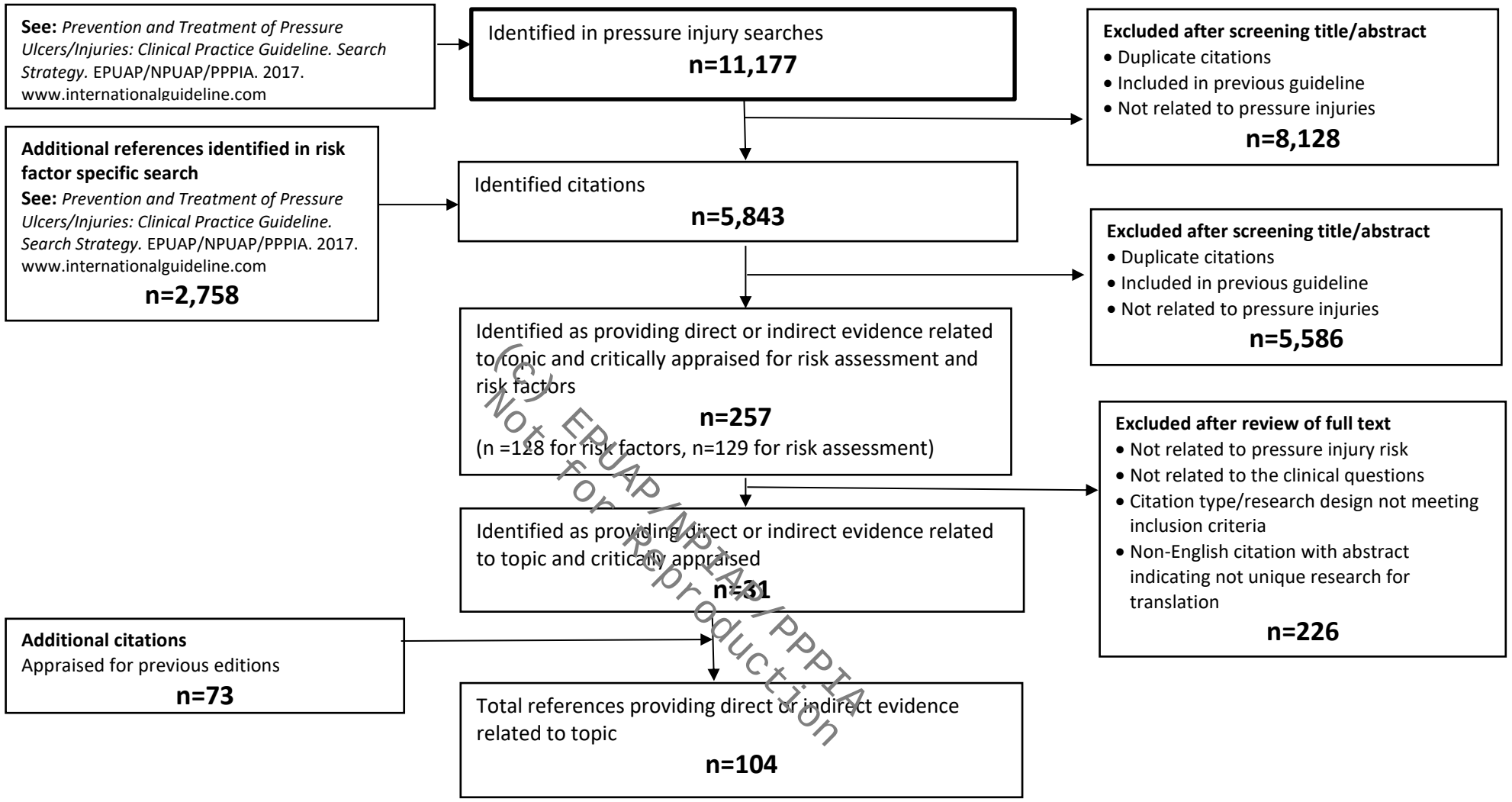
Search results for 2019 International Pressure Injury Guideline: Risk Factors and Assessment



European Pressure Ulcer Advisory Panel, National Pressure Injury Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and Treatment of Pressure Ulcers/Injuries: Clinical Practice Guideline. The International Guideline. Emily Haesler (Ed.). EPUAP/NPIAP/PPPIA; 2019

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.

European Pressure Ulcer Advisory Panel, National Pressure Injury Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and Treatment of Pressure Ulcers/Injuries: Clinical Practice Guideline. The International Guideline. Emily Haesler (Ed.). EPUAP/NPIAP/PPPIA; 2019

