sub-occipital approach can put excess loads on the trunk and neck resulting in complications, one of which is pressure injury.
### Individuals in the Operating Room: data extraction and appraisals

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<th>Limitations and comments</th>
<th>Indirect evidence (healthy volunteers)</th>
</tr>
</thead>
</table>
| **Guo et al., 2017** | To identify if curvilinear spine position increase contact area and reduces interface pressure whilst patients are on an operating table | Healthy volunteers recruited in a teaching hospital in China (n=145)  
Inclusion criteria: aged between 18 to 60 years  
Exclusion criteria: Joint dysfunction, Edema |  
- Pressure-sensing pad placed on operating table  
- Participants self-positioned on operating table with sacrum at the center of pressure-sensing pad in the supine and curvilinear supine positions  
- Head of bed elevated to 15° and leg support lowered to 10°  
- Contact areas between body and table  
- Peak pressures at occiput, scapula, sacrum, calf and heel  
- Highest and mean pressure recorded at particular areas of body  
- Angles of bed  
- Patient comfort  
- Data was recorded at 3 minutes after lying on table and again at various times when angles of bed were altered. |  
- No significant difference in occiput or scapula interface pressure in supine position compared to curvilinear spinal positions  
- Median interface pressure was higher in supine position for:  
  - Sacrum: 41.4 mmHg vs 38.90 mmHg, p<0.001  
  - Heel: 48.0 mmHg vs 42.50 mmHg, p<0.001 |  
- Median interface pressure was higher in curvilinear supine position for:  
  - Calf: 24.1 mmHg vs 33.50 mmHg, p<0.001  
- Curvilinear supine position provided a greater median contact area compared to the supine position (2454.84 vs 2764.52, p<0.001)  
- Patient comfort was high in curvilinear supine position (median 3 versus median 4, p<0.001) |  
- All participants were healthy volunteers and not surgical patients with the effects of anesthesia or comorbidities |  

**Heel pressure injuries in the operating room**

<table>
<thead>
<tr>
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<th>Limitations and comments</th>
</tr>
</thead>
</table>
| **Donnelly, Winder, Kernohan, & Stevenson, 2011** | RCT comparing complete offloading to standard care for prevention of heel PUs in post-operative patients | Participants were recruited from a fracture trauma unit in Ireland (n=239, n=227 completed study)  
Inclusion:  
- Aged > 65 years |  
- Participants were randomized to receive either:  
  - Heel elevation achieved using a commercial device (Heelift® Suspension Boot) plus pressure-redistributing  
- Number of new category 1 or greater PUs on heels or other sites assessed daily for signs of tissue discoloration or ulceration (skin)  
- Effectiveness in preventing PU  
- Significantly fewer PUs in any anatomical location in heel elevation group (7% versus 26%, p<0.001)  
- Significantly fewer patients in the heel elevation group developed a |  
- Significantly fewer PUs in any anatomical location in heel elevation group (7% versus 26%, p<0.001)  
- Significantly fewer patients in the heel elevation group developed a |  
- Potential observer bias due to non-blinding; however, all pressure damage was confirmed by a blinded assessor  
- Half of the subjects had support surface upgraded by nursing |  

