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THE PREVALENCE OF SKIN PRESSURE INJURY IN CRITICAL CARE PATIENTS IN THE UNITED KINGDOM; RESULTS OF A SINGLE DAY POINT PREVALENCE EVALUATION

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ABSTRACT:

Objectives: Hospital acquired pressure injuries (PIs) are a source of morbidity and mortality, many are potentially preventable. This study prospectively evaluated the prevalence and associated factors of PIs in adult critical care patients admitted to Intensive Care Units (ICU) in the United Kingdom (UK). This service evaluation was part of a larger, international single day point-prevalence study of PIs in adult ICU patients. Training was provided to health care givers using an electronic platform to ensure standardised recognition and staging of PIs across all sites. Characteristics of the ICUs were recorded before the survey; deidentified patients' data were collected using a case report form and uploaded onto a secure online platform. Factors associated with ICU-acquired PIs in the UK were analysed descriptively and using generalised linear mixed-effects regression analysis.

Results**:** Data from 1312 adult patients admitted to 94 UK ICUs were collected. The proportion of individuals with at least one PI was 16% (211/1312 patients) of whom 8.8% (n=115/1312) acquired one or more PIs in the ICU and 7.3% (96/1312) prior to the ICU admission. The total number of PIs was 311, of which 148 (47.6%) were acquired in the ICU. A little over half of patients (n=163; 52.4%) had acquired a PI prior to ICU admission. The location of the majority of these PIs was the sacral area followed by the heels, which was also tended to be the site of the more severe. Braden score and prior length of ICU stay were associated with PI development.

Conclusions**:** The prevalence and the stage of severity of PIs were generally low in adult critically ill patients admitted to participating ICUs during the study period. However, PIs are a problem in an important minority of patients. The sacral area and the heels were most vulnerable in terms of severity and numbers. Lower Braden score and longer lengths of ICU-stay were associated with the development of injuries; most intensive care units that participated assess risk using tools which do not account for this.

KEY WORDS:

Pressure sores, pressure injury, critical care, intensive care, risk factors

The study was registered at ClinicalTrials.gov (NCT03270345).

Strengths and limitations of this study (article summary)

Strengths:

- This is the first study ever completed to evaluate the impact of PIs in the adult population.
- It is a robustly planned and executed study.

Limitations:

- Limitations are mainly due to the low incidence and severity of PIs.
- The inability of linking preventative measures used in patients to the prevalence of PIs.
- The study was conducted in the pre-COVID-19 era and majority of patients were nursed in the supine position.

INTRODUCTION:

In 2014, the UK National Institute for Health and Care Excellence (NICE) published a document for the prevention and management of pressure injuries (PIs) in primary and secondary care in the United Kingdom (UK).[1,2] This document was revised in 2019 and states that "pressure ulcers are serious and distressing adverse events that can represent a failure of care".[3] PIs are generated when an area of skin and / or the underlying tissues are damaged due to being placed under sufficient pressure for a period long enough to impair blood supply or when shearing forces generate friction on the skin during manual handling.[1,2] An international classification categorises the injuries into Stages I to IV, Unstageable, and Suspected Deep Tissue Injury according to the extent of the tissue damage. [3,4]

Pressure ulcers caused by both moisture and shear stress, are directly associated with the quality of care provided as well as patient outcomes.[1-4] NICE guidelines[2] state that PIs consume significant resources, and that these should be preventable in the National Health Service (NHS), which has therefore employed tissue viability nurses (TVN) in the majority of hospitals. TVNs provide expert advice in the prevention and the treatment of wounds including PIs.

Unfortunately, critically ill patients in intensive care units (ICUs) are extremely vulnerable due to the severity of their illness, immobility, sedation, poor tissue perfusion, hypoxia and frequently haemodynamic instability. The current prevalence of PIs in the UK ranges widely with estimates from 4.7% to 32.1% in ward areas, while in the ICUs it is not known. [2,5,6] The aim of this service evaluation was to provide up to date information on PIs within UK adult ICUs. The specific objectives were to offer a picture of (a) the prevalence of pressure injury in adult critically ill patients, specifically in relation to presence of PIs on admission and PIs acquired within ICU; (b) the characteristics of the PIs in terms of severity and anatomical

distribution; and (c) to contribute data to the international DecubICUs study, of which this project formed a part.[1]

METHODS:

Study design and participants

This service evaluation was conducted using a single day (midnight to midnight) point prevalence survey in all adult ICU patients. The study protocol was reviewed by the Joint Research Compliance Office at Imperial College Healthcare NHS Trust London and by the Health Research Authority. These bodies deemed the survey a Service Evaluation. All participating Trusts/Hospitals confirmed registration as a Service Evaluation according to their local protocols and non-objection from the relevant local Caldicott Guardian. A full description of the methods can also be found in the DecubICUs global study report.[1] The study was registered at ClinicalTrials.gov (NCT03270345).

Data collection

The study website provided the protocol and an electronic Case Report Form (CRF; Supplementary Electronic Appendix). Data were collected from all participating centres before the study day. Anonymous data were collected in the CRF on all adult patients present in participating ICUs on the 15th May 2018 (Supplement A). Admission data included patients' demographic, type of ICU admission (i.e. medical, elective or emergency surgical, or trauma/burns), principal diagnosis leading to ICU admission, mechanical ventilation on admission, and whether the patient already had pressure injuries at the time of ICU admission. Data included PI assessment which included site and stage (generally referred to as "grade" in the UK),[3-6] and whether injuries were present at ICU admission (specifically these were *areas exhibiting pressure injuries*, rather than discrete injuries; referred to as PIs for simplicity). The injury risk was evaluated using the Braden scale.[7] This scale combines six subscales (mobility, activity, sensory perception, skin moisture, nutritional state, and friction/shear) and ranges 6 to 23, with lower scores reflecting higher risk. Follow-up data gathered were survival status and

length of ICU and hospital stay until hospital discharge, maximally at 12 weeks following the study day (7 August 2018). An online training module was developed for all clinical data collectors and published on the study website (https://www.esicm.org/trials-group-2/decubicus/; Supplement B) prior to initiation in order to assist with consistency of data collection. Hospital and follow up data were collected by clinical and research nurses and the site study coordinator. Individual patient data were collected by the bedside nurse by direct skin observation according to the international staging definitions.[3-6]

Statistics

Data were analysed for normality and summarised as mean (standard deviation; SD) or median (interquartile range; IQR) as appropriate, categorical data were summarised as proportions (%). Overall PI prevalence was calculated as the proportion of the sample who had at least one pressure injury on the study day. ICU-acquired prevalence was calculated as the proportion of the sample who had at least one PI determined to be acquired in the ICU present on the study day. Prevalence is reported as percentage with 95% confidence interval (CI). Tests were two-tailed and statistical significance was set at $p<0.05$. Associations with ICU-acquired PI were explored using a generalised linear mixed-effects regression analysis with the logit link function and including a random effect for site. This method was chosen to balance potential effects resulting from variability in care processes across the participating sites. We avoided data transformations to ensure that the model results remained realistic rather than optimal but unrealistic[8]. All demographic variables as well as those related to acute illness and chronic conditions were included. The variable 'length of ICU stay before study day' was included based on both clinical judgement and the literature on pressure injury risk factors.[9,10] As such, all variables were included following an exploratory approach, irrespective of their relationship with pressure injury in univariate analysis. Results are reported as odds ratios (OR) with 95%

confidence intervals (CI). Statistical analysis was performed using IBM SPSS for Windows 26.0 (IBM Corp., NY, US) and R statistical software 3.6.1.[12]

RESULTS:

Ninety-four adult ICUs distributed across the whole of the UK participated to this study. In 2018, the Scottish Intensive Care Society audit group (SICS) collected data from 72 adult ICUs,[13] while ICNARC report was based on data from 263 NHS adult ICUs in the rest of the United Kingdom.[14] The definition of an ICU can be broad, however for the purpose of this study the authors assumed that 28% (94/335) of ICUs participated to this study in the UK; 51% declared themselves to be university affiliated. The majority of ICUs were mixed medical and surgical (75; 80%), the remainder were surgical of one type or another with one specialist burns unit. Four participating units did not submit descriptive data. The ICUs had a median of 14 beds (IQR 10-20) and 68% declared themselves to be "closed". There were six very large units with more than 40 beds.

Local investigators collected data from 1312 critically ill patients, the majority of whom were cared for in University-affiliated centres (67.3% of patients). The median nurse to patient ratio for the night shift on the survey day was 1:1 (IQR 0.8-1), reflecting the UK national standard of 1:1 nursing for level 3 patients (these are individuals requiring ventilatory and multiple organ support) and 1:2 for level 2 "high dependency" patients. Only one hospital reported that neither physiotherapy nor dietic support was available on the study day. Four units did not report on this specification. A list of preventive measures used is listed in the Supplementary Appendix. C, (Supplementary Table 1) Four units reported that they did not have a section in the patient record for describing pressure injury, and four units entered no data; 59 (63%) units employed

the Waterlow Scale, 11 (12%) used the Braden Scale and 19 (20%) reported using a different PI risk assessment scale and one unit reported not using a scale (four units entered no data).

Overall, 211 patients (16%) exhibited PIs (Table 1). **O**f these, 96 (7.3%) had at least one PI present before ICU admission and 115 (8.8%) acquired PIs following admission (Table 2). The characteristics of the patients included are in Table 1; the majority were men (59.7%) and the median age was 62 years (IQR 50-72). The median number of days in the ICU before the study day was 4 (IQR 1-10) and 51% of these patients were requiring invasive mechanical ventilation on ICU admission. The source of admission to the ICU was in 34.2% of cases the operating theatre followed by the emergency room (30.5%) and the general ward (23.3%). Nine hundred and ninety-two patients (76%) were known to be alive at 84 days, with 271 (20.7%) known to have died (missing data on 49 patients).

The total number of PIs was 311, of which 148 (47.6%) were acquired in the ICU and 154 (52.4%) prior to ICU admission. Thus 54.5% of patients with PIs acquired those following their ICU admission. The majority of PIs were classified as Grade 1 or 2 (Figure 1a), and the number of PIs per patient varied from 1 to 9 sites (Table 2) The sacral area, along with the heels, mouth and nose appeared most vulnerable (Figure 1b), with the sacral and heels accounting for most of the higher-grade injuries; of 97 areas with injuries classified as Grade 3 or above, 33 (34%) were sacral areas and 28 (29%) were heels.

The generalized linear mixed-effects regression analysis identified the following factors as independently associated with ICU-acquired PIs: decreasing Braden scores and increasing prior duration of ICU stay (Table 3). No further inferential analysis was performed due to the low number of events and likely high number of confounders, many of which were unknowable.