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
Risk factors								
Yoshimura, Iizaka, et al., 2015	Retrospective cohort study investigating risk factors for PU in hospital patients undergoing neurosurgery	Participants in a Japanese hospital having neurosurgery (n=277) Inclusion criteria: • Adults undergoing surgery • park bench position • no pressure injury prior to surgery • informed consent. Exclusions criteria: • repeat surgery • missing risk assessment	NA	• Pressure injuries Stage 1 and greater	Risk factors considered in model: • Perspiration present • Surgery length > 6 hours • Core temperature > 38.1C	Pressure injury rate 11% Significant factor on Multivariate logistic regression: • Perspiration present OR 3.09 (95% CI 1.07 to 8.58, p=0.037) • Surgery length > 6 hours OR 8.45 (95% CI 3.04 to 27.46, p<0.001)	• Timing of development of perspiration and PU during surgery is unclear • few risk factors • poor definition of perspiration • data derived cut points	**Level of evidence: 3** **Quality: Moderate**
Gonzalez-Mendez, Lima-Serrano, Martin-Castano, Alonso-Araujo, &	Prospective cohort study **investigating risk factors for PU in patients in ICU**	Participants (n=335) Inclusion criteria: • Adults who were admitted to ICU for > 24 hours	NA	Pressure injuries Stage 1 and greater	Risk factors considered in model: • Severity SAPS 3 (simplifies acute physiology score) • Days of immobilisation • Complications • Age	Pressure injury rate 24.1% Significant factor on Multivariate logistic regression:	• Insufficient number of events. • Unclear risk factor measurement methods	**Level of evidence: 3** **Quality: Low**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
Lima-Rodriguez, 2018		Exclusion criteria: • Pre-existing PU and those admitted to intermediate care			• Gender • Diabetes	• Severity SAPS 3 (simplifies acute physiology score) OR 1.038 (95% CI 1.009 to 1.068, p=0.01) • Days of immobilisation OR 0.423 (95% CI 0.286 to 0.627, p<0.01) • Complications OR 6.484 (95% CI 2.007 to 20.947, p=0.002)		
H. L. Chen, Zhu, Wei, & Zhou, 2018	Retrospective cohort study investigating risk factors for PU in hospital patients	256 (21 missing data) recruited 235 patients with hip fracture at risk on Braden scale exclusion: PU on admission, death	NA	Pressure injuries Stage 1 and greater	• Risk factors considered in model: ○ Season ○ Diabetes ○ Hemoglobin ○ Albumin ○ Length of Surgery ○ Braden Scale score	The only significant factor on Multivariate logistic regression • Braden Scale score)R 1.073 (95% CI 1.025 to 1.14, p=0.015)	• Insufficient number of events. • Unclear risk factor measurement methods	**Level of evidence: 3** **Quality: Very Low**
Lin et al., 2017	Prospective cohort study **investigating risk factors for PU in patients undergoing spinal surgery**	Patients having posterior lumbar and/or thoracic spinal surgery in the prone position on a Jackson table. (n=209) Exclusion: • procedure under sedation or local anaesthesia, • existing PU secondary to neuropathic conditions or neglect	NA	• Pressure injuries Stage 1 and greater	Risk factors considered in model: • Previous skin problems • Myelopathy • Spinal deformity • Operative time >300 mins • Levels of surgery > 4 • Greater body height • Concomitant cancer history • Braden scale<20 • Previous spinal instrumentation and fusion • Increased number	significant factor on Multivariate logistic regression: Previous skin problems (p=0.034) Myelopathy (OR 4.79, p=0.013) Spinal deformity (OR 3.31, p=0.01) Operative time >300 mins (OR 8.12, p=0.005) Levels of surgery > 4 (OR 9.10, p=0.006)	• Unclear if sufficient number of events. • Cut-offs and categorical factors not appropriate and unclear if full sample had complete data	**Level of evidence: 3** **Quality: Very Low**
Apostolopoulou et al., 2014	Prospective cohort study **investigating**	Participants were all admissions to two ICUs in in Greece (n=216)		• PI risk assessed by trained ICU nurses using Jackson/Cubbin	• 64 PIs ≥ Category/stage II in 42 patients • cumulative incidence	• Step-wise logistic regression for factors	• Follow-up period of time is unclear	**Level of evidence: 3**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
	risk factors for PU in ICU patients	Inclusion criteria: • admitted to ICU • ventilated for > 48 hours • actively monitored for PI until discharge or death Exclusion criteria: • none stated Characteristics: • Mean age 66-68 years • 66.7% of patients with PI had only one, 19% experienced two, 9.5% had three and 4.8% had four PIs		Scale within 12 hours of admission • APACHE on admission Co-morbidity using weighted Charlson co-morbidity index	of 29.6% • 14 cases per 1000 ventilated days **Risk factors considered in model:** length of stay of ventilation >20 days, APACHE II at admission, Cubbin/Jackson score, Age, diabetes, malignancy, shock, bloodstream infection, hemodialysis, sedatives, inotropic drugs, corticosteroids **Risk factors significant in univariate analysis** • length of stay of ventilation >20 days (p<0.001) • Age > 70 years (p=0.038) • Diabetes mellitus (p=0.002) • Bloodstream infection (p<0.001) • Hemodialysis (p<0.001) • inotropic drugs (p=0.041)	statistically significant in univariate analysis **Multivariable analysis** • risk of PU is 98.5% greater in patients with Cubbin/Jackson scale score ≤29 (OR 0.015, 95% CI 0.005 to 0.050, p<0.001) • Risk of PU is 622.5% greater in patients with length of stay of ventilation >20 days (OR 7.225, 95% CI 2.461 to 21.207, p<0.001)	• Appears to be missing data (e.g. gender does not add to correct number of participants)	**Quality: Low**
Ham, Schoonhoven, Schuurmans, & Leenen, 2017a	Prospective cohort study **investigating risk factors for PU in an emergency department (trauma)**	Participants were recruited over 12 months (n=254) in one level 1 trauma center in Netherlands Inclusion criteria: • Aged ≥ 18 years	• Backboard removed on arrival before assessment • Immobilized with extrication color and head blocks in supine position until	PU categorized using NPUAP/EPUAP 2009 categories Risk factors collected on admission (n=12): Risk factors: Age, Skin color, Body Mass Index, Time in Emergency	• PU incidence after 72 hours 28.3% (72/254) • PU incidence after 48 hours from admission 13% (33/254) **<u>MV logistic regression Model 2 (PU in 48 hours)</u>**	**<u>MV logistic regression Model 1 (PU in 72 hours)</u>** • Age p=0.0 OR 1.05 95% CI 1.03 to 1.07 • female (reference male) p=0.17 OR 1.74 95% CI 0.79 to 3.88	• Insufficient events for factors in model	**Level of evidence: 3** **Quality: Low**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
		• standard prehospital spinal immobilization • admitted to ED for acute traumatic injuries Exclusion criteria: • Existing skin breakdown • Severe burns (>10%) • Transferred from another hospital Participant characteristics: • Mean age 52 years • Mean BMI 26.6 • 36.6% female • Primarily falls and cycle accidents • 5.1% had medium to very dark skin	radiology excluded spinal injury (unconscious patients were admitted to ICU and immobilized) • Extrication collar replaced with semi-rigid collar	Department, Injury Severity Score (ISS), Mean Arterial Pressure (MAP), hemoglobin (Hb), Glasgow Coma Score (GCS), admission ward after Emergency Department	• Age p=0.01 OR 1.03 95% CI 1.01 to 1.06 • female (reference male) p=0.25 OR 1.71 95% CI 0.69 to 4.21 • skin color (reference dark pigment) p=0.28 OR 0.44 95% CI 0.10 to 1.97 • BMI p=0.93 OR 1.00 95% CI 0.91 to 1.09 • Length time in ED p=0.74 OR 1.00 95% CI 0.91 to 1.08 • ISS p=0.76 OR 1.01 95% CI 0.96 to 1.05 • MAP p=0.13 OR 0.98 95% CI 0.96 to 1.01 • Hb p=0.42 OR 0.87 95% CI 0.61 to 1.23 • GCS p=0.01 OR 1.16 95% CI 1.03 to 1.31 • Position change (reference no change) p=0.33 OR 0.26 95% CI 0.02 to 3.84 • Extra nutrition (reference no extra) p=0.87 OR 1.13 95% CI 0.04 to 0.94 • PR mattress (reference none) p=0.68 OR 0.79 95% CI 0.25 to 4.09	• skin color (reference dark pigment) p=0.64 OR 0.71 95% CI 0.17 to 2.96 • BMI p=0.66 OR 0.98 95% CI 0.91 to 1.06 • Length time in ED p=0.41 OR 1.00 95% CI 1.00 to 1.01 • ISS p=0.03 OR 1.05 95% CI 1.00 to 1.09 • MAP p=0.11 OR 0.98 95% CI 0.96 to 1.00 • Hb p=0.27 OR 0.82 95% CI 0.57 to 1.17 • GCS p=0.00 OR 1.21 95% CI 1.08 to 1.35 • Position change (reference no change) p=0.34 OR 4.50 95% CI 0.21 to 96.53 • Extra nutrition (reference no extra) p=0.04 OR 0.20 95% CI 0.04 to 0.94 • PR mattress (reference none) p=0.68 OR 0.79 95% CI 0.26 to 2.37		
Ranzani, Simpson, Japiassu, & Noritomi, 2016	Prospective cohort study **exploring predictive ability of Braden scale**	Participants were recruited over 6 months in 12 ICUs in 11 hospitals in Brazil (n=9,605) Inclusion criteria:	NA	• MV analysis using Fine-Gray model • Censored after discharge or 30 days in ICU	• 138 people had 157 Category/Stage 1 or greater pressure injuries (1.43%) or 3.33	**Multivariable analysis** (Fine-Gray model) • Age (subdistribution hazard ratio) sHR 1.20,	• Data base collection of pressure injury and general diagnostic/dem	**Level of evidence: 3** **Quality: Low**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