**Level: 2  
Quality: moderate**
## Individuals in the Operating Room: data extraction and appraisals

<table>
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<th>Limitations and comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malkoun, Huber, &amp; Huber, 2012</td>
<td>Cross-over quasi-experiment investigating interface pressure at the Consecutive subjects were recruited from an outpatient vascular laboratory (n=116)</td>
<td>• Fractured hip in previous 48 hours&lt;br&gt;Exclusion:&lt;br&gt;• Existing heel pressure damage&lt;br&gt;• History of previous PU&lt;br&gt;• Considered unsuitable by research team or no consent&lt;br&gt;Characteristics:&lt;br&gt;• Mean age 80 yrs&lt;br&gt;• Mean Braden score 15&lt;br&gt;• Low prevalence of peripheral vascular disease and diabetes&lt;br&gt;• Approximately 1/3 sample were at moderate to high risk of malnutrition&lt;br&gt;• No differences between groups in types of injury or time taken to get to hospital&lt;br&gt;• Significantly more of the control group waited &gt;72 hours between injury and surgery (p=0.0009)&lt;br&gt;• Significantly more of the heel elevation group had surgery of &gt; 2 hrs duration (p=0.034)</td>
<td>• Pressure redistribution support surfaces included cut foam mattresses, alternating mattresses and mattress overlays selected according to individual needs.</td>
<td>temperature, induration, edema, pain, itching) with all skin damage photographed and confirmed by a blinded skin viability nurse who categorized damage on NPUAP scale&lt;br&gt;Secondary outcomes:&lt;br&gt;• Participant opinion assessed via questionnaire&lt;br&gt;• Concordance with an offloading device</td>
<td>PU on ankles, feet or heels (0 versus 29, p&lt;0.001)&lt;br&gt;• Control group more likely (p=0.001) to suffer pressure damage at all time points.&lt;br&gt;&lt;br&gt;Acceptability and concordance&lt;br&gt;• The heel elevation device was rated:&lt;br&gt;  o comfortable by 59% participants&lt;br&gt;  o interfering with sleep by 32% participants&lt;br&gt;  o adversely affecting movement in bed by 41% participants&lt;br&gt;• Reasons for poor concordance included weight and bulk (36%), heat (31%) and discomfort (24%).&lt;br&gt;&lt;br&gt;Adverse events&lt;br&gt;45 adverse events (no significant association between the groups and adverse events, p=0.691)</td>
<td>staff (protocol violations)&lt;br&gt;• Duration of time spent in bed/days treatment was not reported&lt;br&gt;• Study failed to recruit a priori sample size for clinical significance</td>
</tr>
</tbody>
</table>
Clinical question 3: What are the unique pressure injury treatment strategies for individuals in the operating room?

No specific studies identified

Additional topics

Outcomes for surgery and influence of pressure injuries

<table>
<thead>
<tr>
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</thead>
</table>
| Ireland, Kelly, & Cumming, 2015 | Cross sectional study investigating factors associated with length of stay for patients with hip fracture | All Australian Dept Veterans’ Affairs (DVA) registered hospitalizations for hip fracture from 07/08 to 07/09 (n=2,552) | Action® Overlay VEG mat, Prototype leg elevation device, Viater® Medical, Regular theatre table | Measurements were taken 2 minutes after the device was put into place | Prototype device and Oasis block median pressure 0 mmHg at heels | Level of evidence: 4
Quality: low |

Adverse events following hospitalization for hip fracture:
- 14.4% of participants had a diagnosis of skin ulceration (14.5% for community dwelling and 14% for RAC dwelling)
- Skin ulceration increased acute phase length of stay for hip fracture significantly by mean 5.4 days (95% CI 3.4 to 7.5, p<0.001) for community dwelling patients and by mean 3.2 days (95% CI 1.4 to 5.3, p<0.001) for RAC dwelling patients
- Skin ulceration increased total hospital length of stay for hip fracture significantly by mean 5.6 days

- No multivariate logistic analysis or control for pre-existing comorbidity and age or effects of multiple adverse events
- Relies of database records and linkage of hospital records to DVA databases

Characteristics:
- Classified as being admitted from community dwelling or residential aged care (RAC) facilities (27.7%)
- Comorbidities and complications were comparable between

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- No multivariate logistic analysis or control for pre-existing comorbidity and age or effects of multiple adverse events
- Relies of database records and linkage of hospital records to DVA databases

Characteristics:
- Classified as being admitted from community dwelling or residential aged care (RAC) facilities (27.7%)
- Comorbidities and complications were comparable between
### Individuals in the Operating Room: data extraction and appraisals