DISCUSSION:

This service evaluation identified that 16% of 1312 patients in a large sample of UK intensive care units had an area exhibiting pressure damage on the study day. Although 96 patients already had injuries on admission, 115 had acquired them during their ICU stay. Generally, these injuries were not severe, however there were some that were, and these injuries come with a human and institutional cost. The impact of PIs is not easy to measure in terms of patients' outcome and totals costs. In 2004, the estimated annual cost paid by the NHS for the treatment of PIs was between £1.4 billion and £2.1 billion a year. A more recent estimate suggests that the cost of treating a PI varies from £1214 (stage 1) to £14,108 (stage 4 more severe).[2]

Recently, Labeau et al. conducted a worldwide prospective, point-prevalence study comprising 1,117 ICUs in 90 countries and found 6,747 pressure injuries in 3,526 patients[1]. The proportion of ICU-acquired PIs was 59.2%. They identified several factors associated with ICU-acquired pressure injuries including older age, presence of organ support and high severity of illness scores. This analysis of the UK data identified a low prevalence of generally low severity of PIs.. However, having a lower Braden score and a longer length of prior ICU stay were associated with a greater likelihood of acquiring a pressure injury in ICU. The global study (including data from many significantly lower resource settings) identified numerous risk-factor associations, but the overall prevalence was greater (26.6%), as was the total sample (n=13,254)[1]. Importantly, the global cohort was able to identify that local factors, case-mix, and especially type of ICU admission (i.e., medical, elective or emergency surgery), were associated with ICU-acquired PI risk.[15]

The locations of PIs were mainly the sacral area and the heels and the more severe injuries tended to be in these areas. This clearly needs continuous focus in equipment and practice

development and education, along with communication amongst the multidisciplinary team. It is a reasonable assumption that the overwhelming majority of the patients were nursed in the supine position on the study day, nevertheless there were injuries reported to nose, mouth and ears. The results might have been different had the study been conducted during the COVID-19 pandemic, during which there was a widespread need for nursing patients in the prone position. [16-24] The prevalence and location of PIs likely would reflect staff experience and training, positioning of patients and workload.[21] The mouth and the nose may be damaged when using NIV with limited options for interface or suctioning. [23] The nurse to patient ratio was 1:1 for level 3 patients and this is a reflection of UK standards of good care. Due to limitations of data collected we cannot comment on the detailed acuity which contributing units experienced in the period running up to the study day, similarly we cannot infer that staffing has an impact on the prevalence of PIs; the impact of a period of inadequate staffing will be reflected in pressure injuries sometime later.

The study sought information on preventative measures used. [2,4] The NICE guidance does not cover the specific issues relating to the critically ill patient, [2-4] however a list of preventive measures used in the ICUs is in Supplementary Appendix C (Supplementary Table 1). Data in this table are reflective of current NICE guidelines, but the lack of longitudinal data and low prevalence of PI precluded exploration of the relative effectiveness of such measures.

In the UK the presence of ICU PIs generates a mandatory investigation generally initiated via adverse event reporting systems, such as "Datix" (https://rldatix.com). This triggers investigation and challenge but may not account the specific issues relevant to the critically ill. The ability to differentiate which PIs were preventable with appropriate measures and those which were not, due to acuity, nutrition, vasopressors, hydration status etc. would ensure

appropriate attention but cannot be evaluated with this study methodology. It has been acknowledged that some pressure injuries, particularly in a critical care setting, are unavoidable.[23]

The generalized linear mixed-effects regression analysis identified decreasing Braden scores as independently associated with ICU-acquired pressure injuries. The Braden scale includes largely static factors and a dynamic system which adjust risk as time goes on may be worth evaluating. This is even more relevant given that prior LOS has a significant association with the incidence of PIs demonstrated in both this and other studies.[24] The development of such a scale including elapsed-time as a variable would require an extensive longitudinal study; it is not currently clear whether the effort would be justified. Of note, the majority of sites reported using the Braden or Waterlow scales; such scales would be the primary trigger for additional measures (Table 4); neither Braden or Waterlow has notion of prior length of stay. The importance of length of stay has been highlighted previously but this seems not to have translated into current risk assessment.[25] Although better risk prediction can be valuable for comparative audit as part of quality improvement, we do not know if an improved risk prediction score would translate into fewer pressure injuries.

One potential limitations of the study include the sample of intensive care units contributing; we estimate 28% of UK services contribute and we cannot assume this to be a representative sample. However, the site data submitted, and the patient diagnostic data are in line with broader UK critical care (Supplement C, Supplementary Table 2).[26] Conceivably participating sites may have had greater interest in pressure injury or evaluative practice, which may be different from non-contributing sites, and be reflected in quality of care. Finally, bedside nurses may perhaps have been inhibited from reporting injuries over anxieties that this would be

regarded badly by managers. An important mitigation of this is that pressure injury reporting is mandatory in the UK and has arguably become routine.

CONCLUSION:

The prevalence and the stage of severity of PIs, both ICU-acquired and non-ICU-acquired, were low in adult critically ill patients admitted to UK ICUs. Nevertheless, 16% of patients had evidence of pressure injury on the study day, and this clearly represents an opportunity for improvement. Decreasing Braden scores and increasing ICU stay were identified as independently risk factors associated with the prevalence of ICU-acquired PIs. The sacral area and the heels are clearly very vulnerable areas with greater numbers and the site of more severe injuries.

LEGENDS FOR FIGURE 1

Figure 1a: Prevalence by grade of injury classified in the 1312 patients included in the study. 115 patients had ICU acquired pressure injuries, and 96 had injuries that were pre-existing at the time of admission. Some may have had both so totals will not sum.

Figure 1b: Anatomical site of 311 injuries of which 148 (47.6%) in red were acquired in the ICU and 163 (52.4%) in blue were prior to ICU admission.

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Acknowledgment

Contributors

FR, SJB, CB, BB were responsible for coordinating the study in the UK

FR and SJB drafted the manuscript

MD, SOL, SIL produced a UK extract of data from the global study database

FR, SJB, BB, MD and SOL conducted the analysis

SOL and SIB were the lead investigators for the global study

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Competing interests

SIB received grants of honoraria from Pfizer and 3M outside the submitted work. The other authors declare they have no conflicts of interest.

Patient and public involvement

NONE

Data availability statement

Study protocol, statistical analysis plan, and informed consent forms will be shared upon request with any researcher. Local DecubICUs investigator have the right to use the data collected from their respective units. The complete global DecubICUs database is only transferred to the primary investigators, SOL and SIB. They cannot share the database as they are bound to a broad variety of Data User Agreements. Information requests are to be addressed to stijn.blot@ugent.be and sonia.labeau@hogent.be. Information requests concerning the UK data should be addressed to SJB.

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REFERENCES:

1. Labeau S O, Afonso E, Benbenishty J, et al. Prevalence, associated factors and outcomes of pressure injuries in adult intensive care unit patients: the DecubICUs study. *Intensive Care Medicine* 2021;47:160-9.. https://doi.org/10.1007/s00134-020-06234-9.
2. NICE. Pressure ulcer prevention. The prevention and management of pressure ulcers in primary and secondary care. Clinical Guidelines 179. Methods, evidence and recommendations April 2014 https://www.nice.org.uk/guidance/cg179/evidence/full-guideline-prevention-pdf-547610509 . (Accessed August 2021)
3. National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel, and Pan Pacific Pressure Injury Alliance. Prevention and treatment of pressure ulcers: Clinical practice guideline. Emily Haesler ed. Osborne Park, Australia: Cambridge Media; 2014.
4. National Pressure Injury Advisory Panel, European Pressure Ulcer Advisory Panel, and Pan Pacific Pressure Injury Alliance. Prevention and treatment of pressure ulcers: Clinical practice guideline. Emily Haesler ed. Osborne Park, Australia: Cambridge Media; 2019.
5. Edsberg LE, Black JM, Goldberg M, et al. National Pressure Ulcer Advisory Panel pressure injury staging system: Revised pressure injury staging system. *J Wound Ostomy Continence Nur*s 2016;43:585-97.
6. National Pressure Injury Advisory Panel. Position statement on staging – 2017 clarifications. https://npuap.org/page/PositionStatements. (Accessed August 2021)
7. Bergstrom N, Braden B, Laquzza A, Holman V. The Braden scale for predicting pressure sore risk - reliability studies. *Nurs Res* 1985;36:205–10. http://www.ncbi.nlm.nih.gov/pubmed/3299278.

8. Lo S, Andrews S. To transform or not to transform: using generalized linear mixed models to analyse reaction time data. *Front Psychol* 2015; 6:1171
9. El-Marsi J, Zein-El-Dine S, Zein B, et al. Predictors of Pressure Injuries in a Critical Care Unit in Lebanon: Prevalence, Characteristics, and Associated Factors. *J Wound Ostomy Continence Nurs*. 2018; 45:131-136.
10. Cox J, Predictors of pressure ulcers in adult critical care patients. *Am J Crit Care*. 2011;20: 364-75.
11. Society of Critical Care Medicine. Critical Care Statistics. https://www.sccm.org/Communications/Critical-Care-Statistics. (Accessed August 2021)
12. R Core Team (2018) R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Available at https://www.R-project.org/.
13. The Scottish Intensive Care Society audit group. Audit of Critical Care in Scotland 2018, reporting on 2017. https://www.sicsag.scot.nhs.uk/publications/_docs/2018/SICSAG-report-2018-2609-final.pdf?55 . (Accessed August 2021)
14. Intensive Care national audit & research centre. Annual Quality Report 2018/19 for adult critical care. https://onlinereports.icnarc.org/Reports/2019/12/annual-quality-report-201819-for-adult-critical-care . (Accessed August 2021)
15. Deschepper M, Labeau SO, Waegeman W, et al. Heterogeneity hampers the identification of general pressure injury risk factors in intensive care populations: A predictive modelling analysis. *Intensive Crit Care Nurs* 2021 12:103117 (on line ahead of print)

16. Shearer S C, Parsa K M, Newark A, et al. Facial Pressure Injuries from Prone Positioning in the COVID-19 Era. *Laryngoscope* 2021;131:E2139-2142 PMID: 33389768 DOI: 10.1002/lary.29374

17. Perrillat A, Foletti JM, Lacagne AS, et al. Facial pressure ulcers in COVID-19 patients undergoing prone positioning: How to prevent an underestimated epidemic? *J Stomatol Oral Maxillofac Surg*. 2020;121:442–444. doi: 10.1016/j.jormas.2020.06.008.

18. Kim RS, Mullins K. Preventing facial pressure ulcers in Acute Respiratory Distress Syndrome (ARDS) *J Wound Ostomy Continence Nurs*. 2016;43:427–429. doi: 10.1097/WON.0000000000000247.

19. Lucchini A, Bambi S, Mattiussi E.et al. Prone position in acute respiratory distress syndrome patients: a retrospective analysis of complications. *Dimens Crit Care Nurs*. 2020;39:39–46. doi: 10.1097/DCC.0000000000000393.

20. Nazerali RS, Song KR, Wong MS. Facial pressure ulcer following prone positioning. *J Plast Reconstr Aesthetic Surg*. 2010;63:e413–e414. doi: 10.1016/j.bjps.2009.11.001.

21. Azoulay E, Timsit JF, Sprung CL, et al. Prevalence and Factors of Intensive Care Unit Conflicts: The Conflicus Study. *Am J Respir Crit Care Med*. 2009;180:853-60.

22. Alqahtani JS, AlAhmari MD. Evidence based synthesis for prevention of noninvasive ventilation related facial pressure ulcers. *Saudi Med J*. 2018;39:443-452. doi: 10.15537/smj.2018.5.22058.PMID: 29738002 .