	and proposing additional predictive items	First admission only Exclusion criteria: Subsequent admissions Pressure injury on or within 48 hours of admission		• Pressure injury determined by trained nurses • Uncertain how many risk factors collected	incidents/1,000 patient-days in ICU • 27.5% Category/Stage 1, 68% Category/Stage II.2.2% Category/Stage III, 0.7% Category/Stage IV and 1.4% unclassified or SDTI • 61% coccyx/sacrum, 10.1% buttocks, 7.2% heels	95% CI 1.03 to1.39, p=0.022 • Sex sHR 1.45 95% CI 1.02 to 2.06, p=0.0039 • Diabetes sHR 1.48, 95% CI 1.03-2.11, p=0.033 • Hematological malignancy sHR 2.63, 95% CI 1.24 to5.60,p=0.012 • Peripheral artery disease sHR 3.21, 95% CI 1.02 to10.04, p=0.046 • Braden score ≤ 13 sHR 3.89, 95% CI 2.46 to 6.13, p<0.001 • MAP <60mmHg on admission sHR 1.50, 95% CI 0.94 to 2.40, p=0.089 • Mechanical ventilation during first 24 hours sHR 2.14, 95% CI 1.37 to 3.34, p=0.001 • Renal replacement therapy 2.16, 95% CI 1.48 to 3.15, p<0.001	ographic information • Low incidence of pressure injuries	
Joseph & Nilsson Wikmar, 2016a	Prospective cohort study **investigating risk factors in trauma patients**	Participants were recruited over 12 months in specialized acute care units in South Africa (n=145 included, 141 analyzed) Inclusion criteria: • Aged over 18 years • Admitted to a government funded hospital	N/A	• Medical complications including pressure injuries screened weekly by medical team • MV regression analysis	29.8% (n=42) developed pressure injury Univariate analysis risk factors (n=15): gender, age, etiology of trauma, gunshot injury, tetra/paraplegia, completeness of injury, associated injuries, pulmonary condition, UTI, spinal surgery, neuropathic pain, level consciousness,	**MV logistic analysis** • Motor complete injury (AIS A/B) OR 3.51 95% CI 1.22 to 10.04, p=0.019 • Vertebral injury OR 4.41, 95% CI 1.10 to 17.58, p=0.036 • UTI OR 2.86, 95% CI 0.90 to 9.09, p=0.075	• Only conducted weekly check for PU presence and method of assessment not reported	**Level of evidence: 3** **Quality: low**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
		• Survival ≥ 7 days Exclusion criteria: ASIA Impairment Scale E at 7 days post injury Participant characteristics: • 85.5% males • Mean age at injury 33.5 (SD13.8) • 51.7% required spinal surgery • Mean time to surgery 9.93 hrs (SD 9.5)			education, pre-injury employment, ethnicity Goodness of fit p=0.83, accuracy diagnostic of model 81.6%			
Nassaji, Askari, & Ghorbani, 2014	Prospective cohort study **investigating risk factors for PU in ICU male patients**	Participants were recruited over 9 months in one 20 bed ICU in Iran (n=2046 admissions, n=352 met inclusion, n=160 smokers) Inclusion: • Admitted to ICU in study period Exclusion: • Female • No skin assessment within 24 hours of admission Characteristics: • Length of stay was a mean 10-11 days (smokers longer, p=0.009)	PU screening on admission and then assessed daily by researchers Routine PU prevention strategies	Presence of PU If PU present grading (using EPUAP scale) • • site of PU • time to PU development • smoking status	**HAPU incidence** 25.6% (n=90) PUs Significantly more of smokers experienced a PU than non-smokers (38.8% versus 14.6%, p<0.001) **Category/stage** • Stage I: 53.2% of smoker PUs, 85.7% non-smoker PU • Stage II: 37.1% of smoker PUs, 14.3% non-smoker PU • Stage III: 9.7% of smoker PUs, 0% non-smoker PU • Stage IV: none Patients with PU were more likely to have: • Older age (p=0.001)	**Logistic regression** • Age OR 1.05 (95% CI 1.03 to 1.07, p<0.001) • Length of ICU stay OR 1.19 (1.13 to 1.25, p<0.001) • Fecal incontinence OR 3.42 (95% CI 1.45 to 8.06, p=0.005) • Diabetes mellitus OR 5.58 (95% CI 1.83 to 18.70, p=0.003) • Anemia OR 2.68 (95% CI 1.22 to 5.91, p=0.014) • Smoking OR 1.03 (95% CI 1.01 to 1.06, p=0.003) • Trauma OR 15.95 (95% CI 3.73 to 68.65, p<0.001)	• One of the aims was comparing risk factors in smokers versus non-smokers – due to low rate of female smoking, women were excluded • Cut off points and definitions for different risk factors not reported	**Level of evidence: 3** **Quality: Very low**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
		• Mean age 48-55 years (smokers older, p<0.001) • Diabetes mellitus 10-24% (more DM in smokers p=0.015) • Fecal incontinence 38-64% (higher in smokers, p<0.001)			• higher BMI (p=0.029) • diabetes mellitus (p<0.001) • hypertension (p = 0.006) • anemia (p =0.007) • fecal incontinency (p<0.001) • lower Glasgow Coma Scale score (p<0.001) • trauma (p<0.001) • longer hospitalization (p<0.001)			
Tayyib, Coyer, & Lewis, 2015	Prospective cohort study **investigating risk factors for PU in ICU patients**	Participants were all admissions to two ICUs in in tertiary hospitals in Saudi Arabia in a 30-day study period (n=90 admissions, n=84 included in study) Inclusion criteria: • admitted to ICU in study time frame and consenting Exclusion criteria: • Pre-existing PU Characteristics: • Mean age 52.8 years (range 18 to 99 years) • 66.6% men • Primarily non-Saudi nationals • 85.7% assessed as being at high risk for	Comprehensive skin assessment performed second daily on every participant by the same researcher	Presence of PU If PU present: • Grading (using NPUAP/EPUAP scale) and site of PU • Ventilation status • Frequency of repositioning • Sequential Organ Failure Assessment (SOFA) score	**HAPU incidence** 39.3% (33/84) 41 PUs recorded in the 33 participants **Sites:** Sacrum 24.3% Heel 29.2% **Category/Stage:** 1 23/41 (56.09%) 2 15/41 (36.5%) 3 3/41 (7.3%) **Incidence of MDRPU** 8.3% (7/84) 20% of all PUs and primarily located on ears **Risk factors considered in model (n=7)** Age, length of stay in ICU, history of cardiovascular disease, infrequent repositioning, emergency	**Binary logistic regression model for all stages of PU** Age OR=1.254 (95% CI 1.054 to1.492, p=0.011) Longer stay in ICU OR=1.831 (95% CI 1.014 to 3.309, p=0.045) Infrequent repositioning OR=250.04 (95% CI 5.230 to 11954.16, p=0.005) **Binary logistic regression model for PU stages 2 to 4** Length of stay in ICU OR=1.23 (95% CI 1.087 to 1.392, p=0.001) Infrequent repositioning OR=2.96 (95% CI 1.23 to 7.153, p=0.015)	High rate of PU noted	**Level of evidence: 3** **Quality: Very low**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
		PU (mean Braden score 10±2.12)			admission, mechanical ventilation status, lower Braden score			
Demarre et al., 2015	Retrospective analysis of a RCT study **investigating factors associated with PU in general hospital**	Participants recruited in 5 hospitals in Belgium (n=610) Inclusion criteria: • Braden score < 17 Exclusion criteria: • Category 2 to 4 PU • DO not resuscitate status • Bodyweight <30kg or >160kg • Not consenting Characteristics: • Median age 80 years • Median Braden score 14.0 (interquartile range 12 to 15) • 27.5% bedbound and 61.3% chair bound • 15% admitted with non-blanchable erythema (PU Category/Stage 1)	• Participants received an alternating low pressure air mattress (two types used and no significant difference between two for PU rate) • Staff received training in differentiating between incontinence associated dermatitis and PU and using Braden scale • Transparent plastic disc used to differentiate non-blanchable and blanchable erythema	Skin assessment performed daily by ward nurse and weekly by research team (interrater reliability κ=0.71 to 0.81) PU classified using NPUAP/EPUAP classification system Follow up period of 14 days	**PU incidence** • 14.6% developed non-blanchable erythema (PU Category/Stage 1) • Cumulative PU incidence 5.7% (n=35) including 3.9% PU category/stage II (n=24) and 1.8% Category/stage 3 to4 (n=11) • Of patients with Category/Stage 1 PU on admission, 13.7% developed Category/Stage 2 to 4 **Sites:** Sacrum 3.4% (n=22) Heels 1.7% (n=9) **Risk factors considered in model:** Age, weight, length, BMI, blood pressure, Braden score (including subscales) body temperature, gender, continence status, catheter, ward type, primary diagnosis, medications, type of mattress, incontinence-associated dermatitis (IAD) present	**Multivariate analysis with PU Category/Stage 2 to 4 as dependent variable** Non-blanchable erythema OR=5.36 (95% CI 2.40 to 11.99, p<0.001) Urogenital diagnosis OR=3.76 (95% CI 1.03 to 13.70, p=0.044) Body temperature OR=1.65 (95% CI 1.02 to 2.66, p=0.041) Catheter insitu OR=2.00 (95% CI 0.92 to 4.37, p=0.081) IAD OR=2.15 (95% CI 0.92 to 4.37, p=0.079) Braden score OR=0.87 (95% CI 0.75 to 1.01, p=0.074) **Multivariate analysis with PU Category/Stage 1 as dependent variable** Internal medicine ward OR=4.16 (95% CI 1.20 to 7.52, p=0.027) IAD OR=2.99 (95% CI 1.20 to 7.52, p=0.019) Non-blanchable erythema on admission OR=3.73 (95% CI 1.53 to 9.11, p=0.004) Braden score OR=0.79 (95% CI 0.67 to 0.94, p=0.009)	Low event rate (only 11 PU Category/Stage 3 to 4 PU)	**Level of evidence: 3** **Quality: Low**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