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</tr>
</thead>
<tbody>
<tr>
<td><strong>Mariconda et al., 2015</strong></td>
<td>Prospective observational study investigating outcomes for patients following hip fracture</td>
<td>Consecutive patients with fractured hip admitted in a 15-month period (n=568 meeting inclusion criteria)</td>
<td>Surgical correction of fractured hip</td>
<td>Multivariate analysis Considering patient demographics, surgical variables, fracture classification, length of stay, complications and mortality</td>
<td>days (95% CI 4.0 to 7.4, p=not sig) for community dwelling patients and by mean 3.7 days (95% CI 1.7 to 5.9, p&lt;0.001) for RAC dwelling patients</td>
<td>Study conclusions: Acquiring a pressure injury following admission for hip fracture is associated with a significant increase in length of stay</td>
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<tr>
<td></td>
<td></td>
<td>Inclusion criteria:</td>
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<td></td>
<td></td>
<td>• Aged ≥ 50 years</td>
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<td></td>
<td></td>
<td>• Low energy trauma</td>
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<td></td>
<td></td>
<td>Exclusion criteria:</td>
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<tr>
<td></td>
<td></td>
<td>• Pathological fracture</td>
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<td></td>
<td></td>
<td>• Conservative management</td>
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<td></td>
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<td>Participant characteristics:</td>
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<td></td>
<td></td>
<td>• Mean age 78.3 yrs (range 50 to 105)</td>
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<td></td>
<td></td>
<td>• 77.3% sample was female</td>
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<td></td>
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<td>• Mean BMI 25.3 (range 15.2 to 44.4)</td>
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<td></td>
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<td>• 20.8% had dementia</td>
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<td></td>
<td></td>
<td>• Mean MMSE 21.7</td>
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<td></td>
<td></td>
<td>• 70.1% had full mobility prior to fracture (walk unaccompanied without aids)</td>
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<tr>
<td><strong>Mehaffey et al., 2017</strong></td>
<td>Cross sectional study to determine</td>
<td>Participants were a taken from the National Inpatient Survey conducted in 1050</td>
<td>NA</td>
<td>• PU following fracture of the hip was inversely related to the MMSE score (odds ratio (OR) 0.90; 95% CI 0.87 to 0.94, p&lt;0.001) and to surgery performed within 72 hours (OR 0.53, 95% CI 0.30 to 0.93; p=0.028).</td>
<td>• Patients lost to follow up (n=16) were excluded from analysis</td>
<td>Level of evidence: 4</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>• PU following fracture of the hip was directly associated with ASA grade (OR 2.41, 95% CI 1.40 to 4.14, p=0.001)</td>
<td>• Minimal analysis presented for PU</td>
<td>Quality: high</td>
</tr>
</tbody>
</table>

Data Tables: 2019 Guideline Update: Individuals in the Operating Room © EPUAP/NPIAP/PPPIA
### Individuals in the Operating Room: data extraction and appraisals

<table>
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<tr>
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<th>Limitations and comments</th>
<th>Quality</th>
</tr>
</thead>
</table>
| whether the pressure injuries increase mortality in patients undergoing major vascular procedures | hospitals in the US (n=538,808 people, n=16,000 with pressure injury) | | were identified and evaluated | Clinical outcome (pressure injury vs no pressure injury)  
• Death (6.3% vs 2.7%, p<0.001)  
• Length of stay (17±1.04 vs 6.6±0.13, p<0.001)  
• Place of discharge (p<0.001)  
• Wound complication (6.1% vs 4.2%, p<0.001)  
• Infection complications (2.4% vs 1.1%, p<0.001)  
• Cardiovascular complications (4.5% vs 4.1%, p=0.002)  
• Systemic complications (0.8% vs 0.7%, p=ns)  
• GIT complications (0.5% vs 0.8%, p<0.001)  
• Procedural complications (2.9% vs 2.6%, p=0.01)  
• Neurological complications (18.2% vs 8%, p<0.001) | • The database is lacking data on clinical granularity and no details on treatment interventions  
• Data may not be directly translatable to individual centers  
• Unclear whether pressure injury preceded factors or vice versa | high |