23. Edsberg LE, Langemo D, Baharestani MM, et al. Unavoidable pressure injury: state of the science and consensus outcomes. *J Wound Ostomy Continence Nurs* 2014; 41:313-334

24. Zhang Y, Zhuang Y, Shen J, et al. Value of pressure injury assessment scales for patients in the intensive care unit: Systematic review and diagnostic test accuracy meta-

analysis. *Intensive & Critical Care Nursing*. 2021;64;103009. doi: 10.1016/j.iccn.2020.103009

25. Cox J. Risk factors for pressure injury development among critical care patients. *Crit Care Nurs Clin N Am* 2020;32;473-488
26. Intensive Care National Audit and Research Centre. On line reports available at https://onlinereports.icnarc.org/Home (accessed August 2021)

TABLE 1: Characteristics of patients

Characteristic	All patients (n = 1312; 100%)[a]	No pressure injuries (n = 1101; 83.9%)[a]	With pressure injuries (n = 211; 16%)[a]	ICU-acquired pressure injuries (n = 115; 8.8%)[a]
Age, years (M, IQR)	62 (50–72)	62 (49–72)	65 (54–74)	62 (52–73)
Sex (male) n (%)	783 (59.7)	656 (59.6)	127 (60.2)	68 (59.1)
Body Mass Index class[b] n (%)				
Underweight (<18.5)	57 (4.3)	42 (3.8)	15 (7.1)	10 (8.7)
Normal weight (18.5–24.9)	464 (35.4)	381 (34.6)	83 (39.3)	49 (42.6)
Pre-obesity (25–29.9)	3910 (29.8)	341 (31.0)	50 (23.7)	27 (23.5)
Obesity class I (30–34.9)	227 (17.3)	195 (17.7)	32 (15.2)	12 (10.4)
Obesity class II (35–40)	90 (6.9)	75 (6.8)	15 (7.1)	11 (9.6)
Obesity class III (>40)	83 (6.3)	67 (6.1)	16 (7.6)	6 (5.2)
Mechanical ventilation on ICU admission n (%)	669 (51.0)	555 (50.4)	114 (54.0)	77 (67.0)
Type of admission n (%)				
Medical	617 (47.0)	495 (45.0)	122 (57.8)	63 (54.8)
Elective surgery	279 (21.3)	260 (23.6)	19 (9.0)	11 (9.6)

Emergency surgery	309 (23.6)	255 (23.2)	54 (25.6)	31 (27.0)
Trauma and burns	107 (8.2)	91 (8.3)	16 (7.6)	10 (8.7)
Comorbidities n (%)				
Acquired Immune Deficiency Syndrome	6 (0.5)	5 (0.5)	1 (0.5)	1 (0.9)
Chronic Obstructive Pulmonary Disease	173 (13.2)	143 (13.0)	30 (14.2)	17 (14.8)
Malignancy	164 (12.5)	137 (12.4)	27 (12.8)	14 (12.2)
Cancer, solid tumour	118 (9.0)	102 (9.3)	16 (7.6)	8 (7.0)
Metastatic cancer	32 (2.4)	27 (2.5)	5 (2.4)	1 (0.9)
Haematologic cancer	27 (2.1)	19 (1.7)	8 (3.8)	5 (4.3)
Immunocompromised	104 (7.9)	79 (7.2)	25 (11.8)	15 (13.0)
Corticosteroid therapy	57 (4.3)	39 (3.5)	18 (8.5)	10 (8.7)
Immunosuppression	33 (2.5)	24 (2.2)	9 (4.3)	5 (4.3)
Chemotherapy	37 (2.8)	34 (3.1)	3 (1.4)	2 (1.7)
Cirrhosis	39 (3.0)	27 (2.5)	12 (5.7)	7 (6.1)
Diabetes	239 (18.2)	193 (17.5)	46 (21.8)	25 (21.7)
Heart failure	130 (9.9)	102 (9.3)	28 (13.3)	15 (13.0)
Impaired mobility	120 (9.1)	95 (8.6)	25 (11.8)	10 (8.7)
Malnutrition	45 (3.4)	27 (2.5)	18 (8.5)	12 (10.4)
Peripheral vascular disease	41 (3.1)	27 (2.5)	14 (6.6)	5 (4.3)
Renal failure	106 (8.1)	93 (8.4)	13 (6.2)	5 (4.3)

Simplified Acute Physiology Score II category n (%)				
≤23	385 (29.3)	353 (32.1)	32 (15.2)	16 (13.9)
24–33	327 (24.9)	283 (25.7)	44 (20.94)	26 (22.6)
34–44	290 (22.1)	220 (20.0)	70 (33.2)	37 (32.2)
≥45	310 (23.6)	245 (22.3)	65 (30.8)	36 (31.3)
Braden score category[d] n (%)				
Very High Risk (≤ 9)	110 (8.4)	79 (7.2)	31 (14.7)	18 (15.7)
High Risk (10–12)	370 (28.2)	284 (25.8)	86 (40.8)	51 (44.3)
Moderate Risk (13–14)	236 (18.0)	194 (17.6)	42 (19.9)	27 (23.5)
Mild Risk (15–18)	396 (30.2)	349 (31.7)	47 (22.3)	19 (16.5)
No Risk (19–23)	193 (14.7)	189 (17.2)	4 (1.9)	/
Length of stay in ICU prior to study day (Median, IQR)	4 (1–10)	3 (1–9)	8 (3–20)	12 (6–26)
Length of stay in ICU (M, IQR)	9 (4–24)	8 (3–20)	19.5 (8–45.75)	26.5 (12–53)
Length of stay from ICU admission to hospital discharge (M, IQR)	18 (8–40)	16 (8–35)	33 (14.25–61.75)	42 (18–63.75)
Length of stay in hospital after study day (M, IQR)	11 (6–28)	10 (5–24)	21 (9–41)	22 (10–42)

Patients still in ICU 3 months after study day	2 (0.2)	1 (0.1)	1 (0.5)	/
Patients still in non-ICU ward 3 months after study day	93 (7.1)	59 (5.4)	34 (16.1)	22 (19.1)
Deceased during hospital stay	271 (20.7)	210 (19.1)	61 (28.9)	29 (25.2)
28-days mortality	196 (14.9)	157 (14.3)	39 (18.5)	15 (13.0)

Abbreviations: ICU, intensive care unit; M, median; IQR, interquartile range

[a]Totals may not sum to 1312, 1101, 211 and 115, respectively, owing to missing values.

[b]Body Mass Index is body weight in kilograms divided by body height in meters squared

[c]Range of possible scores is 0–163; a higher SAPS II score indicates a higher severity of disease and acute illness; scores are categorized according to the sample's quartiles

[d]Range of possible scores is 6–23

TABLE 2: Number of PIs acquired before and after ICU admission and number of sites per patient. This reflects only the PIs documented as present on admission and those acquired in ICU. The data collected does not support effective extrapolation of number of PIs acquired on ICU in those patients with PIs present on admission.

Number of body sites affected	Patients with ICU-acquired PIs (n=115 patients, 148 sites)	Patients with PIs acquired prior to ICU admission (n=96 patients, 154 sites)
1	95 (82.6%)	68 (70.8%)
2	13 (11.3%)	11 (11.5%)
3	4 (3.5%)	12 (12.5%)
4	1 (0.9%)	1 (1.0%)
5	1 (0.9%)	3 (3.1%)
6	1 (0.9%)	-
9	-	1 (1.0%)

TABLE 3: Generalized Linear Mixed model with SITE as random effect.

Variable		Odds ratio	Conf low	Conf high	p.value
Days in ICU before study day					
	0–3 days	Reference			
	4–6 days in ICU before study day	2,2946	1,0633	4,9515	0,0343
	7–9 days in ICU before study day	2,2990	0,9055	5,8371	0,0799
	10–12 days in ICU before study day	7,7737	3,4155	17,6928	0,0000
	>12 days in ICU before study day	7,7284	3,9435	15,1459	0,0000
Age		1,0097	0,9927	1,0270	0,2651
Male sex		0,9774	0,6130	1,5584	0,9235
Body Mass Index					
	18.5–24.9: normal weight	Reference			
	<18–5: underweight	1,9729	0,8023	4,8512	0,1388
	25–29.9: pre-obesity	0,5647	0,3186	1,0008	0,0503
	≥30: obesity	0,6029	0,3409	1,0666	0,0821
Braden Score		0,7654	0,6924	0,8462	0,0000
Admission type: medical		1,1058	0,4702	2,6003	0,8177
Admission type: elective surgery		0,8344	0,2815	2,4734	0,7440
Admission type: emergency surgery		1,0251	0,4132	2,5435	0,9573
Chronic Obstructive Pulmonary Disease		0,9644	0,4957	1,8764	0,9151
Acquired Immune Deficiency Syndrome		3,6742	0,2691	50,1720	0,3292
Heart failure		1,0690	0,5139	2,2238	0,8582
Peripheral vascular disease		0,9658	0,3048	3,0599	0,9528
Diabetes		1,2216	0,6954	2,1459	0,4863
Cirrhosis		2,2538	0,8236	6,1680	0,1136
Malignancy		0,9043	0,4233	1,9319	0,7950
Immunocompromised		1,9557	0,9106	4,2003	0,0855
Vasopressor use		0,6427	0,3418	1,2086	0,1701
Sedation		0,7703	0,4045	1,4668	0,4271
Muscle relaxant use		1,1277	0,3088	4,1182	0,8557
Mechanical ventilation on admission		1,3380	0,7887	2,2699	0,2803
Renal replacement		1,6310	0,8266	3,2183	0,1583
Simplified Acute Physiology Score II score		0,9927	0,9735	1,0123	0,4616

TABLE 4: Primary trigger for extra preventative measures (90 units responded)

Trigger	Frequency	% of sites reporting
High risk profile as indicated by a risk assessment scale	69	76.6
Mechanical ventilation	4	4.4
Anticipated ICU stay>3days	1	1.1
Coma/sedation	2	2.2
Malnutrition	1	1.1
Obesity	1	1.1
Presence of pressure injury	7	7.7
Other	5	5.5
Total	90	

Figure 1a

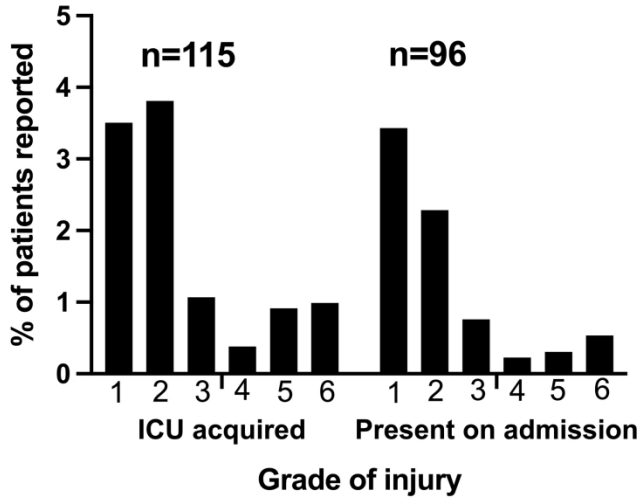

Figure 1b

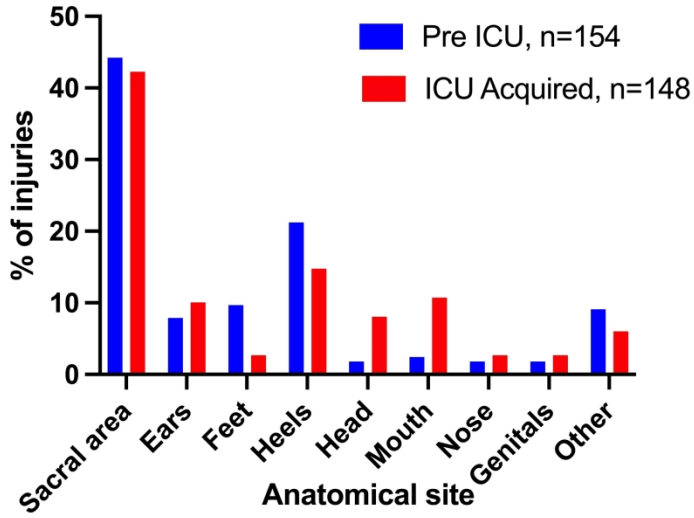

Figure 1a: Prevalence by grade of injury classified in the 1312 patients included in the study. 115 patients had ICU acquired pressure injuries, and 96 had injuries that were pre-existing at the time of admission. Some may have had both so totals will not sum.
Figure 1b: Anatomical site of 311 injuries of which 148 (47.6%) in red were acquired in the ICU and 163 (52.4%) in blue were prior to ICU admission.