Matozinhos, Velasquez-Melendez, Tiensoli, Moreira, & Gomes, 2017	Prospective cohort study **investigating risk factors for PU in hospitalized patients**	Participants were a convenience sample of patients in hospital in a 6 month period in Brazil (n=442) Inclusion criteria: • admitted to ICU • ventilated for > 48 hours • actively monitored for PI until discharge or death Exclusion criteria: • none stated Characteristics: • 62.2% individuals aged 18 to 60 years • 55% female • 51.2% half had brown/dark skin • 51.7% half non-smokers • 60% had no PU risk on Braden scale • 49% normal BMI		• Data collection by trained nurses using standardized questionnaire	**HAPU incidence** 2.42/1,000 people days (95% CI 1.63 to 3.58) Following factors were no statistically significantly related to PU development: • Age being over 60 years • Gender • Skin color • Smoking status • Nutritional status measured (malnourish, eutrophic or overweight defined by BMI ranges) **Statistically significant risk factors:** Braden Scale score (risk increases as Braden score decreases, p<0.01)	**Multivariate regression model** • Only significant factor was Braden Scale score (adjusted hazard risk: high risk Braden Scale score 6.31 (95% CI 2.73 to 14.58, p<0.001) **Non-significant factors in multivariable model** • age over 60 (HR 0.44, 95% CI 0.18 to 1.06, p=not sig value not reported) • Gender (adjusted HR 0.66, 95% CI 0.27 to 1.61, p=not sig value not reported) • Smoker (HR 1.38 (95% CI 0.44 to 4.36, p=not sig value not reported) • Overweight (HR 0.50 (95% 0.08 to 2.99, p=not sig value not reported)	• Not entirely clear whether the risk factor preceded the PU in this study • Unclear how PU was identified or categorized • Sample selection not reported, small sample size	**Level of evidence: 3** **Quality: Very Low**
Dhandapani, Dhandapani, Agarwal, & Mahapatra, 2014	Prospective cohort study investigating **risk factors in individuals admitted with brain injury**	Participants were recruited in a neurosurgery department in India (n=89 met inclusion criteria) Inclusion criteria: • Adults	Standard care including ventilation, antibiotics, gastric ulcer and seizure prophylaxis Ripple bed, hourly turning	• Daily assessment for sacral or trochanter PU • AHCPR criteria used	**PU incidence** • 7% at 2 weeks • 16% at 3 weeks **Univariate analysis** significant factors	**Multivariate analysis** **Significant factors** • Enteral feeding for more than 7 days, OR 5.65 (95% CI 1.6 to 19.9, p=0.03) • Mean hemoglobin change at 2 weeks OR -2.07 (95% CI -3.5 to -0.7, p=0.05)	• Unclear who performed assessment for PU • Only assessed for sacral or trochanter PU • High attrition	**Level of evidence: 3** **Quality: Very Low**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
		• Admitted within 24 hours of a severe traumatic brain injury Exclusion criteria: • Aged > 60 years • Glasgow Coma Scale (GCS) 3 • Significant systemic disorder Characteristics: • 61% aged 18 to 40 years • 92% male • 25% had systemic injuries • 62% had a surgical intervention • 36% had total enteral feeding for more than 7 days • 61% had tracheostomy • 49% had a fever for at least 7 days			GCS, p=0.05 Enteral feeding for more than 7 days (p=0.005) Mean hemoglobin change at 2 weeks (p<0.005) Non-significant factors Age (p=0.14), gender (p=0.29), surgery (p=0.54), fever (p=0.12), mean albumin change at 2 weeks (p=0.34)	**Non-significant factors** • GCS, OR 3.22 (95% CI 1.00 to 10.31 p=0.67) • Age, OR 5.26 (95% CI -1.7 to 12.3 p=0.33), • Surgery, OR 1.14 (95% CI 0.35 to 3.7, p=0.92), • Mean albumin change at 2 weeks, OR -0.16 (95% CI -0.5 to 0.2, p=0.42)		
Cox & Roche, 2015	Retrospective cohort study **exploring association between vasopressor use and development of PU in UCU patients**	Participants were in two medical-surgical and cardiothoracic ICUs in the US (n=306) Inclusion criteria: • Aged ≥18 years • ICU admission ≥ 24 hours	• All participants received a low-air-loss mattress	• PU incidence determined through retrospective record review	**PU incidence** • PU incidence rate 13% (n=41) • Of PUs, 39% were suspected DTI, 37% Category/Stage II, 12% Category/Stage I and 12% Unstageable.	**Significant variables in logistic regression analysis** • Cardiac arrest:; odds ratio [OR] 3.894, 95% CI 0.998 to 15.118, p=0.05 • mechanical ventilation longer than 72 hours: OR 23.604, 95% CI 6.427 to 86.668, p<0.001	• Statistical power for multivariate analysis was achieved • Only considers PUs that developed in participants who took vasopressors so	**Level of evidence: 3** **Quality: Low**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
		• Received a vasopressor in ICU Exclusion criteria: • Aged under 18 years • ICU admission < 24 hours • Did not receive a vasopressor • Pre-existing PU Participant characteristics: Mean age 71 years (SD 13.8) 57% male 78% white skinned Mean ICU length of stay 6.7 days (SD 7.0) 59% admitted for cardiac conditions, 15^ admitted for sepsis or infection			• 56% sacral, 34% buttocks, 5% heel, 5% other	• hours of MAP <60mmHg while receiving vasopressors: OR 1.096, 95% CI 1.020 to 1.178, p=0.01 • administration of vasopressin OR 4.816, 95% CI 1.666 to 13.925, p=0.004 • Cardiac diagnosis at time of ICU admission:, OR 0.035, 95% CI 0.002 to 0.764, p=0.03	it is unknown how this compares to patients who did not take vasopressin • Unclear how PUs were identified and by whom • Relied on records – length of follow up is not clear	
Van Der Wielen, Post, Lay, Glasche, & Scheel-Sailer, 2016	Prospective cohort study investigating factors associated with development of hospital-acquired PU	Participants were observed in an acute and rehabilitation spinal center in Switzerland for 6 months (n=185) Inclusion criteria: • Admitted in the 6 months observation period • Aged ≤ 18 years • AIS grade A-D Exclusion criteria: • None	All participants received best practice for PU prevention based on risk assessment	• Participants were examined every 12 hours during admission and HAPU graded according to EPUAP classification	**Incidence rate HAPU** • 29.7% developed a HAPU • Of PUs, 30.9% were grade 1. 58.2% grade 2, 10.9% grade 3 **Factors associated with having a PU** • Time since SCI injury, with HAPU being more common in individuals with injury within preceding 12 months or with injury > 26 years ago (p=0.002)	**Regression analysis for time until occurrence of first HAPU** • Time since first lesion odds ratio (OR) 1.04, 95% CI 1.01 to 1.06, p=0.005 • Readmission for PU as the reason for admission OR 2.03, 95% CI 0.91 to 4.54, p=0.085 • Readmission for other reasons OR 2.29, 95% CI 0.78 to 6.72, p=0.132	• Does not describe who performed skin assessments • Does not report wound management strategies • Small patient group without reporting comorbidities • >30% PUs unhealed on discharge so no	**Level of evidence: 1** **Quality: Moderate**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
		Participant characteristics: • 73% male • 25% aged < 35 years and 11% aged > 66 years			• Reason for admission, with first rehabilitation being most common reason for admission in individuals with HAPU (51.5%), followed by orthopedic surgery (41.4% p=0.006) • Length of stay (p<0.001)		data on complete healing	
Sternal, Wilczynski, & Szewieczek, 2017	Retrospective cohort study exploring risk factors for PU in palliative care setting	Consecutive participant records over one year from one palliative care ward in Poland were reviewed (n=329 participants) Inclusion criteria: • Inpatient in a participating facility Exclusion criteria: Not stated Participant characteristics: • Mean age 70.4±11.8 years • 55.3% female • 95% had cancer	• Comprehensive PU prevention scale was in place that included regular daily assessment, best practice with respect to support surfaces, positioning, skin care, hydration and nutrition	• Patients were evaluated daily during admission • Waterlow scale within 2 hours of admission and then daily • Risk assigned based on Waterlow score ≥10 for risk, ≥15 high risk and ≥20 very high risk • For analysis, patients were analyzed as no PU developed (group A), admitted with PU (group B) and hospital acquired PU (group C)	**Prevalence** • 62.3% had no PU • 25.5% admitted with a PU • 11.8% HAPU	**Multivariable logistic regression** **Factors assessed at admission:** • Waterlow score at admission (odds ratio [OR] 1.140, 95% CI 1.057 to 1.229, p=0.001) • admitted from another hospital (OR 2.938, 95% CI 1.339 to 6.448, p=0.007) • hemoglobin level at admission (OR 0.814, 95% CI 0.693 to 0.956, p=0.012) • systolic blood pressure at admission (OR 0.976, 95% CI 0.955 to 0.997, p=0.023) **Factors assessed during hospitalization:** • mean Waterlow score (OR 1.194, 95% CI 1.092 to 1.306, p=0.001) • mean systolic blood pressure (OR 0.956, 95% CI 0.929 to 0.984, p=0.003)	• Relied on retrospectively collected data • Specific to terminally ill individuals • Method of assessment and by whom conducted and any interrater reliability not reported • Unclear if risk factor preceded PU for factors assessed during admission	**Level of evidence: 3** **Quality: Very Low**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