### Prevalence studies

| L. Nilsson et al., 2016 | Prevalence survey identifying rate of adverse events including PU in surgical patients | Random sample of 20 to 40 records each month were reviewed in 63 Swedish hospitals covering a 12 month period (n=19,141 reviewed, n=3301 were surgical patients, corresponds to 1.6% national surgical records) | All hospitals had their own review teams consisting of clinicians from different backgrounds who discussed each adverse event | Adverse events were categorized based on type (including PU Category/Stage 2 to 4) Adverse events were categorized by severity based on level and type (temporary or permanent) of harm to patient | Adverse events  
15.4% (n=507) of admissions experienced at least one adverse event  
37.5% (n=247) adverse events were considered non-preventable Pressure ulcer incidence  
• All age groups: 6.1% (n=31)  
• Aged 18 to 64 years: 1.1% (n=2) | • Relied on medical record data  
• No interrater reliability conducted for identifying or categorizing adverse events  
• Did not include having a surgical procedure in the protocol | Level of evidence: 4  
Quality: low |
# Individuals in the Operating Room: data extraction and appraisals

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</tr>
</thead>
</table>
| Bulfone, Marzoli, Wuatrin, Fabbro, & Palese, 2012 | Prevalence study | Operating theatres in a teaching hospital (North Italy) | N/A | • Pressure ulcers were graded as per NPUAP classification  
• Clinical inspection | • Overall Incidence during intraoperative period: 13/102 (12.7%)  
• During general surgery: 4/13 (38.4%)  
During vascular surgery: 2/13 (15.3%) | researchers assumed the random sampling would represent OR patients  
• Unclear how PU was identified and whether PU on admission was included |
| Bry, Buescher, & Sandrik, 2012 | Prevalence study | Urban trauma unit (USA) | N/A | • HAPU was reported by nursing staff to the researchers who then assessed and staged PU  
• Clinical inspection  
• No information about PU staging system reported  
• SDTI 45%  
• Stage II PU 14.6%  
• Stage III PU 20.7%  
• Unstageable PU 19.5% | • Average incidence rate for at least one HAPU in a patient:  
○ Critical care: 5.0 per 1000 patient days  
○ General hospital: 1.1 per 1000 patient days  
○ Facility: 1.5 per 1000 patient days  
• 82 patients with at least 1 HAPUs were identified within study period. | • Single centre data absent of comparison group  
• No direct observation on management strategies  
• Lack of information about HAPUs identified |
<table>
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<th>Level of evidence:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haleem, Heinert, &amp; Parker, 2008</td>
<td>Database review prevalence study</td>
<td>Participants were a consecutive cohort of those admitted to one hip fracture unit in the UK under one clinician. (n=4654) Participant characteristics: • Mean age was 76.6yrs for those without PU and 82.1yrs for those with PU (p&lt;0.001)</td>
<td>N/A</td>
<td>• Data base review • PU was defined as any break in the skin (stages II to IV) on buttocks, heels or sacral region.</td>
<td>• Incidence of PU 3.8% • Participants with PU had a significant longer time from admission to surgery (37.7hrs versus 27.6 hrs, 95% CI 17.36 to 2.84, p&lt;0.0067) No significant difference between duration of anesthesia between those with and without PU (p=0.16)</td>
<td>• Broad definition of PU and method of identification is not reported • All participants received Standardized management</td>
<td>4</td>
</tr>
<tr>
<td>Lumbley, Ali, &amp; Tchokouani, 2014</td>
<td>Retrospective record review study reporting characteristics of individuals developing pressure injury during surgery</td>
<td>Participants were individuals who underwent surgery in a 6 year period at one medical center in US (n=812 pressure injury cases, 222 met inclusion criteria) Inclusion criteria: • Experienced a pressure injury deemed to be related to intraoperative period • Aged &lt; 80 years • Surgery &gt; 2 hours Participant characteristics: 68% male Average age 57.5 years (range 18-80) 68.5% white, 6.8% African American, 20.3% race unknown</td>
<td>NA</td>
<td>• Pressure injury noted in medical record • Also collected demographic, diagnostic and medical data from records</td>
<td>• Mean surgical time was 3hrs 55mins (range 2 to 16), with 94 incidents in the 2-4 hour range and 38 in the 4-6 hour range • Comorbidities were varied including hypertension (n=67), cardiac disease (n=62), diabetes (n=55), respiratory disease (n=49), cancer (n=31), malnutrition (n=23) • Intraoperative position was most often supine (n=189), prone (n=17) and lateral (n=11) • Surgical type was most often abdominal (n=98), non-cardiac thoracic (n=37), orthopedic (n=33), trauma/burn (n=32) • Pressure injury location was most often coccygeal/sacral (n=86), buttocks (n=45), penile (n=16), heels (n=12) and scrotal (n=12) Author conclusions: supine abdominal surgery of 2-4hours duration is most associated with pressure injuries</td>
<td>• Rationale for case length inclusion was that a case &lt; 2 hours is not sufficiently long to lead to a pressure injury • Unclear how pressure injuries were deemed to be related to intraoperative period • Relied on medical record data • No MV analysis or comparator group • Single center study • No pressure injury severity reported • Large amounts of missing data</td>
<td>4</td>
</tr>
</tbody>
</table>