176x284mm (300 x 300 DPI)

Online Resource 4. Study protocol

Decub*ICU*s

Decubitus in Intensive Care Units

A Multicenter International One-Day Prevalence Study

1 Organisational information

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Louise ROSE, Toronto (Canada)
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Ged WILLIAMS, Abu Dhabi (United Arab Emirates)

Coordinating center: Ghent University, Belgium (Prof. Dr. S. Blot)

National representatives:

The role of the national representatives can be summarized as follows:

(1) Advertise the study in the individual countries and identify participating hospitals and local investigators in their country.
(2) Apply for regulatory approval in a national level where applicable and ensure that ethical committee (EC) approvals or waivers for all the participating hospitals in the country are in place prior to the initiation of the study.
(3) Assist with the translation of the study protocol/CRF where required.
(4) Ensure good communication with the participating sites in the respective country and to animate local investigators to achieve optimal recruitment and follow up during the period of the study. During the period of database quality control (data 'cleaning') the national representative should animate the individual to reply in possible queries.

Local co-ordinators:

Local co-ordinators in individual institutions will have the following responsibilities:

(1) Provide leadership for the project in their institution
(2) Ensure all relevant regulatory approvals are in place and communicated with the coordinating center
(3) Ensure adequate data collection and act as guarantor for the integrity and quality of the data
(4) Ensure timely completion of the e-CRFs
(5) Ensure collaboration to solve possible queries that may arise during the database quality control process.

2 Protocol summary

Study title:	Decubitus in Intensive Care Units
Acronym:	Decub*ICU*s
Design:	multicentre, international one-day prevalence study
Target population:	all patients present on **15 May 2018**

Interventions: no interventions – observational study

Outcomes:

- major risk factors for pressure injury development;
- preventive measures used in distinct ICU populations and countries;
- identifying shortages in the availability of evidence-based measures to prevent pressure injuries;
- occurrence rates of pressure injuries with/without accurate adjustment for risk profile and preventive measures taken;
- benchmarking between regions/countries;
- clinical outcomes associated with pressure injuries (major organ derangements and 12 week mortality);
- economic outcomes associated with pressure injuries (length of ICU stay) and linking these outcomes with local practice regarding prevention measures applied/available.

Subanalyses:

- country and regional differences in prevalence of pressure injuries and outcome;
- age, sex and morphology-related differences in prevalence of pressure injuries and outcome;
- comorbidities, prevalence and outcome of pressure ulcers;
- relationship of ICU organisational issues with prevalence of pressure ulcers and outcome;
- prevalence and outcome in specific subgroups (trauma, surgical, medical, etc…).

Study duration: one-day prevalence [**15 May 2018**]

Follow-up period: until hospital discharge or at 12 weeks to evaluate ICU and hospital outcomes [**7 August 2018**]

3 Description of the study

3.1 Introduction

Pressure injuries remain among the most important complications of hospitalisation. They are associated with an increased infection risk, pain and disability, high level of dependence, longer hospitalisation, and as such higher hospital costs. The total annual cost for pressure injuries in the UK has been estimated to range 1.4 to 2.1 billion pounds [1].

Because severe pressure injuries are generally considered preventable, the occurrence rate of pressure injuries has increasingly been used as a quality indicator in hospital care. In addition, and in accordance with the ruling on Inpatient Prospective Payment System by the Centers for Medicare and Medicaid, hospitals in the US are no longer reimbursed for hospital costs related to severe pressure injuries (stage III or higher). These evolutions have put substantial emphasis on the prevention of pressure injuries.

In the past decades increasing efforts to prevent pressure injuries have been made, but –contrariwise– the challenge of pressure injury prevention seems to become harder as medicine progresses. Indeed, favourable evolutions in emergency medicine and organ support have led to an increasing pool of long-term intensive care (ICU) patients. Patients admitted to ICUs are at particular high risk for pressure injuries because of their debilitated physical condition and exposure to numerous risk factors. Risk factors for ICU patients are generally the same as those in a general hospital population. Yet, in ICU patients they are exaggerated in terms of both a stronger effect and the presence of more factors at the same time [2]. Also, the proportion of elderly admitted to ICU is on the rise. In a university hospital the number of patients aged >75 years increased by one third over a 15-year period [3].

Although many studies reporting on pressure injuries in ICU settings are outdated single-center or regional initiatives [4-7], a recent randomized trial conducted in the United Kingdom found a prevalence of new or substantially worsened pressure injuries of 15% in intensive care (ICU) patients with an anticipated stay of at least 36 hrs [8]. A 58% prevalence was identified in a Brazilian single center study among adult ICU patients of which 55.5% were estimated to be at high risk of developing a pressure injury according to the Braden scale, while 40% actually developed one [9].

The changing ICU patient profile, the high prevalence and the substantial economic impact make large-scaled international studies necessary to keep up with present epidemiology of pressure injuries in ICUs.

3.2 Objectives

Our objective is to provide an up-to-date, international “global” picture of the extent and patterns of pressure injuries in ICUs. Thereto we plan to perform a 1-day, prospective, multicenter point-prevalence study. The large scale of the project should allow thorough epidemiological analyses. More precisely the study will enable to identify:

- major risk factors for pressure injury development;

- preventive measures used in distinct ICU populations and countries;
- shortages in the availability of evidence-based measures to prevent pressure injuries;
- malpractice in pressure injury prevention in particular regions or countries;
- occurrence rates of pressure injuries with/without accurate adjustment for risk profile and preventive measures taken;
- benchmarking between regions/countries; clinical outcomes associated with pressure injuries (major organ derangements and mortality);
- economic outcomes associated with pressure injuries (length of ICU stay) and linking these outcomes with local practice regarding prevention measures applied/available.
- country and regional differences in prevalence of pressure injuries and outcome.

3.3 Methods

3.3.1. Network development

Steering committee

Point prevalence studies are only of value when performed on a vast scale. To sample a representative cohort, we intend to recruit about 1200 ICUs with all continents covered and as many countries as possible within each continent. Thereto an international steering committee will be established. Following our extensive experience in international research projects (see profile of the principal investigators) we currently have research contacts in all continents. Clinicians/researchers with a high ability to recruit centres will be invited in the steering committee.

Recruitment strategy

To maximize the recruitment of centers, different approaches to invite ICUs for participation will be used:

- development of a dedicated informative website including an extensive Frequently Asked Questions (FAQs) section. In all recruitment initiatives the website will be mentioned;
- our current network of researchers and participants in other studies will be contacted (e.g., all 3587 participants in the EVIDENCE-project, representing 79 countries);
- members of the steering committee will contact their personal network;
- endorsement of the European Society of Intensive Care Medicine (ESICM), will be pursued. The ESICM facilitates spread of their projects through blast mails to all their members. In the past, we succeeded in gaining endorsement from the ESICM for three of our research projects;
- for countries currently lacking from our network, embassies will be contacted to obtain a list of hospitals with intensive care activity (this strategy has been successfully used for the development of the EVIDENCE project). Especially for African and Eastern European countries this can be an important approach;
- advertisement on websites of critical care societies such as the ESICM, the Society of Critical Care Medicine (SCCM), and the American Association for Critical Care Nurses (AACCN);
- flyers will be distributed at national and international critical care symposia and congresses.

3.3.2. Organizing the point-prevalence study

For the point prevalence study a date will be picked (**15 May 2018**). Centers prepared to participate must obtain approval of the local ethics committee or review board. A local investigator with email contact is a prerequisite. Centers will be alerted by repeated email in the weeks before the study date. At that time, they will be asked to provide minimal data regarding the organisation of the unit (e.g. staffing and number of ICU beds).

3.3.3. Data recording

Pressures injury stages will be graded following the classification system jointly developed by the National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel, and Pan Pacific Pressure Injury Alliance [10]. A concise educational web-base training package will be available to optimally prepare participating ICUs for data recording.

Data will be recorded using electronic or pre-printed case report forms. Electronic forms (e-CRFs) can be consulted and submitted online. For countries with restricted digital resources, pre-printed forms will be available. These will be downloadable via the dedicated website or sent via fax, postal mail or email two weeks preceding the point prevalence measurement. After data input, pre-printed forms can be submitted through the channel best suiting the participating centers' commodities. Besides the FAQs section on the study website, a dedicated telephone hotline will be available for any queries during the study follow-up period.

Data to be recorded include patient demographics, data on severity of underlying disease and acute illness, organ failure, pressure ulcers, major risk factors for pressure ulcers, and measures taken to prevent pressure uinjuries. For more detail, see the case report form.
Participating ICUs will be asked to provide patient follow up until hospital discharge or for 84 days. At that time point survival status and length of ICU and hospital stay will be recorded.

3.3.4. Analyses & reporting of the study results
The principal investigators will perform data analyses. Data will be analysed as a whole and per continent, the latter to allow defining benchmark thresholds per continent. Initial data will be presented at international congresses as abstract and published in an international peer reviewed medical journal.

4 Study population

4.1 Inclusion criteria
All adult patients (>18 years of age) present on **15 May 2018**

4.2 Exclusion criteria
There are no exclusion criteria. All patients should be included. Patients with severe clinical conditions not allowing safe pressure injury identification should not be evaluated for the respective risk zones. If it is known that the patient has a pressure injury at the body sites that cannot be safely evaluated, the stage of the pressure injury should be recorded as previously known. If it is unknown whether the patient has a pressure injury at these body sites, this should be indicated with a '?' (See also case report form).

5 Study course

5.1 Patients' enrolment
Patients' enrolment will be limited to **15 May 2018** (from 00:00 until 24:00).

5.2 Ethics committee approval
Even though this is an epidemiological study with entirely anonymous data collection, it is advised to submit the protocol to the local ethics committee for approval.

5.3 Therapeutic intervention
The study is purely observational in nature; no interventions are planned.

5.4 Daily documentation
Data collection includes three stages:
a. on admission: see center report form;
b. on the study day: see case report form;
c. during follow up period: outcome at ICU and hospital discharge.

6 Organisation

6.1 Documentation
Data will be recorded using electronic or pre-printed case report forms by the attending intensivist, a trained research nurse, or an appropriately instructed nurse.

6.2 Collecting data
Data should be submitted digitally, faxed or (e-)mailed periodically to the coordinating center (See contact information).