						• mean evening body temperature (OR 3.830, 95% CI 1.729 to 8.486, p=0.001) • lowest recorded hemoglobin level (OR 0.803, 95% CI 0.672 to 0.960, p=0.016) • lowest recorded sodium concentration (OR 0.880, 95% CI 0.814 to 0.951, p=0.001)		
Yoshimura, Nakagami, et al., 2015 (With Nakagami)	Observational cohort study exploring **the influence of microclimate on development of PU in operating room**	Participants were recruited in a Japanese general hospital (n=35 eligible, n=33 enrolled, n=29 complete data for analysis) Inclusion criteria: • Undergoing surgery in park bench position • Free from PU before surgery Exclusion criteria: • Repeated surgery, skin disorders or scars in the area observed • Anhidrosis or autonomic nerve abnormality Participant characteristics:	• Monitoring probes attached to patient during surgical procedure to measure microclimate • Patient positioned on a support surface of urethane foam mattress, gel pad and bean bag • Active warming applied to patient	• Erythema assessed by a researcher and confirmed by a nurse in operating room • Patients followed for 7 days following surgery for any new PU in the lateral thorax region • Microclimate observations (skin temperature and perspiration) conducted every 30 mins during surgery then for 30 mins post-surgery • Interface pressure distribution measured every 30 mins with a pressure mapping device	PU rate was 24.1% (all Category 1) **Factors associated with developing park-bench position PU** *(univariate analysis)* • Significantly more likely to be male (85.3% versus 32%, p=0.01) • More likely to have higher hemoglobin (14.6±1.16g/dl vs 13.0±1.48 g/dl, p=0.02) • Longer surgery (7.6±1.1 vs 6.7±0.9, p=0.04) • Significantly lower baseline skin temperature 34.9±0.5°C vs. 35.3±0.4°C, p=0.03) • Greater change in skin temperature over surgery duration (2.7±0.3°C vs. • 1.9±0.8°C, p=0.02)	**Multivariate hierarchical logistic regression** • Change in skin temperature (0.1°C): odd ratio (OR) 1.44, 95% CI 1.09 to 2.33 • Average peak pressure (mmHg): OR 1.41, 95% CI 0.96 to2.54 • Length of surgery (hour): OR 1.57, 95% CI 0.46 to 5.95 **Author conclusions: Elevated skin temperatures are an independent risk factor for PU. As temperature increases, local tissue metabolism accelerates and there is reduced oxygen and nutrients where pressure is being applied to the skin leading to PU.**	• Small sample • Only one position for surgery and long surgery duration • Non-blinding of outcome measurement	**Level of evidence: 3** **Quality: Low**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
		• Mean age approx. 44.4±13.2 years • 44.8% male • 100% had ASA category 1 or 2 • Most patients were undergoing cerebellopontine angle tumor removal • Mean surgery length 6.9±1.0 hours			• Higher mean baseline, end and average peak interface pressure (119.1±36.8 mmHg • vs. 94.5±23.1 mmHg, p=0.04) • Non-significant factors were presence of perspiration and amount of perspiration			
Smith et al., 2017	Prospective cohort study **exploring pain as predictor of PUs Category/Stage 2 or greater**	Participants were recruited in 26 hospital and community based centres in UK over two years (n=634, n=602 completed [7863 potential skin sites]) Inclusion criteria: • Aged ≥18 years • Able to report if they have pain • At high risk of PU (based on Braden scale, existing Category/Stage 1 PU, experiencing localized skin pain) • Acutely ill Exclusion criteria: • Obstetrics patients, • Aged <18 years • Two or more existing Category/Stage 2 PUs or greater on sacrum, buttocks, heels or hips	N/A	• Development of a Category/Stage 2 PU or greater • Time to PU development • Baseline and twice weekly skin assessment • Follow up for maximum of 30 days or until not classified of having high risk of PU • Univariate logistic regression for: age (as both categorical and continuous variable), presence of pain, weight loss, Braden score on mobility subscale, presence of skin alterations, presence of Category/Stage 1 PU, clinical setting (hospital vs community) for	**Patient outcomes** • 25.2% developed at least one PU • 77.1% had a PU related to pain • Pain was more frequently reported with more severe skin status rating • From evaluable skin sites (n=7483), 3% developed a Category/Stage ≥2 PU • Proportion of skin sites developing a Category/Stage ≥2 PU increased with severity of baseline skin status • 14.4% of skin sites had PU pain at baseline, 10.3% of these developed a Category/Stage ≥2 PU **Time to PU development** • People with baseline Category 1 PU had development of a	**Multivariable (MV) logistic regression** • Presence of category 1 PU (OR 3.25, 95% CI 2.17 to 4.86, p<0.0001) • alterations to intact skin (OR 1.98, 95% CI 1.30 to 3.00, p=0.0014) • pressure area related pain (OR 1.56, 95% CI 0.93 to 2.63 p=0.0931)	• Blinded end point not possible, but assessments performed by independent clinical staff • Low loss to follow-up	**Level of evidence: 1** **Quality: High**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
		Participant characteristics: • Hospital based care (m=397) and community based (n=205) • Mean age 77 years • 37% had no PU on entry • 91% using analgesia on entry		• Overdispersion model included gender, BMI, Braden scale domains, presence of Category/Stage ≥2 PU, chronic wound, type of mattress	Category/Stage ≥2 PU 2.32 times faster com- • pared to those without baseline Category 1 PU (95% CI 1.73 to 3.12) • People with baseline PU pain had development of a Category/Stage ≥2 PU 2.28 times faster com- • pared to those without baseline PU pain (95% CI 1.59 to 3.27) **Author conclusion: Pain increases risk of PU at that clinical site, and pain decreases the time until PU development**			
Brienza, Krishnan, Karg, Sowa, & Allegretti, 2017	Identify characteristics of newly injured SCI persons associated with PU that developed during acute-care & inpatient rehabilitation	Retrospective analysis of prospective cohort study with recruitment of participants (n=104) within 24-72 hours of hospital admission to specialized SCI unit. Participants later were transferred to SCI rehab unit. Study conducted in USA. Inclusion criteria: • new SCI patients who received acute medial & surgical treatment or admitted to inpatient rehab • ≥18 year	Routine acute traumatic SCI care	Outcome: first pressure ulcer PU measured by research nurse every 3 days in acute care and weekly in rehab Risk factors analyzed univariately: • ASIA p<0.01 • Mechanical ventilation p=0.01 • Pneumonia p=0.01 • Age p=0.22 • Gender p=0.79 • UTI p=0.09 • Steroid p=0.78 • Diabetes p=0.43	• Incidence was 27% (n=28) • 37.5% (39/104) developed pressure ulcer during acute care or rehab	Multivariate logistic regression Predictors: • ASIA (ASIA A-ASIA B) p=0.05 OR 4.5 (CI 1-20.65) • ASIA A–ASIA C p=0.01 OR 4.6 (CI 1.3-16.63) • Nonsignificant factors: • Age p=0.76 OR.99 (CI 0.96-1.02) • Gender p=0.6 O0.82 (CI 0.26-2.55) • Urinary tract infection p=0.09 OR0.45 (CI 0.17-1.14) • Steroids p=0.32 OR 0.61 (CI 0.23-1.63)	Limitations: • small sample • failure to address PU prevention. •	**Level of evidence: 3** **Quality: Low**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
		Exclusion criteria: • preexisting disease that affected inflammatory response to SC; • prior SCI or neurological disease that affected motor or sensory function • diabetics were excluded but included after the first year.				• Mechanical ventilation p=0.25 OR0.51 (CI0.16-1.60 **Author concluded: High-injury severity increase pressure ulcer risk in SCI patients. Pneumonia is associated with new PU formation.**		
Borghardt, Prado, Bicudo, Castro, & Bringuente, 2016	Identify the incidence of PU, describe the factors associated with its development	Participants recruited in ICUs in a university hospital in Brazil (n=77) Inclusion criteria: • Adults > 18 years, • free of PU on admission Exclusion criteria: • Patients without metabolic profile lab tests Participant characteristics: • Primarily surgical patients since emergency department closed • Length of stay 5 – 110 days (Mean: 31.5 days)	N/A	Researcher collected the data from admission to discharge or patient's death. NPUAP staging system used for assessment and classification of PUs Sociodemographic/clinical variables: age, length of stay, body mass index (BMI), history of diabetes mellitus, smoking and congestive heart failure Metabolic data: hemoglobin, hematocrit, lymphocyte cell count, albumin, transferrin Factors related to PUs: number, location, categories, Waterloo and Braden scores .	**Rate of pressure injures** Total: 17 of 77 patients or 22% incidence (95% CI 12.6 to 31.5) Univariate analysis: Incidence of PUs: Divided the number of new PU cases in the units evaluated by the number of patients who were hospitalized in intensive care units during the study period. Bivariate analysis: Conducted to identify significant variables with p<0.20. The significant results were submitted to logistic regression analysis with p<0.05 **Author conclusions: Author asserts that all factors**	MV analysis significant factors: • Risk level Waterlow scale (p=0.397) • Risk level on Braden (p=0.003)	• small sample size • Authors state that pressure injuries are "due to frictional forces [pressure, friction, and shearing]" although pressure is a force discrete from friction and shear. No mention deformation as a component. • No control group • No power analysis • Flowchart of participation seems to have	**Level of evidence: 1** **Quality: Moderate**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