Quality: low
### Additional evidence from systematic reviews to support discussion

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<tr>
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</table>
| Madrid et al., 2016 | Systematic review investigating active body warming systems for decreasing perioperative hypothermia | The systematic review included only one RCT that reported PUs. The included RCT was conducted in a UK operating room (n=338 participants) | Participants received either forced air warming device plus warmed IV fluids. Temperature setting, duration and anatomical location not reported (n=161) or standard care consisting of normal ambient temperature, minimal patient exposure, warmed blankets and warmed IV fluids at clinical discretion (n=163) | Pressure ulcers (not state how these were identified or assessed) | There was a non-significant reduction in risk of PU associated with active body system warming RR 0.54, 95% CI 0.25 to 1.17, p=0.12 | • Study was considered to be at moderate risk of bias. It was randomized and non-blinded  
• Identification and assessment of PUs not reported (i.e. unclear if Category/Stage I included)  
• No meta-analysis in this review                                                                 |

Quality: moderate
Table 1: Level of Evidence for Intervention Studies

<table>
<thead>
<tr>
<th>Level</th>
<th>Experimental Designs</th>
<th>Quasi-experimental design</th>
<th>Observational-analytical designs</th>
<th>Observational-descriptive studies (no control)</th>
<th>Indirect evidence: studies in normal human subjects, human subjects with other types of chronic wounds, laboratory studies using animals, or computational models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td><strong>Experimental Designs</strong></td>
<td><strong>Quasi-experimental design</strong></td>
<td><strong>Observational-analytical designs</strong></td>
<td><strong>Observational-descriptive studies (no control)</strong></td>
<td><strong>Indirect evidence</strong>: studies in normal human subjects, human subjects with other types of chronic wounds, laboratory studies using animals, or computational models</td>
</tr>
<tr>
<td>Level 2</td>
<td>Randomized trial</td>
<td>Prospectively controlled study design</td>
<td>Cohort study with or without control group</td>
<td>Observational study with no control group</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>Quasi-experimental design</td>
<td>Pre-test post-test or historic/retrospective control group study</td>
<td>Case-controlled study</td>
<td>Cross-sectional study</td>
<td></td>
</tr>
<tr>
<td>Level 4</td>
<td>Observational-analytical designs</td>
<td>Observational study with no control group</td>
<td>Case series (n=10+)</td>
<td>Cross-sectional study</td>
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</tr>
<tr>
<td>Level 5</td>
<td>Indirect evidence</td>
<td>Indirect evidence</td>
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</tr>
</tbody>
</table>

Table 2: Levels of evidence for diagnostic studies in the EPUAP-NPUAP-PPPIA guideline update