6.3 Data management and archiving

6.3.1 Data property
The individual data provided by a participating ICU are primarily the property of the ICU who generated the data. All investigators have the right to access their data at any time.

6.3.2 Data control
Data control will involve the following levels:

- all participants are provided with detailed information (See instructions form). The coordinating center will provide a rapid response for any query throughout the study period (See contact information);
- data plausibility check will start at the entry level, setting validity limits for each variable. Investigators will be queried in case of outliers, excessive numbers of missing values.

6.3.3 Subsequent use of data

The steering committee, on behalf of the investigators, has the right to use all data that are pooled in the databank for scientific purposes. Investigators will be regularly informed about ongoing study activities. All participants have the right to access the data, pooled in the databank, for research purposes after the research project has been terminated, and with the approval of the steering committee. A copy of the databases generated by the project can only be provided to third-part entities after specific approval by the participating ICUs.

6.3.4 Archiving

A copy of the electronic databank will be kept in the coordinating centers and preserved for 15 years for subsequent use by the steering committee and investigators. It is recommended that a copy of all case report forms be kept at each center for future reference.

6.3.5 Publication rules

The executive committee will appoint a writing committee to draft the scientific report(s). Authorship will take the following elements into account: study design, study organisation, data collection, patient enrolment, data analysis, and contribution to the manuscript. All national representatives and local coordinators will have their efforts recognized by being mentioned as 'collaborator' in the authorship of the paper and as such listed in PUBMED. Members of the executive committee, national representatives and local coordinators may suggest research questions for secondary manuscripts and take initiative in drafting the paper after approval by the head investigators. In this regard, the head investigators control the risk of potential overlap between manuscripts.

6.4 Sponsorship

The DecubICUs project is in part supported by the LIFE Priority Fund of the European Society of Intensive Care Medicine, and the Flemish Society of Critical Care Nurses.

6.5 Statistical analysis

A single final analysis is planned at the end of the study; no interim analyses are planned. Study cohort characteristics will be described as proportions for categorical variables and for continuous variables as mean and standard deviation if normally distributed or median and inter-quartile range if not normally distributed (according to the Kolmogorov-Smirnov test for normality). Relationships with binary outcome variables (e.g. pressure ulcers, mortality) will be assessed by means of unadjusted and adjusted logistic mixed (multi-level) effects modelling in order to consider a centre effect. Likewise, linear mixed-effect modelling will be used to assess unadjusted and adjusted relationships with continuous outcome variables (e.g. length of ICU stay, organ failure score). Covariates that will be evaluated on their relationship with the presence of pressure ulcers encompass various organizational aspects of the ICU (e.g. nurse-to-patient ratio), pressure ulcer prevention measures (e.g. type of matrasses used), and severity of underlying disease and acute illness (co-morbidities, SAPS2 score, organ failure,…).

Covariates with an association with the outcome variable at a statistical level <0.25 in unadjusted logistic/linear mixed-effects analysis will be considered for adjusted analysis. A stepwise approach will be used to eliminate terms into the regression model where $p<0.15$ or $p<0.10$ (depending on the more favorable Hosmer-Lemeshow goodness-of-fit test) was set as the limit to keep covariates in the model. Results of logistic regression will be reported as adjusted odds ratios with 95% confidence intervals. If of value, pressure ulcer rates will be provided for large geographic regions (e.g. continent). Eventual differences in pressure ulcer rates might offer the opportunity to evaluate variances in prevention measures on a large scale.

Statistical analysis will be performed using SPSS for windows version 23.0 (Chicago, US). The head investigator (SB) is in charge of all statistical analysis and he is backed by the team of the Dept. of Biostatistics at the Faculty of Medicine & Health Sciences, Ghent University. In case unusual statistical challenges are faced, Dr. Ellen Deschepper of the Dept. of Biostatistics will be consulted.

Initial data will be presented at international congresses as abstract and published in an international peer reviewed medical journal.

7 References

1. Bennett G, Dealey C, Posnett J, (2004) The cost of pressure ulcers in the UK. Age Ageing 33: 230-235
2. Keller BP, Wille J, van Ramshorst B, van der Werken C, (2002) Pressure ulcers in intensive care patients: a review of risks and prevention. Intensive Care Med 28: 1379-1388
3. Blot S, Cankurtaran M, Petrovic M, Vandijck D, Lizy C, Decruyenaere J, Danneels C, Vandewoude K, Piette A, Verschraegen G, Van Den Noortgate N, Peleman R, Vogelaers D, (2009) Epidemiology and outcome of nosocomial bloodstream infection in elderly critically ill patients: a comparison between middle-aged, old, and very old patients. Critical care medicine 37: 1634-1641
4. Iranmanesh S, Rafiei H, Sabzevari S, (2012) Relationship between Braden scale score and pressure ulcer development in patients admitted in trauma intensive care unit. Int Wound J 9: 248-252
5. Manzano F, Navarro MJ, Roldan D, Moral MA, Leyva I, Guerrero C, Sanchez MA, Colmenero M, Fernandez-Mondejar E, (2010) Pressure ulcer incidence and risk factors in ventilated intensive care patients. J Crit Care 25: 469-476
6. Nijs N, Toppets A, Defloor T, Bernaerts K, Milisen K, Van Den Berghe G, (2009) Incidence and risk factors for pressure ulcers in the intensive care unit. J Clin Nurs 18: 1258-1266
7. Terekeci H, Kucukardali Y, Top C, Onem Y, Celik S, Oktenli C, (2009) Risk assessment study of the pressure ulcers in intensive care unit patients. Eur J Intern Med 20: 394-397
8. Harvey SE, Parrott F, Harrison DA, Bear DE, Segaran E, Beale R, Bellingan G, Leonard R, Mythen MG, Rowan KM, Investigators CT, (2014) Trial of the route of early nutritional support in critically ill adults. N Engl J Med 371: 1673-1684
9. Matos LS, Duarte NLV, Minetto RdCs, (2010) Incidence and prevalence of ulcer for pressure in CTI of a Public Hospital of DF. Revista Eletronica de Enfermagem 12: 719-726
10. National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and Treatment of Pressure Ulcers: Quick Reference Guide. Emily Haesler (Ed.). Cambridge Media: Osborne Park, Australia; 2014.

8 Contact details

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Appendix 1: Center Report Form

CENTER REPORT FORM Center: __ __ __

Did the data collectors consult an educative module on the correct staging of pressure injuries prior to data collection?
□ No □ Yes, the module provided by the ESICM □ Yes, another module

Section 1: general data

Institution: ....

Type of hospital: ☐ University/academic ☐ Non-university

Hospital capacity: __ __ __ __ beds
ICU capacity: __ __ __ __ beds

Type of ICU: ☐ Closed ☐ Open (non-ICU doctors may write orders)

ICU speciality:
Surgical ☐ cardiac ☐ non-cardiac ☐ transplantation ☐ mixed ☐ burns ☐ trauma

Medical ☐ coronary ☐ neurologic ☐ respiratory ☐ mixed
Mixed medical/surgical ☐ Other ☐ Please, specify ....

How many patients were (approximately) treated in your ICU in 2017? _ __ __ patients

Section 2: data pertaining to the study day

How many ICU beds are occupied at the day of the study? __ __ __ __ ICU beds

Number of nurses on the day of the study
Between 2 - 3 am: __ __ __
Between 8 - 9 am: __ __ __
Between 4 - 5 pm: __ __ __

Physiotherapist available on the day of the study? ☐ Yes ☐ No

Is your unit currently participating in an (inter)national study on pressure injuries? ☐ Yes ☐ No

Do patient files contain a specific section for reporting pressure injuries? ☐ Yes ☐ No

Dietician/nutrition specialist available on the day of the study? ☐ Yes ☐ No

Which preventive measures are used in your ICU? (see codes list)
__ __
__ __

Which of the **above** measures are used in **all** patients (irrespective of risk profile)? (see codes list)
__ __
__ __

Which risk assessment scale is used to estimate the risk of pressure injuries?
☐ No scale ☐ Norton scale ☐ Braden scale ☐ Waterlow scale ☐ Other scale (specify):

What is the primary trigger to use extra preventive measures?
☐ high risk profile as indicated by a risk assessment scale
Ulcer: ☐ stage I ☐ stage II ☐ stage III ☐ stage IV ☐ U (unstageable) ☐ S (depth unknown)
☐ mechanical ventilation ☐ anticipated ICU stay >3 days ☐ coma/sedation ☐ vasopressor use
☐ malnutrition ☐ incontinence ☐ obesity
☐ Other (specify): ....

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Appendix 2: Case Report Form

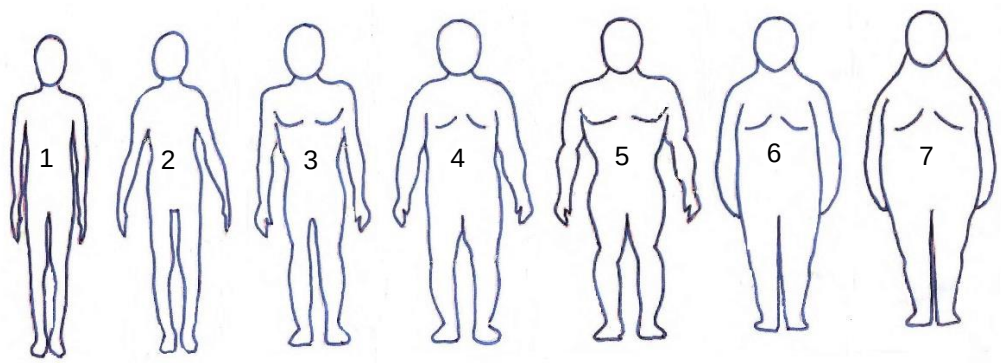
CASE REPORT FORM Center: __ __ __ __ __ Patient: __ __

Patient demographics & admission data

Date of ICU admission: __ __ / __ __ / __ __ __ __ (dd/mm/yyyy) **Sex:** ☐ male ☐ female

Age: __ __ __ years **Weight:** __ __ __ kg **Length:** __ __ __ cm

Morphological type: __



Type of admission: ☐ medical ☐ surgical ☐ elective ☐ emergency ☐ trauma ☐ burns

Mechanical ventilation on admission: ☐ yes ☐ no

Admission source: ☐ other hospital ☐ emergency room ☐ operating room ☐ general ward ☐ other

Primary diagnosis (only 1, see Codes list): __ __ __

Secondary diagnosis (max. 3, see Codes list): __ __ __ / __ __ __ / __ __ __

Comorbidities:

☐ COPD	☐ AIDS	☐ cancer (solid tumour)
☐ cirrhosis	☐ renal failure	☐ metastatic cancer
☐ heart failure	☐ diabetes	☐ hematologic cancer
☐ steroid therapy	☐ chemotherapy	☐ immunosuppression
☐ malnutrition	☐ impaired mobility	☐ peripheral vascular disease