					included in the model have been shown previously to be important risk factors for PU formation.		a typo, " 77 were excluded" (vs. included) in the study	
Bly, Schallom, Sona, & Klinkenberg, 2016	Retrospective record review to identify risk factors for pressure injuries in critically ill adults	Record review of all patients listed on monthly prevalence records over a10 month period in two ICUs in a US hospital (n=435 admissions, 345 included) Inclusion criteria: Admitted to the ICU in the study period Included repeat admissions in the same period (analyzed first admissions separately) Exclusion criteria: None Pressure injuries present on admission not included in analysis Participant characteristics: 55% males 73% Caucasian, 26% African American Mean age 60.5 (SD 15.8) years	N/A	• 41 variables collected • Included 19 variables as risk factors ○ Oxygenation variables (n=9) ○ Perfusion variables (n=4) ○ Comorbidity variables (n=6)	**Pressure injury incidence** ICU-acquired pressure injury incidence 109 patients (31%) Mean days to pressure injury was 9.3 (SD 7.2)	**Logistic regression of all significant factors for first admissions (n=306)** • Any transport off unit OR 2.79 (95% CI 1.08 to 7.25, p<0.05) • Number of days to bed change OR 2.89, 95% CI 1.26 to6.63, p<0.05) • Systolic blood pressure <90mmHg OR 5.12, 95% CI 1.41 to 18.65, p<0.05 • Use of > 1 vasopressor OR 3.71, 95% CI 1.42 to 9.69 p<0.05 • History of pulmonary disease OR 2.37, 95% CI 1.07 to 5.24, p<0.05 **Logistic regression of 20 significant factors in bivariate analysis for all admissions (n=397)** • Any transport off unit OR 2.28 (95% CI 1.11 to 4.70, p<0.05) • Number of days to bed change OR 1.93, 95% CI 10.99 to 3.75) • Systolic blood pressure <90mmHg OR 3.50, 95% CI 1.24 to 9.91	• Study attrition unclear • Inadequate samples for number of factors	**Level of evidence: 3** **Quality: Very Low**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
		Mean length of stay in ICU 11 days (SD 11.1) 17% had a pressure injury on admission to hospital and 25% on admission to ICU (not included in analysis)				• Use of > 1 vasopressor OR 3.71, 95% CI 1.42 to 9.69 • Feeding tube OR 5.68, 95% CI 1.19 to 27.11		
Chiari et al., 2017	Evaluate the incidence of PU in older adults with fragile proximal hip fracture from hospital admission to discharge and to evaluate predictors of PU, categorized as medical, nursing and rehab care, and organizational	Consecutive patients presented with fragility hip in 3 Italians hospitals were recruited (1130 met inclusion, 1083 agreed to enroll) Inclusion: • >65 years • Diagnosis fragility hip fracture Exclusion: • Periprosthetic or pathological fractures • presence of a PU Characteristics: • Length of stay : mean 10.9 days • Deaths during study N=16 (1.48%) • Time from fracture to arrivl at ER: mean 23 hours		Pressure injuries measured daily with inspection of skin using NPUAP criteria All data collected until discharge or PU developed	Incidence any pressure injuries: 22.7%; Incidence category/Stage II pressure injuries 11.4% **Univariate analysis** • Average percent of days ≥4 with pain (more in +PU) p<0.005 • Average hours from fracture to ER (more in PU-) p=0.027 • Hospitalized in orthogeriatrics (more in PU-) p=0.018 • Transfer to another hospital before our ER (more PU+) p=0.013 • Patients without caregiver (more n PU-) p=0.045 • Average days from surgery to start of PT (more in PU+) p=0.035	**Logistic Regression** • Age p=0.015 OR 1.030 (CI 1.006-1.054), • Absence of bed railing p=0.026 OR 1.668 (CI 1.062-2.622) • Daily postop positioning p=0.008 OR 0.897 (CI 0.828-0.971) • Days with urinary catheter p<0.0005 OR 1.013 (CI 1.008-1.018) • Days with partial presence of caregiver p=0.012 OR 0.994 (CI0.990-0.999) • Days with a foam valve p<0.0005 OR 1.025 (CI 1.018-1.032) • Days with pain p=0.008 OR 1.008 OR 1.008 (CI 1.002-1.014) • Wearing diaper p0.061 OR 1.555 (CI 0980-2.467){not significant but improved predictive value of model when other factors held constant **Logistic Regression for without immobilization**	• Failure to use BMI to evaluate patient constitution	**Level of evidence: 3** **Quality: Low**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
						• Age p=0.002 OR 1.068 (CI 1.024-1.114) • Daily post op positioning p<0.001 OR 0.689 (CI 0.598-0.795), • Days wait until start PT p=0.012 OR 1.182 (CI 1.038-1.346, • No anti-decubitus mattress with motor p=0.040 OR 3.715 (CI 1.061-13.007).		
Shaw, Chang, Lee, Kung, & Tung, 2014b	Cohort study exploring the context of immediate and thirty-minute-later incidence of and associated risk factors for pressure injuries	Participants were recruited in a teaching hospital in Taiwan (n=297) Inclusion criteria • 18 years and older • Communicate in Mandarin or Taiwanese • first elective surgical procedure • Surgery ≥ 30 minutes • Spinal or general anesthesia, • No pressure injury or trauma before surgery Exclusion criteria: • Not stated • Participant characteristics not reported under risk factors:	N/A	• Pressure injuries were measured using the NPAUP/EPUAP staging system • Occurrence of pressure injuries were observed immediately and 30 minutes postoperatively • Logistic regression model was used to assess the effects of relevant factors on each type of pressure ulcer after adjustments for covariates.	**Pressure injury incidence** The incidence of immediate and 30-minutes pressure injuries were 9.8% (29/297) and 5.1% (15/297), respectively • Risk factors collected: Gender • Age • Braden score • Intra-operative positioning • Operation time • Type of anesthesia • body temperature • blood pressure • Occurrence of intra-operative shear power and wetness • Use of heart-lung machine • Post-operative blood pressure	**MV analysis** Immediate pressure injuries: • Operation age (OR=1.03,95% CI 1.00-1.08) • type of anesthesia [general anesthesia] (yes vs no, OR=17.06,95%CI: 2.09-49.43), • type of operation position (nonsupine vs supine, OR=32.06, 95% CI: 4.48-48.79), • type of surgery (orthopedic surgery vs general surgery, OR=3.33, 95% CI:1.05-10.61), • admission Braden score (OR=0.95, 95% CI: 0.91-0.99), • number of nursing intervention (OR=0.94, 95% CI:0.90-0.98) 30-minute post-operatively:		**Level of evidence: 3** **Quality: Low**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
		Patients enrolled from medical specialties including cardiovascular, general surgery, chest surgery, orthopedic surgery, neurosurgery, plastic surgery, and urologic surgery			• Number of nursing interventions	• Operation age (OR=1.06,95% CI 1.00-1.12) • type of operation position (nonsupine vs supine, OR=18.16, 95% CI: 1.32-52.63) • type of surgery (orthopedic surgery vs general surgery (OR=9.29, 95% CI: 1.05-28.50; cardiac surgery vs general surgery, OR=22.60, 95% CI:1.2-43.85) • number of nursing interventions (OR=0.95, 95%CI: 0.91-0.99)		
Lin et al., 2017	Retrospective cohort study investigating risk factors for pressure injury in people undergoing posterior lumbar and/or thoracic surgery	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	• 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, antiplatelet use, previous skin problems, Braden	**Pressure injury incidence** 23% (48 Category./Stage I PU and 2 Category/Stage II pressure injuries) **Multivariate analysis (5 factors)** • 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	• Insufficient number of events • Cutoffs and categorical factors not clearly defined Unclear if full sample included in analysis		**Level of evidence: 3 (prognostic)** **Quality: Very Low**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	P value; odds ratio (OR); CI	Limitations and comments	
				scale score, myelopathy, radiculopathy, non-specific numbness, spinal deformity, lumbar prolapse, cervical myelopathy, lumbar spinal stenosis, spondylolisthesis, spinal metastasis, anterior surgical approach, posterior surgical approach, surgery with fusion, ASA grade, height, weight, BMI, operative time, number of screws, levels of surgery				