<table>
<thead>
<tr>
<th>Level</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>Individual high quality (cross sectional) studies according to the quality assessment tools with consistently applied reference standard and blinding among consecutive persons.</td>
</tr>
<tr>
<td>Level 2</td>
<td>Non-consecutive studies or studies without consistently applied reference standards.</td>
</tr>
<tr>
<td>Level 3</td>
<td>Case-control studies or poor or non-independent reference standard.</td>
</tr>
<tr>
<td>Level 4</td>
<td>Mechanism-based reasoning, study of diagnostic yield (no reference standard). Low and moderate quality cross sectional studies.</td>
</tr>
</tbody>
</table>

Table 3: Levels of evidence for prognostic studies in the EPUAP-NPUAP-PPPIA guideline update

<table>
<thead>
<tr>
<th>Level</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>A prospective cohort study.</td>
</tr>
<tr>
<td>Level 2</td>
<td>Analysis of prognostic factors amongst persons in a single arm of a randomized controlled trial.</td>
</tr>
<tr>
<td>Level 3</td>
<td>Case-series or case-control studies, or low quality prognostic cohort study, or retrospective cohort study.</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
# Individuals in the Operating Room: data extraction and appraisals

## CROSS SECTIONAL/SURVEY/PREVALENCE STUDIES/OBSERVATIONAL

<table>
<thead>
<tr>
<th>Endnote ID</th>
<th>Author/year</th>
<th>Focussed question</th>
<th>Sampling method</th>
<th>Representative sample</th>
<th>States number invited</th>
<th>Participants</th>
<th>Clear outcome measures</th>
<th>Valid reliable outcome measurement</th>
<th>Comparable results for multiple sites</th>
<th>Confounders identified and accounted for</th>
<th>Minimal bias</th>
<th>Reliable conclusions</th>
<th>Level of evidence</th>
<th>Quality</th>
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<tbody>
<tr>
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<td>N</td>
<td>Y</td>
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<td>11029</td>
<td>L. Nilsson et al., 2016</td>
<td>Y</td>
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<td>9506</td>
<td>Mariconda et al., 2015</td>
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<td>Y</td>
<td>U</td>
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<td>U</td>
<td>NA</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
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<td>17859</td>
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<td>Y</td>
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<td>Y</td>
<td>Y</td>
<td>4</td>
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## CASE SERIES

<table>
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<tr>
<th>Author/year</th>
<th>Focussed question</th>
<th>Participant characteristics reported</th>
<th>Inclusion criteria defined</th>
<th>Consecutive recruitment</th>
<th>Intervention clearly reported</th>
<th>Outcomes relevant and defined a priori</th>
<th>Valid reliable outcome measurement</th>
<th>Per cent dropout reported and acceptable</th>
<th>Estimates of random variability</th>
<th>Comparable results for multiple sites</th>
<th>Minimal bias</th>
<th>Reliable conclusions</th>
<th>Level of evidence</th>
<th>Quality</th>
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<tr>
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<td>N</td>
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<td>4</td>
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</tbody>
</table>

## PROGNOSTIC STUDIES

Data Tables: 2019 Guideline Update: Individuals in the Operating Room © EPUAP/NPIAP/PPPIA
### Individuals in the Operating Room: data extraction and appraisals

<table>
<thead>
<tr>
<th>Author/year</th>
<th>Adequate description of baseline characteristics</th>
<th>Satisfactory study attrition</th>
<th>Clear outcome measures/prognostic factors</th>
<th>Range of prognostic factors/confounders measured identified</th>
<th>Method of measuring prognostic factor is reported, valid and reliable</th>
<th>Same method of measurement of prognostic factor for all</th>
<th>Continuous variables or appropriate cut offs</th>
<th>Percent participants with complete data acceptable</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 per factor)</th>
<th>Level of evidence</th>
<th>Quality</th>
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<tr>
<td>Hayes et al., 2014</td>
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<td>Kim et al., 2018</td>
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<td>Chen et al., 2013</td>
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<td>Y</td>
<td>U</td>
<td>N</td>
<td>3 (prognostic)</td>
<td>Low</td>
</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, search 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 un-concealed allocation and lack of blinding; full yes: appraised risk of bias on true randomisation, selection of reported result from multiple measurements/analyses
8. 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
9. 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

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### References


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als in the Operating Room: data extraction and appraisals