Site(s) of surgery (max. 3, see Codes list): __ __ __ / __ __ __ / __ __ __

Study day parameters

Heart rate	(min.) __ __ __	(max.) __ __ __	bpm
Body temperature	(min.) __ __ __	(max.) __ __ __	°C
Therapeutic hypothermia	☐ yes	☐ no	
Systolic blood pressure	(min.) __ __ __	(max.) __ __ __	mmHg
Mean arterial pressure	(min.) __ __ __	(max.) __ __ __	mmHg
Lactate	(max.) __ __ __	mmol/L	
Vasopressor use	☐ yes	☐ no	
Sedation	☐ yes	☐ no	
Muscle relaxants	☐ yes	☐ no	
Respiratory rate	(min.) __ __ __	(max.) __ __ __	/minute
PaO_2/FiO_2	(min.) __ __ __	(max.) __ __ __	
Mechanical ventilation	☐ yes	☐ no	
Blood urea	(max.) __ __ __	☐ mg/dL or ☐ mmol/L or ☐ BUN (max.) __ __ __ mg/dL	
Blood creatinine	(max.) __ __ __	☐ mg/dL or ☐ mmol/L	
Leucocytes	(min.) __ __ __	(max.) __ __ __	$10^3/mm^3$
Platelets	(min.) __ __ __	$10^3/mm^3$	
Urine output	__ __ __	mL/24hours	
Renal replacement therapy	☐ yes	☐ no	
Serum potassium	(min.) __ __	(max.) __ __	mmol/L
Serum sodium	(min.) __ __ __	(max.) __ __	mmol/L
Total bilirubin	(max.) __ __ __	☐ mg/dL or ☐ mmol/L	
Serum bicarbonate	(min.) __ __	mmol/L	
Glasgow Coma Score	__ __		

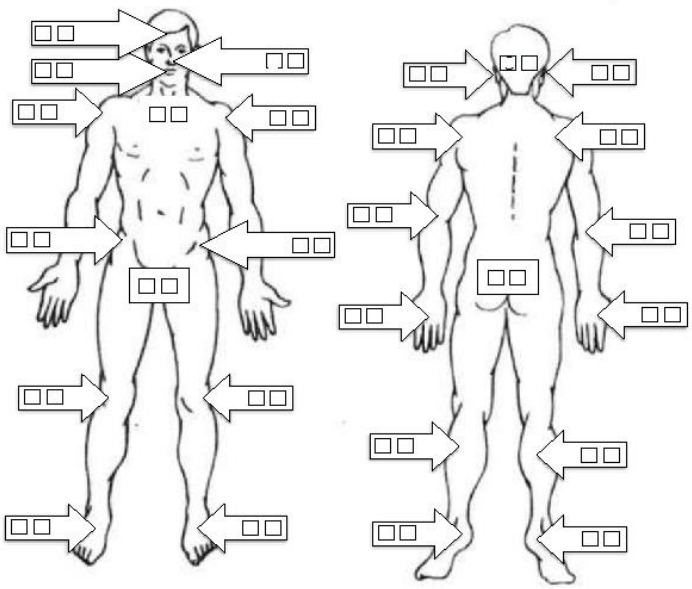
Device use on day of study (see Codes list)

__ __

Pressure injury prevention measures used (see figure and Codes list)

__ __ __ __ __ __ __ __ __ __ __ __

Pressure injuries (see Codes list)



Lesions following fixation of the patient: ☐ wrist(s) ☐ ankle(s) ☐ trunk

Pressure injury risk assessment

Sensory perception: ☐ completely limited ☐ very limited ☐ slightly limited ☐ no impairment

Moisture: ☐ constantly moist ☐ very moist ☐ occasionally moist ☐ rarely moist

Activity: ☐ bedfast ☐ chair-fast ☐ walks occasionally ☐ walks frequently

Mobility: ☐ completely immobile ☐ very limited ☐ slightly limited ☐ no limitation

Nutrition status: ☐ very poor ☐ probably inadequate ☐ adequate ☐ excellent

Friction and shear: ☐ problem ☐ potential problem ☐ no problem

Outcomes

Date of ICU discharge: __ __ / __ __ / __ __ __ __ (dd/mm/yyyy) ☐ alive
☐ dead

Date of hospital discharge:__ __ / __ __ / __ __ __ __ (dd/mm/yyyy) ☐ alive
☐ dead

Patient still in hospital on **7 August 2018** (= 15 May 2018 + 84 days) ☐

Appendix 3: Instructions to complete the center report form and case report form

Participants should register online on our webpage (www.esicm.org/research/decubICUs). Registration deadline is set to two weeks before the data collection date (1 May 2018). Enter the mailing address clearly. Providing a valid email is mandatory to facilitate correspondence during the study. Please inform us timely of any changes in your mailing address/email.
Upon completion of the online registration form, participating centers can chose to use either electronic either paper copy CRFs. To obtain paper copy CRFs, please contact the coordinating center (see contact information) by e-mail, postal mail or fax, specifying by which channel you wish to receive the CRFs (postal mail, fax, …). Please provide a valid postal address or fax number. To access the e-CRFs, each investigator will receive personalised login information to enter our secured website, where all data should be electronically entered. Each ICU will be assigned a code number. Please use this center number in all correspondence with the coordinating center. We invite the investigators to take some time in exploring the data entry area before the start of the study. Please feel free to contact the coordinating centre in case of any questions.

- -

Upon registration, the following data must be provided:

☐ Institution: name of the hospital
☐ Type of hospital: university/academic or non-university hospital
☐ Hospital capacity: the number of beds must be indicated
☐ ICU capacity: the number of beds must be indicated
☐ Type of ICU: the ICU is classified according to the majority (> 60 %) of regular admissions. Please indicate whether your ICU is open or closed.
☐ ICU specialty: the most appropriate choice must be marked. This should be based on the majority of admissions (> 60%). A free text can be added to report other specialties if applicable.
☐ Number of patients treated in 2015: if exact figures are lacking, provide a realistic estimate.

On the study day, two CRFs must be completed, i.e., (1) a CRF providing center-related data and (2) a CRF providing patient-related data.

1. CENTER REPORT FORM

This CRF consists of two sections

Section 1: the same data as upon registration must be provided. These are general data related to the identification of the hospital and participating ICU

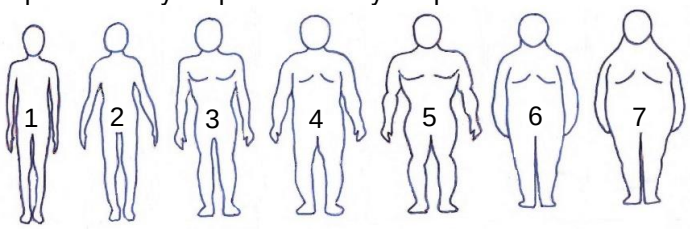
☐ Center nr.: center number provided by the coordinating center.
☐ Institution: name of the hospital
☐ Type of hospital: university/academic or non-university hospital
☐ Hospital capacity: the number of beds must be indicated
☐ ICU capacity: the number of beds must be indicated
☐ Type of ICU: the ICU is classified according to the majority (> 60 %) of regular admissions. Please indicate whether your ICU is open or closed.
☐ ICU specialty: the most appropriate choice must be marked. This should be based on the majority of admissions (> 60%). A free text can be filled in for other specialties if applicable.
☐ Number of patients treated in 2015: if exact figures are lacking, please provide a realistic estimate.

Section 2: pertains to center-related data on the study day

☐ Number of ICU beds occupied at the day of the study: provide number of beds.
☐ Number of nurses on the day of the study: provide the number of nurses per shift.
☐ Availability physiotherapist: take any time of availability during the study day into account.
☐ Participation in other study on pressure ulcers: all studies, even local or institutional, must be taken into account.
☐ Specific section in patient files: relates to any section dedicated to reporting pressure ulcers.
☐ Preventive measures that are used in the unit: use code list provided to indicate all measures used (if necessary) to prevent pressure ulcers in the unit.
☐ Measures used in all patients: from the measures reported in the above question, indicate which are always used in all patients (standard preventive measures).
☐ Risk assessment scales: check the scale(s) used in your unit. For other scales than Norton and Braden scale, please provide the scale's name.
☐ Primary trigger: check what is most appropriate (question not only pertaining to the day of study).

2. CASE REPORT FORM

- ☐ Center nr.: center number provided by the coordinating center.
- ☐ Patient nr.: provide sequential numbers from 1 to n for your center.
- ☐ Date of admission: the format day/month/year should be used.
- ☐ Sex: check the appropriate box.
- ☐ Age: patient's age (in years) at their last birthday.
- ☐ Weight: patient's weight in kilograms must be provided.
- ☐ Length: patient's length in centimetres should be provided.
- ☐ Morphological type: please refer to the figure below to choose the morphological type your patient matches best. Report the digit 1/2/3/4/5/6/7 on the case report form to indicate which of the types on the figure best corresponds with your patient's body shape.



- ☐ Type of admission: surgical is defined as surgery in the 4 weeks preceding admission. Elective surgery is defined as surgery scheduled >24 hours in advance; emergency surgery as scheduled within 24 hours of operation. Trauma is defined as ICU admissions directed related to, or as a complication of, a traumatic event in the 30 days preceding admission. Both trauma and surgical admissions could be chosen simultaneously if a trauma patient was operated on. All other admissions are considered medical. Codes for site of surgery are listed separately (up to 3 sites).
- ☐ Mechanical ventilation on admission: indicate whether the patient was on mechanical ventilation on ICU admission.
- ☐ Admission source: only one choice is possible.
- ☐ Primary diagnosis: the main reason for admission to the ICU. Only one primary diagnosis should be entered (see Codes list).
- ☐ Secondary diagnoses: defined as associated acute conditions on admission. Up to 3 secondary diagnoses are possible (see Codes list). If no relevant secondary diagnoses, please leave blank.
- ☐ Comorbidities: chronic diseases present prior to admission. More than one can be chosen according to the following definitions:
  - COPD: GOLD stage ≥ I.
  - Cirrhosis: defined as the histological development of regenerative nodules surrounded by fibrous bands in response to chronic liver injury, leading to portal hypertension and end stage liver disease.
  - Heart failure: New York Heart Association III-IV.
  - Steroid therapy: defined as immunosuppressive therapy where steroids are used to downregulate uncontrolled immune responses such as in autoimmunity or chronic inflammatory conditions
  - Malnutrition: defined as a state of nutrition in which a deficiency or excess (or imbalance) of energy, protein, and other nutrients causes measurable adverse effects on tissue/body form (body shape, size and composition) and function, and clinical outcome.
  - Cancer: solid tumour.
  - Metastatic cancer: metastases proven by surgery, computed tomography or magnetic resonance scan, or any other method.
  - Hematologic cancer: lymphoma, acute leukaemia, or multiple myeloma.
  - AIDS: HIV positive patients with clinical complications such as Pneumocystis pneumonia, Kaposi's sarcoma, lymphoma, tuberculosis, or toxoplasma infection.
  - Renal failure: defined as the need for chronic renal support or history of chronic renal insufficiency with a serum creatinine over 3.6 gm/dL (300 µmol/L).
  - Immunosuppression: administration in the 6 months prior to ICU admission of steroid treatment (at least 0.3 mg/kg/day prednisolone for at least one month), severe malnutrition, congenital immune-humoral or cellular immune deficiency state.
  - Chemotherapy: in the 6 months prior to ICU admission.
  - Insulin dependent diabetes mellitus: the need, prior to ICU admission, for insulin injections to control blood sugar levels.
  - Impaired mobility: underlying neurological or neuromuscular condition leading to impaired mobility, such as hemi-, para-, or quadriplegia or –paresis, or spasticity.
  - Peripheral vascular disease: defined as lower extremity arterial atherosclerosis.