Risk Assessment

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	Limitations and comments	
Risk scales							
Gunes & Efteli, 2015	Prospective cohort study **investigating validity and reliability of Turkish version of Risk Assessment Pressure Sore**	Prospective enrolment of new admissions to a Turkish university hospital ICU over 12 month period (n=146 screened, n=122 participated) Inclusion criteria: • Aged ≥ 18 years	Assessment with the RAPS scale	RAPS scale: 9 variables (general physical condition, physical activity, mobility, moisture, food intake, fluid intake, sensory perception, body temperature and serum albumin level) rated on a 4 point scale and friction/shear measured on a 3 point scale. Conducted	**Pressure injury incidence** Category/Stage 1 PU n=21 Category/Stage 2 PU n=9 Category/Stage 3 PU n=1 **Validity of RAPS scale for different cutoff scores** • Score ≤ 26: area under curve 0.50, sensitivity 69.3%, specificity 36.4%, positive predictive value (PPV) 37.2%, negative predictive value (NPV) 90.8%	• Single site study • Tool not compared to other tools	**Level of evidence: 1 (prognostic)** **Quality: high**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	Limitations and comments	
	(RAPS) Scale in ICU	• Expected length of stay (LOS) ≥ 7 days • No pressure ulcer (PU) on admission Characteristics: • Mean age 56.5±18.6 yrs • Mean LOS 10.4 ± 5.3 days • Mean length of follow up 18.2 ± 4.9 days • 42.6% sample was male • 48.3% had a primary diagnosis of respiratory failure		at baseline (within 24 hours of admission) by nurses. Skin assessment using NPUAP Pressure Ulcer Classification System Conducted at baseline and weekly thereafter.	• Score ≤ 27: sensitivity 74.2%, specificity 31.8%, positive predictive value (PPV) 38.7%, negative predictive value (NPV) 91.3% • Score ≤ 30: sensitivity 17.4%, specificity 36.4%, positive predictive value (PPV) 29.1%, negative predictive value (NPV) 96.3% • Score ≤ 31: area under curve 0.50, sensitivity 100%, specificity 0%, positive predictive value (PPV) 25%, negative predictive value (NPV) 100% • Best balanced cut off score was ≤ 27 **Reliability** Cronbach's alpha 0.81 Interrater reliability ICC 0.58 to 0.92		
Fulbrook & Anderson, 2016	Psychometric study **exploring interrater reliability of COMHON Index**	Convenience sample in an Australian ICU (n=26 patient participants) Self-selected ICU nurses to conduct assessments (n=5) Participant characteristics: • Mean age 69.1 years (SD 17.2, range 37 to 87) • Primarily male sample (69%) • Primarily post-operative cardiac patients (62%) Rater characteristics: • 4-8 years' experience in ICU	Five nurse raters assisted patients using: • COMHON index – includes 5 items (consciousness level, mobility, haemodynamics, oxygenation, nutrition) • Braden Scale • Norton Scale • Waterlow Score	• Procedures for performing assessments (e.g. gap for each assessor in using each scale) and gap between raters seeing each patient is not reported	**Inter rater reliability** • Braden scale sum score: ICC 0.60, 95% CI 0.50 to 0.80 • COMHON Index sum score: ICC 0.90, 95% CI 0.83 to 0.95 • Norton Scale sum score: ICC 0.77, 95% CI 0.65 to 0.88 • Waterlow sum score: ICC 0.47, 95% CI 0.22 to 0.79 **Correlation between tools** • COMHOM had strong correlation with Braden scale (r=–70, p<0.001) • COMHOM had moderate correlation with Norton scale (r=–0.66, p<0.001) • COMHOM had no correlation with Waterlow score (r=0.10, p=0.25) • Braden scale had strong correlation with Norton scale (r=0.77, p<0.001)	• Power analysis for sample size met • Self-selected raters may have different skills to the general nurse population • Duration between assessments between nurses and scales was unclear – it is possible clinical risk changed in the time frame • ICU nurses may have more experience assessing the components included on the COMHON • No training was provided in using	**Level of evidence: 4 (reliability study)** **Quality: Moderate**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	Limitations and comments	
		• All received training prior to conducting assessments			• Braden scale had poor correlation with Waterlow score (r=–22, p=0.02) • Norton Scale had low correlation with Waterlow score (r=–30, p=0.001) **Author conclusions: COMHON Index has good interrater reliability in the ICU and is consistent with assessments using Braden and Norton scales.**	Waterlow scale as this was the tool already used	
Dijkstra, Kazimier, & Halfens, 2015	Cross sectional study **evaluating the Care Dependent Scale (CDS) as a risk screening tool for people in home or aged care**	Convenience sample of people receiving home care (n=2639), living in residential homes (n=4077) or admitted to a nursing home (n=6917) in the Netherlands (total n=13,633) Participant characteristics: Mean age ranged from 79.8 to 85.2 depending on location Approximately 30% sample male	Patients were assessed using the CDS PU was assessed by staff nurses who documented location, grade and duration. Data was entered as dichotomous yes/no for PU presence	CDS that covers eating/drinking, incontinence, body posture, mobility, day/night pattern, un/dressing, body temperature, hygiene. Avoidance of danger, communication social contact, sense of rules/values, daily activities, learning activities and recreational activities	**PU prevalence** Home care 4.4%, Residential care 3.2%, Nursing homes 8.8% **Comparison between PU group versus no-PU group** • No significant difference in age in home care (79.8 vs. 79.3 yrs, p=0.769), or nursing homes (82.8 vs. 82.4, p= 0.153) • In residential home group, people with Pus were significantly older (85.5 vs. 85.2, p = 0.019) • Women in all locations were more likely to have PU than men **Receiver Operator Curves: Area under curve (AUC)** Residential homes 0.79, AUC nursing homes 0.63, AUC home care 0.70 **Sum score cutoff for CDS identifying PU risk** Home care : CDS sum score of ≤72 (identifying 89% true positives and 35% true negatives for PU) Residential homes: CDS sum score of ≤65 (83% true positives and 54% true negatives for PU) Nursing homes: CDS sum score of ≤58 (90% true positives and 24% true negatives for PU) **Odds ratio**	• It is not clearly documented that the CDS was conducted before clinical assessment for PU, and limitation suggest it may not have been as causality direction is stated as unclear (e.g. PU may have led to restricted mobility vs restricted mobility increasing risk for PU)	**Level of evidence: 4 (prognostic)** **Quality: moderate**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	Limitations and comments	
					All the variables on the CDS had a significant ($p<0.01$) odds ratio (OR for pressure ulcers versus no pressure ulcers in all three locations. e.g. • un/dressing: OR home care 3.0 (95% CI 1.9 to 4.6), OR residential home 11.9 (95% CI 5.5 to 25.5), OR nursing home 4.6 (95% CI 2.9 to 7.2) • body temp: OR home care 3.1 (95% CI 2.1 to 4.6), OR residential home 5.1 (95% CI 3.4 to 7.4), OR nursing home 2.4 (95% CI 1.9 to 3.1) In home care OR ranged 2.1 to 4.0 across variables, in residential care 2.6 to 11.9, in nursing homes 1.3 to 4.6) **Conclusions: AUC values are insufficient to use CDS as a predictive tool**		
Park & Choi, 2016	A prospective cohort study **exploring the performance of the Incontinence-Associated Dermatitis Severity (IADS) instrument in predicting PU in patients with fecal incontinence**	Participants were recruited in 5 ICUs in South Korea (n=131 eligible, n=120 completed and analyzed) Inclusion criteria: • ICU patient aged ≥ 40 years • Fecal incontinence with Bristol stool type 5 -7 (soft to liquid) • No IAD or PU on admission • Braden Scale score ≤ 16 Exclusion criteria: None stated Participant characteristics:	• IADS tool was used to evaluate skin • Bates-Jensen Wound Assessment Tool (BWAT) was use to discriminate PU and IAD	• Assessments conducted by trained wound care nurses (ICC of IADS was 0.96, ACC for BWAT was 0.92) • Participants were assessed daily for 7 days, the highest scores and PU stage during the 7 day period were used in data analysis	**Participant outcomes** • Average IADS score 9.30±7.42 • 33% participants (n=40) developed a PU • Mean BWAT score was 23.3±3.84 **IADS tool** • Higher IADS score was associated with greater likelihood of PU (OR 1.22, p5% CI 1.12 to 1.33, $p<0.001$) • AUROC 0.79 (95% CI 0.701 to 0.869) • Optimal cutoff score was 8/9 (9 has higher probability, sensitivity 72.5%, specificity 71.2%) **Author conclusions: IADS could be used to predict PU development in patients with fecal incontinence**	• Power calculation sample size was 97 • IADS tool is limited in anatomical area so would not be predictive of PU in other regions • Nurses were not blinded to the scores on other tools	**Level of evidence: 1 (prognostic)** **Quality: moderate**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	Limitations and comments	
		• Mean age 67.5 ± 13.1 • 64.5% participants aged over 65 years • 43.3% had Bristol stool type 7 (liquid) • Average frequency of incontinence was , 4 hours • 92.5% also had urinary incontinence • Average Braden scale score 11.9±1.7					
Krishnan et al., 2016	Retrospective study to **determine cut-off point for SCIPUS and to assess risk for PU development at varying time points**	Participants were recruited in a rehabilitation center offering acute care and inpatient rehab care in US (n=104 eligible, n=34 included, n=23 analyzed) Inclusion criteria: • Aged 18 years or older • Receiving acute care Exclusion criteria: • pre-existing diseases affecting inflammatory response to SCI • Previous SCI or other neurological disease • Complete SCIPUS information collected in another study	• SCIPIS (includes 15 items – age, tobacco use, residency, level of activity, mobility, completeness of SCI, incontinence, autonomic dysreflexia, diabetes, comorbidities, impaired cognition, hypoalbuminemia, low hematocrit • PU staging according to NPUAP classification 2007	• SCIPUS was conducted on initial visit • In acute care setting, risk re-assessment for PU development was either 2-3 days after initial SCIPUS and/or 5-7 days after first risk assessment • In rehab setting, risk re-assessment for PU was either 5-7 days after initial SCIPUS and/or 14-21 days after first risk assessment	**Acute hospitalization** **2-3 day skin assessment:** • n=18 individuals, n=2 PUs (11.1%) • mean SCIPUS score individuals with PU 17.5±2.1 • mean SCIPUS score individuals without PU 13±3.6 **5-7 day skin assessment:** • n=23 individuals, n=6 PUs (26%) • mean SCIPUS score individuals with PU 14.6±3.7 • mean SCIPUS score individuals without PU 13.4±3.**5** **In inpatient setting:** SCIPUS cut off score of 15 had sensitivity 100%, specificity 75%, 22.2% positive predictive value, 4% negative predictive value when skin assessment conducted at 2-3 days **Rehabilitation** **5-7 day skin assessment:** • n=18 individuals, n=2 PUs (11.1%) • mean SCIPUS score individuals with PU 9.6±0.5	• Does not state how skin assessment was conducted or by whom • Management strategies were not clear • No categorization or details regarding PUs	**Level of evidence: 4 (prognostic)** **Quality: moderate**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	Limitations and comments	
					• mean SCIPUS score individuals without PU 9.9±2.6 **14-21 day skin assessment:** • n=14 individuals, n=3 PUs (21.4%) • mean SCIPUS score individuals with PU 9.6±0.5 • mean SCIPUS score individuals without PU 10.9±3.**1** **In inpatient setting:** SCIPUS cut off score of 9 had sensitivity 66.7%, specificity 45.5%, 14.3% positive predictive value, 0.7% negative predictive value when skin assessment conducted at 2-3 days **Author conclusions: higher cut-off scores for high risk of PU were calculated compared with the original SCIPUS study and optimal time for reassessment was 2-3 days**		
Xie, Peel, Hirdes, Poss, & Gray, 2016	Cross sectional study **to validate InterRAI Pressure Ulcer Risk Scale (PURS)**	Data was collected from 3 cohort studies conducted over 5 years in 11 hospitals in Australia (n=1418 participants, n=1,371 with complete data) Inclusion criteria: • Admitted to a participating hospital • Exclusions criteria: coronary care or ICU admission • Palliative care • Transferred away from unit within 24 hours	No intervention	• Assessments conducted by trained nurse assessors within 24 hours of admission • PUs categorized according to NPUAP classification system • PU presence assessed on admission and at discharge from acute care • Research nurse visited daily and recorded any adverse events including PU development • PU prevalence at a specific point in time (admission to ward) and	**Prevalence and incidence** • 6.2% had a PU on admission • 3.3% developed a PU during hospitalization **Psychometric qualities of PURS** • Prevalence including Category/Stage 1: AUC 0.81 (standard error 0.02, 95% CI 0.76 to 0.86) • Incidence: c-statistic 0.70 (SE0.04, 95% CI 0.63 to 0.77) • At cut-off value PURS score of 3 sensitivity for prevalence 72.9%, specificity 71.3% • At cut-off value PURS score of 3 sensitivity for incidence 50%, specificity 72%	• Recruitment unclear • Retrospective design • Length of admission unclear • Management strategies unclear • Similarity between different facilities unclear	**Level of evidence: 4 (prognostic)** **Quality: moderate**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	Limitations and comments	
		Participant characteristics: • Mean age 81±6.8 • 55% female • 86% admitted to a medical ward • 19.1% required extensive assistance to move in bed • 25.3% were fecal incontinent • 34.4% had dyspnea on rest • 49% had frequent pain • 6.5% had a previous PU		incidence (new PU developing in PU free population)			
Ranzani, Simpson, Japiassu, & Noritomi, 2016	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) Inclusion criteria: • Admitted to ICU Exclusion criteria: • PU on admission to ICU • PU developed within 48 hours of ICU admission	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 IUCs and 2 hourly repositioning was reinforced	• Daily collection of PU development • ICU nurses conducted skin assessments and classifications • Primary outcome was PU of any stage developing in an ICU between 48 hours and 30 days of ICU admission • The analysis model accounted for competing risk events i.e. events that could occur due to similar risk factors but that even precludes a PU developing (i.e. death, which is more likely to occur in mechanically ventilated patients, as PU is)	**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	• 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**

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	Limitations and comments	
					(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 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 0.0.584 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 **Author conclusions: Braden scale has good predictive ability in critical care, but a lower cut off score for risk is proposed**		

Ref	Type of Study	Sample	Intervention(s)	Outcome Measures & Length of Follow-up	Results	Limitations and comments	
Gadd & Morris, 2014	Retrospective chart review to determine whether pressure injury prevention interventions are implemented when a total Braden Scale score reflects that the patient is at risk	Participants were recruited in community hospitals (n=322) in the USA (n=20 participants) Inclusion criteria: • Admissions (all ages) between April and June 2011	N/A	at risk versus not-at-risk patients on Braden Score	**Consistency of implementing practice** • Significant difference in Braden scores for people receiving interventions the day before a pressure injury developed compared to those not receiving an intervention (13.7±2.8 vs 18.5±2.3, p=0.001) • 20% of pressure injury interventions were not implemented in the patient population deemed at risk • When patients were at no-risk with low subscale scores they were less likely to receive preventative interventions	• Could have expanded review of literature and discussion	**Level of evidence: 5** **Quality: Low**

Table 1: Level of Evidence for Intervention Studies

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

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

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

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

Level 1	A prospective cohort study.
Level 2	Analysis of prognostic factors amongst persons in a single arm of a randomized controlled trial.
Level 3	Case-series or case-control studies, or low quality prognostic cohort study, or retrospective cohort study.