- ☐ Study day parameters:
  - PaO2/FiO2 should be recorded simultaneously and the lowest value during the day is reported. In absence of respiratory support, use the conversion tables below to estimate the FiO2 and/or PaO2. Artefacts should be avoided (transient decrease during pneumothorax etc.).
  - Mechanical ventilation: indicate whether the patient was on mechanical ventilation on the study day.
  - Urine output: if the patient dies within the first 24 hours, the urine output should be estimated for the 24 hour period (e.g., if the patient dies after 8 hours and had 500 ml of urine during his ICU stay, the urine output would be 1.5 L).
  - Renal replacement therapy: any form of renal therapy (CVVH, CVVHD, etc.).
  - Glasgow Coma Score: report only the "assumed" Glasgow coma score. In other words, a patient who is in deep coma only because he is being treated with high doses of sedative agents should be considered to have a Glasgow coma score of 15.

Conversion tables for PaO_2 and FiO_2 estimation

Estimating PaO_2 from a given SO_2

SO_2 (%)	PaO_2 (mmHg)
80	44
81	45
82	46
83	47
84	49
85	50
86	52
87	53
88	55
89	57
90	60
91	62
92	65
93	69
94	73
95	79
96	86
97	96
98	112
99	145

FiO_2 estimation

Method	O_2 flow (l/min)	Estimated FiO2 (%)
Nasal cannula	1	24
	2	28
	3	32
	4	36
	5	40
	6	44
Nasopharyngeal catheter	4	40
	5	50
	6	60
Face mask	5	40
	6-7	50
	7-8	60
Face mask with reservoir	6	60
	7	70
	8	80
	9	90
	10	95

- ☐ Devices used: indicate all devices used on the day of the study (see Codes list).
- ☐ Pressure injury prevention measures used: indicate all prevention measures used in the patient on the day of the study (see Codes list).
- ☐ Pressure injuries: indicate any pressure injuries on the identification chart. Report pressure stage in one box and indicate whether the lesion is ICU-acquired by checking the second box (see Codes list for more information). If necessary, indicate any pressure injuries outside the arrows indicating high-risk zones. Patients with severe clinical conditions hampering safe pressure injury identification should not be evaluated for the respective risk zones. If it is known that the patient has a pressure injury at the body sites that cannot be safely evaluated, the stage of the pressure injury should be recorded as previously known. If it is unknown whether the patient has a pressure injury at these body sites, this should be indicated with a '?'.

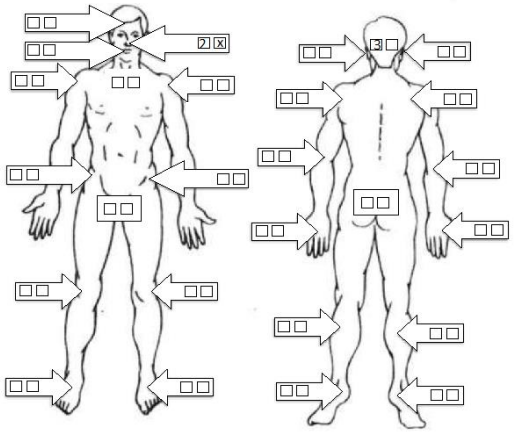


Figure – Exemplary pressure injury identification chart.
Stage 2 pressure injury at the nose; ICU-acquired as second box is checked.
Stage 3 pressure injury at the back of the head; not ICU-acquired as second box is not checked.

Pressure injury risk assessment: the risk for developing pressure ulcers is assessed by means of the six elements included in the Braden score (Bergstrom N, et al., Nurs Res 1987): sensory perception, skin moisture, activity, mobility, friction and shear. For each of the six elements, check the box that corresponds the best with the patients' condition. Find hereby a more detailed description of the boxes to check.

Sensory perception. Ability to respond meaningfully to pressure-related discomfort.

1. Completely limited. Unresponsive (does not moan, flinch, or grasp) to painful stimuli, owing to diminished level of consciousness or sedation. OR Limited ability to feel pain over most of the body.
2. Very limited. Responds only to painful stimuli. Cannot communicate discomfort except by moaning or restlessness. OR Has sensory impairment that limits the ability to feel pain or discomfort over half of the body.
3. Slightly limited. Responds to verbal commands but cannot always communicate discomfort or the need to be turned. OR Has some sensory impairment which limits ability to feel pain or discomfort in 1 or 2 extremities.
4. No impairment. Responds to verbal commands. Has no sensory deficit that would limit ability to feel or voice pain or discomfort.

Moisture. Degree to which skin is exposed to moisture.

1. Constantly moist. Skin is kept moist almost constantly by perspiration, urine, etc. Dampness is detected every time patient is turned.
2. Very moist. Skin is often, but not always, moist. Linen must be changed at least once per shift.
3. Occasionally moist. Skin is occasionally moist requiring an extra linen approximately once daily.
4. Rarely moist. Skin is usually dry. Linen requires changing only at routine intervals.

Activity. Degree of physical activity.

1. Bedfast. Confined to bed.
2. Chairfast. Ability to walk severely limited or non-existent. Cannot bear own weight and/or

must be assisted into chair or wheelchair.

3. Walks occasionally. Walks occasionally during day, but only for very short distances, with or without assistance. Spends majority of each shift in bed or chair.
4. Walks frequently. Walks outside room at least twice daily and inside room at least every 2 hours during walking hours.

Mobility. Ability to change and control body position.

1. Completely immobile. Does not make even slight changes in body or extremity position without assistance.
2. Very limited. Makes occasional slight changes in body or extremity position but unable to make frequent or significant changes independently.
3. Slightly limited. Makes frequent though slight changes in body or extremity position independently.
4. No limitation. Makes major and frequent changes in position without assistance.

Nutrition. Usual food intake pattern.

1. Very poor. Never eats a complete meal. Rarely eats more than half of any food offered. Eats 2 servings or lessof protein (meat or diary products) per day. Takes fluids poorly. Does not take a liquid dietary supplement. OR Has no oral intake and/or has been maintained on clear liquids or IV nutrition for more than 5 days.
2. Probably inadequate. Rarely eats a complete meal and generally eats only about half of any food offered. Protein intake includes only 3 servings per day. Occasionally will take a dietary supplement. OR Receives less than optimum amount of liquid diet or tube feeding.
3. Adequate. Eats more than half of most meals. Eats 4 servings of protein (meat or dietary products) per day. Occasionally will refuse a meal but will usually take a supplement when offered. OR Is receiving tube feeding or total parenteral nutrition that probably meets most of nutritional needs.
4. Excellent. Eats most of every meal. Never refuses a meal. Usually eats 4 or more servings of meat and dietary products. Occasionally eats between meals. Does not require supplementation.

Friction & shear.

1. Problem. Requires moderate to maximum assistance in moving. Complete lifting without sliding against sheets is impossible. Frequently slides down in bed or chair, requiring frequent repositioning with maximum assistance. Spasticity, contractures, or agitation leads to almost constant friction.
2. Potential problem. Moves feebly or requires minimum assistance. During a move, skin probably slides to some extent against the sheets, chair, restraints, or other devices. Maintains relatively good position in chair or bed most of the time, but occasionally slides down.
3. No apparent problem. Moves in bed and in chair independently and has sufficient muscle strength to lift up completely during move. Maintains good position in bed or chair.

Outcomes: Report date of ICU discharge and hospital discharge and survival status of the patient. If the patient is still in the hospital 84 days after the study date, check the box.
After completing both CRFs on the day of study, all completed forms should be kept in a safe place in the unit in order to be available for outcome registration 84 days after the day of study [7 August 2018].

All forms should be submitted before 18 September 2018.

Appendix 4: List of codes

PRIMARY and SECONDARY DIAGNOSES

Description: The primary and maximally 3 secondary diagnoses (acute or acute on chronic disease) should be recorded for all patients as they best reflect the reason(s) for ICU admission.

100 Neurological:

101 Stroke by ischemic or haemorrhagic mechanism (non-traumatic)
102 Intracerebral hemorrhage
103 Subarachnoid hemorrhage
104 Neurologic infection
105 Neurologic neoplasm
106 Neuromuscular disease
107 Dementia
108 Seizures
109 Polyneuritis and polyradiculoneuritis: includes polyneuritis due to infection, inflammation, toxic, Guillain-Barré syndrome
110 Post-anoxic coma
111 Delirium tremens
112 Spinal cord surgery
113 Other

200 Respiratory:

201 Exacerbation of chronic pulmonary disease (either obstructive or non obstructive)
202 Asthma attack
203 Pulmonary embolism
204 Pleural effusion
205 Mechanical airway obstruction
206 Inhalation pneumonitis: induced by gastrointestinal contents, blood, smoke, and/or gases
207 Respiratory neoplasm (include larynx and trachea)
208 Respiratory arrest
209 Pulmonary edema (non-cardiogenic)
210 Community-acquired bacterial pneumonia
211 Healthcare-associated bacterial pneumonia
212 Viral pneumonia
213 Fungal pulmonary infection
214 Near-drowning
215 Other

300 Cardiovascular / vascular:

301 Acute myocardial infarction
302 Unstable angina
303 Cardiac arrest
304 Cardiopathy: includes ischemic, valvular, hypertensive, alcoholic and other, non-infectious forms
305 Cardiogenic shock
306 Congestive heart failure
307 Rhythm disturbance
308 Perivascular disease
309 Hypertension
310 Aortic aneurysm
311 Dissecting/ruptured aorta
312 Elective abdominal aneurysm repair
313 Peripheral vascular surgery
314 Valvular heart surgery
315 CABG
316 Peripheral artery bypass graft
317 Carotid endarterectomy
318 Endocarditis
319 Other

400 Renal/genito-urinary tract:
- 401 Acute kidney injury
- 402 Chronic renal failure
- 405 Renal neoplasia
- 406 Non-malignant gynaecological diseases, non-malignant: lesions of ovary, uterus, cervix, vulvae, vagina not due to neoplasia
- 407 Malignant gynaecological diseases
- 408 Urosepsis
- 409 Other

500 Hematological:
- 501 Transfusion reaction
- 502 Neutropenia
- 503 Neutropenic sepsis
- 504 Thrombocytopenia, coagulopathy
- 503 Non-malignant disease (e.g. anaemia, aplastic anaemia, methemoglobinemia, congenital disorders of blood coagulation factors)
- 504 Malignant disease: lymphoma, acute leukaemia and multiple myeloma
- 505 Other

600 Digestive:
- 601 Hepatic failure
- 602 Gastro-intestinal perforation/obstruction/rupture
- 603 Gastro-intestinal bleeding due to varices, ulcer or diverticulitis
- 604 Inflammatory disease (ulcerative colitis, crohn's disease)
- 605 Neoplasia of the upper digestive tract (oesophageal, gastric or duodenal)
- 606 Neoplasia of the lower digestive tract (colon and rectum)
- 607 Pancreatitis
- 608 Other

700 Metabolic:
- 701 Drug overdose, intoxication
- 702 Diabetic ketoacidosis
- 703 Metabolic coma
- 704 Endocrinopathy
- 705 Other

800 Pregnancy-related:
- 801 Eclampsia, preeclampsia
- 802 HELLP syndrome
- 803 Delivery haemorrhage
- 804 Other

900 Trauma & skin:
- 901 Head trauma (isolated)
- 903 Polytrauma, without brain trauma
- 904 Polytrauma, with brain trauma
- 905 Spinal cord injury
- 905 Burn injury
- 907 Skin lesions requiring intensive care, non-traumatic (e.g. toxic epidermal necrolysis)
- 908 Pressure ulcer requiring surgical debridement or extensive wound care
- 909 Severe surgical wound infection
- 910 Other

000 Other diseases

SITE(S) OF SURGERY

Description: For patients undergoing surgery the anatomical site of surgery should be indicated. Up to three surgery sites can be reported on the case report form. Invasive radiological procedures or definitive pacemaker insertions should not be considered as surgical procedures.