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

RISK FACTOR STUDIES

CRITERIA 1-8	QUALITY DOMAINS 1-4			
	1. Is there sufficient number of events (rule of thumb: more than 10 events per risk factor)?	2. Is there sufficient presentation of data to assess the adequacy of method and analysis?	3. Is the strategy for model building (i.e., inclusion of variables) appropriate and based upon a conceptual framework?	4. Is the selected model adequate for the design?
1.The baseline study sample is adequately described for key characteristics.		X		
2. A clear definition/ description of the risk factor measured is provided and a clear definition/ description of how the risk factor was measured is provided		X	X	X
3. Continuous variables used or appropriate (i.e. not data-dependent) cut-points for continuous data.		X	X	
4.An adequate proportion of sample has complete data for risk factors.		X	X	X
5.Range of potential risk factors are measured			X	X
6.Range of potential risk factors are accounted for in the analysis			X	X
7.Appropriate imputation			X	X
8.No selective reporting		X	X	X
	COLUMN 12	**COLUMN 1, 3, 7, 8, 11**	**COLUMN 3, 4, 7, 8, 9, 10, 11**	**COLUMN 3, 4, 8, 9, 10, 11**

- High quality studies: 'yes' for all quality domains
- Moderate quality studies: 'yes' for quality domain 1 and at for least two other quality domains
- Low quality studies: 'no' for criteria 1 and 'no' or 'partial yes' for two other quality domain
- Very low quality studies: 'no' for criteria 1 and 'no' or 'partial yes' for all three remaining quality domain

	1	2	3	4	5	6	7	8	9	10	11	12					
Author/year	Baseline sample adequately described	Study attrition acceptable (<20% lost to follow-up)	Clear definition of risk factors	Range of risk factors /potential confounders measured	Risk factor measurement method valid and reliable	Method of measurement same for all	Appropriate continuous variables or cut-point	Adequate sample with complete data	Appropriate imputation method	Potential confounders accounted in analysis	No selective reporting	Adequate sample size (rule of thumb >10 events per risk factor)	Is there sufficient presentation of data to assess the adequacy of method and analysis?	Is the strategy for model building (i.e., inclusion of variables) appropriate and based upon a conceptual framework?	Is the selected model adequate for the design?	Level of evidence	Quality
Apostolopoulou et al., 2014	Y	U	Y	Y	Y	Y	N	U	U	Y	Y	N	Y	PY	N	3 (prognosis)	Low
Bly et al., 2016	Y	U	N	Y	Y	Y	Y	U	NA	Y	Y	N	PY	PY	PY	3 (prognosis)	Very low
Borghardt et al., 2016	Y	U	Y	Y	Y	Y	Y	Y	U	Y	U	Y	PY	PY	PY	1 (prognostic)	Moderate
Brienza et al., 2017	Y	U	Y	Y	Y	Y	Y	U	NA	Y	Y	N	PY	PY	PY	3 (prognostic)	Very low
H. L. Chen et al., 2018	Y	Y	Y	Y	N	Y	Y	U	NA	Y	Y	N	PY	PY	PY	3 (prognosis)	Very low
Chiari et al., 2017	Y	Y	Y	Y	U	Y	N	U	NA	Y	U	Y	N	P	P	3 (prognostic)	Low
Cox & Roche, 2015	Y	U	Y	Y	N	Y	Y	U	NA	Y	Y	N	Y	Y	PY	3 (prognosis)	Low
Demarre et al., 2015	Y	Y	Y	Y	Y	Y	Y	U	NA	Y	Y	N	Y	Y	Y	3 (prognosis)	Low
Dhandapani et al., 2014	Y	Y	Y	Y	N	U	N	U	NA	Y	Y	N	PY	PY	PY	3 (prognosis)	Very low
Gonzalez-Mendez et al., 2018	Y	Y	Y	Y	Y	Y	Y	U	NA	Y	Y	N	Y	PY	PY	3 (prognostic)	Low
Ham, Schoonhoven, Schuurmans, & Leenen, 2017b	Y	Y	Y	Y	Y	Y	Y	Y	NA	Y	Y	N	Y	Y	N	3 (prognostic)	Low
Joseph & Nilsson Wikmar, 2016b	Y	Y	Y	Y	Y	Y	Y	Y	NA	Y	Y	N	Y	PY	PY	3 (prognostic)	Low
Lin et al., 2017	Y	U	Y	Y	U	Y	N	U	NA	Y	N	U	N	N	N	3	Very Low

Risk Factors and Risk Assessment: data extraction and appraisals

	1	2	3	4	5	6	7	8	9	10	11	12					
Author/year	Baseline sample adequately described	Study attrition acceptable (<20% lost to follow-up)	Clear definition of risk factors	Range of risk factors /potential confounders measured	Risk factor measurement method valid and reliable	Method of measurement same for all	Appropriate continuous variables or cut-point	Adequate sample with complete data	Appropriate imputation method	Potential confounders accounted in analysis	No selective reporting	Adequate sample size (rule of thumb >10 events per risk factor)	Is there sufficient presentation of data to assess the adequacy of method and analysis?	Is the strategy for model building (i.e., inclusion of variables) appropriate and based upon a conceptual framework?	Is the selected model adequate for the design?	Level of evidence	Quality
																(prognosis)	
Matozinhos et al., 2017	Y	U	Y	N	Y	Y	Y	U	NA	N	Y	N	PY	PY	PY	3 (prognosis)	Very low
Nassaji et al., 2014	Y	U	Y	N	U	Y	Y	U	NA	Y	Y	U	N	N	PY	3 (prognosis)	Very low
Ranzani, Simpson, Japiassu, Noritomi, & Amil Critical Care, 2016	Y	Y	Y	Y	N	Y	N	U	NA	Y	Y	N	Y	PY	PY	3 (prognosis)	Low
Shaw, Chang, Lee, Kung, & Tung, 2014a	Y	Y	Y	Y	Y	Y	Y	Y	NA	Y	Y	N	Y	Y	Y	3 (prognosis)	Low
Smith et al., 2017	Y	Y	Y	Y	Y	Y	Y	Y	NA	Y	Y	Y	Y	Y	Y	1 (prognosis)	High
Sternal et al., 2017	Y	U	Y	Y	N	Y	Y	U	NA	U	N	U	PY	PY	PY	3 (prognosis)	Very Low
Tayyib et al., 2015	Y	Y	Y	Y	PY	Y	N	U	NA	Y	Y	N	PY	PY	N	3 (prognosis)	Very Low
Van Der Wielen et al., 2016	Y	Y	Y	N	Y	Y	N	U	NA	N	Y	Y	Y	PY	PY	1 (prognosis)	Moderate
Yoshimura, Nakagami, et al., 2015	Y	Y	Y	Y	Y	Y	N	Y	NA	N	Y	N	Y	PY	N	3 (prognosis)	Low
Yoshimura, Iizaka, et al., 2015	Y	Y	N	Y	N	Y	N	Y	NA	Y	Y	Y	PY	PY	N	3 (prognosis)	Moderate

CROSS SECTIONAL/SURVEY/PREVALENCE STUDIES/OBSERVATIONAL

Endnote ID	Author/year	Focussed question	Sampling method	Representative sample	States number invited participants	Clear outcome measures	Valid reliable outcome measurement	Comparable results for multiple sites	Confounders identified and accounted for	Minimal bias	Reliable conclusions	Level of evidence	Quality
9626	Dijkstra et al., 2015	Y	Y	Y	Y	U	U	N	Y	N	Y	4 (prognostic)	moderate
12974	Xie et al., 2016	Y	U	U	Y	Y	Y	U	N	N	U	4 (prognostic)	Moderate

COHORT STUDIES

	Author/year	Focussed question	Comparable source	States number invited	Likelihood of outcome at enrolment	Percent drop out in study	Comparison btw drop outs and participants	Clear outcome measures	Assessment blinded, or discuss potential bias	Valid, reliable assessment with supporting reference	More than one measure of exposure	Confounders identified and accounted for	Provides confidence intervals	Minimal bias	Reliable conclusions	Level of evidence	Quality
8087	Gunes & Efteli, 2015	Y	Y	Y	Y	Y	N/A	Y	N/A	Y	Y	N	Y	U	Y	1 (prognostic)	high
10694	Park & Choi, 2016	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	1 (prognostic)	High
13718	Ranzani, Simpson, Japiassu, & Noritomi, 2016	Y	Y	Y	Y	Y	Y	Y	N	U	Y	Y	Y	Y	U	1 (prognostic)	High
12971	Krishnan et al., 2016	Y	Y	Y	Y	NA	NA	Y	N	U	U	N	N	U	U	4 (prognostic)	moderate

DIAGNOSTIC STUDIES

	Author/year	Nature of test is defined	Test compared to a gold standard	Where no gold standard exists, compared with valid reference standard	Clear population from which	Independent measurement of test and	Test and standard measured as close in time as possible	Results for all patients reported	Pre-test diagnosis reported	Minimal bias	Reliable conclusions	Level of evidence	Quality
10784	Fulbrook & Anderson, 2016	Y	Y	N/A	N	Y	U	Y	N/A	N	U	Level 4 (reliability study)	moderate

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 unconcealed 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

Endnote ID	Author/year	PICO research question and inclusion criteria	Explicitly states a-priori protocol[1]	Rationale for selection of study designs	Comprehensive search[2]	Duplicate study selection[3]	Duplicate data extraction[4]	Excluded studies listed[5]	Adequate description of included studies[6]	Risk of bias assessed[7]	Source of funding reported[8]	Appropriate meta-analysis including weighting and adjustment for heterogeneity	Meta-analysis considers risk of bias of studies	Discussion consider risk of bias of studies	Assessment of publication bias if quantitative analysis is done	Potential conflicts of interest of authors reported and managed	Review Inclusion/Exclusion
14491	Alderden, Rondinelli, Pepper, Cummins, & Whitney, 2017				Y			N		N		NA		N	NA		Exclude
	H.L. Chen, Shen, Liu, & Liu, 2017				N			N		N		N		N	NA		Exclude

Endnote ID	Author/year	PICO research question and inclusion criteria	Explicitly states a-priori protocol[1]	Rationale for selection of study designs	Comprehensive search[2]	Duplicate study selection[3]	Duplicate data extraction[4]	Excluded studies listed[5]	Adequate description of included studies[6]	Risk of bias assessed[7]	Source of funding reported[8]	Appropriate meta-analysis including weighting and adjustment for heterogeneity	Meta-analysis considers risk of bias of studies	Discussion consider risk of bias of studies	Assessment of publication bias if quantitative analysis is done	Potential conflicts of interest of authors reported and managed	Review Inclusion/Exclusion
	Kang & Zhai, 2015				N			N		N		Y		N	Y		Exclude
	Lima Serranoa, González Méndez, Carrasco Cebolleroc, & Lima Rodríguez, 2017				Y			N		Y		Y		N	N		Exclude
	Wei, Chen, Zha, & Zhou, 2017				N			N		Y		Y		N	Y		Exclude

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