000 No surgery in the current hospital stay

100 Neurosurgery:
- 101 Cerebrovascular accident: neurosurgery of intracranial hematoma or other non-traumatic accident (haemorrhage, aneurysm)
- 102 Intracranial tumour: neurosurgery for any type of tumour primary or secondary
- 103 Spinal surgery
- 104 Ear, nose and throat surgery
- 105 Maxillo-facial surgery
- 106 Other

200 Thoracic surgery:
- 201 Pneumonectomy
- 202 Lobectomy
- 203 Pleural surgery: includes all surgery on pleura either for tumour or talcage/abrasion for pneumothorax
- 204 Lung transplantation
- 205 Other

300 Cardiac surgery:
- 301 Valvular, without coronary artery by-pass graft (CABG): surgical treatment of valvulopathies without coronary surgery
- 302 Valvular with CABG: valvular repair with coronary surgery
- 303 CABG without valvular repair
- 304 Other: pericardial effusion, congenital anomaly, ventricular aneurysm, neoplastic disease, vena cava clipping/filter
- 305 Heart transplantation
- 306 Heart & lung transplantation
- 307 Major aortic surgery: includes all surgery on aorta for dissection, atheroma, aneurysm
- 308 Carotid endarterectomy: includes all surgery on the carotid artery
- 309 Other major vascular surgery: includes all surgery on intrathoracic or intraabdominal vessels
- 310 Peripheral vascular surgery: includes all surgery on non-intracranial, non-intrathoracic, non-intraabdominal vessels, either arteries or veins with or without by-pass graft
- 311 Other

400 Renal-urinary tract:
- 401 Renal surgery
- 402 Urologic surgery

600 Digestive:
- 601 Upper gastro-intestinal surgery (up to and including the jejunum)
- 602 Lower gastro-intestinal surgery
- 603 Biliary tract: surgery of gallbladder and/or biliary tract
- 604 Liver: partial hepatectomy, portal-systemic shunt surgery
- 605 Liver transplantation
- 606 Pancreas

700 Metabolic:
- 701 Endocrine surgery (thyroid, adrenal, pancreas etc.)

800 Obstetric/gynaecologic:
- 801 Obstetric surgery: Caesarean section, surgery for ectopic pregnancy, peri- or post-partum haemorrhage, intra-uterine death
- 802 Gynaecological surgery: surgery of uterus, ovaries, cervix, genitalia

900 Trauma:
- 901 Brain: surgery for subdural, epidural, intracerebral haematoma or skull fracture
- 902 Thorax: surgery of intra-thoracic organs (cardiac, respiratory or digestive tract) and vessels
- 903 Abdomen
- 904 Limb
- 905 Multiple
- 906 Other

DEVICES

Description: For patients in which devices are used the type of device should be indicated. Report all devices used.

100 Respiratory tract:
- 101 Oral endotracheal tube
- 102 Nasal endotracheal tube
- 103 Tracheostomy with cannula
- 104 Nasal oxygen cannula
- 105 Mask for non-invasive ventilation
- 106 Oxygen mask
- 107 Other

200 Peripheral intravascular catheters:
- 201 Right hand
- 202 Left hand
- 203 Right arm
- 204 Left arm
- 205 Right foot
- 206 Left foot
- 207 Other location

300 Central venous catheters:
- 301 Internal jugular vein right
- 302 Internal jugular vein left
- 303 Subclavian vein right
- 304 Subclavian vein left
- 305 Femoral vein right
- 306 Femoral vein left
- 307 Other location

400 Arterial line:
- 401 Radial artery, right
- 402 Radial artery, left
- 403 Femoral artery, right
- 404 Femoral artery, left
- 405 Other location

500 Urinary tract catheter:
- 501 Urethral
- 502 Suprapubic
- 503 Other

600 Feeding tubes:
- 601 Orogastric
- 602 Nasogastric
- 603 Percutane Endoscopic Gastrostomy (PEG)
- 604 Duodenal / jejunal

000 Other devices

PRESSURE INJURY STAGES

Description: Pressure injury stages definitions used are published as National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and Treatment of Pressure Ulcers: Quick Reference Guide. Emily Haesler (Ed.). Cambridge Media: Osborne Park, Western Australia; 2014.
The case report form includes a figure to report pressure injury development at different body sites. Each site is marked by two selection boxes. Use these boxes next to each corresponding body site to indicate :

- the category/stage of pressure injuries (first box, codes 1/2/3/4/U/S)
- whether the injury was present upon ICU admission (check second box if ICU acquired)

Box 1: category/stage of pressure injuries (codes 1/2/3/4/U/S)

1 - Category/Stage I: Non-blanchable erythema
Intact skin with non-blanchable redness of a localized area usually over a bony prominence. Darkly pigmented skin may not have visible blanching; its color may differ from the surrounding area. The area may be painful, firm, soft, warmer or cooler as compared to adjacent tissue. Category I/Stage I may be difficult to detect in individuals with dark skin tones. May indicate “at risk” individuals (a heralding sign of risk).

2 - Category/Stage II: Partial thickness skin loss
Partial thickness loss of dermis presenting as a shallow open ulcer with a red pink wound bed, without slough. May also present as an intact or open/ruptured serum-filled filled blister. Presents as a shiny or dry shallow ulcer without slough or bruising*. This Category/Stage should not be used to describe skin tears, tape burns, perineal dermatitis, maceration or excoriation. *Bruising indicates deep tissue injury.

3 – Category/Stage III: Full thickness skin loss
Full thickness tissue loss. Subcutaneous fat may be visible but bone, tendon or muscle are *not* exposed. Slough may be present but does not obscure the depth of tissue loss. *May* include undermining and tunneling. The depth of a Category/Stage III pressure ulcer varies by anatomical location. The bridge of the nose, ear, occiput and malleolus do not have subcutaneous tissue and Category/Stage III ulcers can be shallow. In contrast, areas of significant adiposity can develop extremely deep Category/Stage III pressure ulcers.
Bone/tendon is not visible or directly palpable.

4 - Category/Stage IV: Full thickness tissue loss
Full thickness tissue loss with exposed bone, tendon or muscle. Slough or eschar may be present on some parts of the wound bed. Often include undermining and tunneling. The depth of a Category/Stage IV pressure ulcer varies by anatomical location. The bridge of the nose, ear, occiput and malleolus do not have (adipose) subcutaneous tissue and these ulcers can be shallow. Category/Stage IV ulcers can extend into muscle and/or supporting structures (e.g., fascia, tendon or joint capsule) making osteomyelitis possible. Exposed bone/muscle is visible or directly palpable.

U - Unstageable/ Unclassified: Full thickness skin or tissue loss –: depth unknown
Full thickness tissue loss in which the base of the ulcer is covered by slough (yellow, tan, gray, green or brown) and/or eschar (tan, brown or black) in the wound bed. Until enough slough and/or eschar are removed to expose the base of the wound, and therefore Category/Stage cannot be determined. Stable (dry, adherent, intact without erythema or fluctuance) eschar on the heels serves as “the body’s natural (biological) cover” and should not be removed.

S - Suspected Deep Tissue Injury: depth unknown
Purple or maroon localized area of discolored intact skin or blood-filled blister due to damage of underlying soft tissue from pressure and/or shear. The area may be preceded by tissue that is painful, firm, mushy, boggy, warmer or cooler as compared to adjacent tissue. Deep tissue injury may be difficult to detect in individuals with dark skin tones. Evolution may include a thin blister over a dark wound bed. The wound may further evolve and become covered by thin eschar. Evolution may be rapid exposing additional layers of tissue even with optimal treatment.

Box 2: ulcer present upon ICU admission
Check the second box if ICU acquired.
Please refer to the instructions form for an exemplary pressure ulcer identification chart.

PREVENTIVE MEASURES
Description: All measures **used specifically in order to prevent pressure ulcers** on the study day should be reported. Measures listed which are commonly used on the ward but not specifically in order to prevent pressure ulcers should NOT be scored (e.g. use of body moisturizing products, massage).

100 Low-tech (non-powered) support surfaces
- 101 Standard foam mattresses
- 102 Alternative foam mattresses/overlays (e.g. convoluted foam, cubed foam)
- 103 Gel-filled mattresses/overlays
- 104 Fibre-filled mattresses/overlays
- 105 Air-filled mattresses/overlays
- 106 Water-filled mattresses/overlays
- 107 Bead-filled mattresses/overlays
- 108 Foam cushions
- 109 Non-foam cushions (except ring cushions)
- 110 Ring cushions
- 111 Sheepskins

200 High-tech support surfaces
- 201 Alternating-pressure mattresses/overlays: patient lies on air-filled sacs which sequentially inflate and deflate and relieve pressure at different anatomical sites for short periods; may incorporate a pressure sensor.
- 202 Air-fluidised beds: warmed air circulated through fine ceramic beads covered by a permeable sheet; allows support over a larger contact area.
- 203 Low-air-loss beds: patients are supported on a series of air sacs through which warmed air passes.
- 204 Continuous bedside pressure mapping devices indicating excessive pressures.

300 Various
- 301 Turning beds/frames: these devices work by either aiding manual repositioning of the patient, or by automatic motor-driven turning and tilting. They may have a static or an alternating support surface in conjunction with the frame.
- 302 Patient repositioning: patient is repositioned in the bed and / or chair within predefined fixed timeframes.
- 303 Ice friction
- 304 Blow-drying
- 305 Bolstering of the heels
- 306 Floating heels
- 307 Hydrating body moisturizers
- 308 Soft silicone multi-layered foam dressing

000 Other preventive measures

E-learning module: Stages of pressure injuries

Disclaimer

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Classification of pressure injuries

The International Pressure Injury Category System (2009) was developed by:

- the National Pressure Ulcer Advisory Panel (NPUAP)
- the European Pressure Ulcer Advisory Panel (EPUAP)

and incorporated in the International Clinical Practice Guideline (2014)* developed by:

- the National Pressure Ulcer Advisory Panel (NPUAP)
- the European Pressure Ulcer Advisory Panel (EPUAP)
- the Pan Pacific Pressure Injury Alliance (PPPIA)

*This consensus guideline serves as basis for this educational module

Pressure injury

Definition

A pressure injury is a localized injury to the skin and/or underlying tissue usually over a bony prominence, as a result of pressure, or pressure in combination with shear.

A number of contributing or confounding factors are also associated with pressure injuries; the significance of these factors is yet to be elucidated.

Stages* of pressure injuries

- Stage I: Nonblanchable Erythema
- Stage II: Partial Thickness Skin Loss
- Stage III: Full Thickness Skin Loss
- Stage IV: Full Thickness Tissue Loss
- Unstageable: Depth Unknown
- Suspected Deep Tissue Injury: Depth Unknown

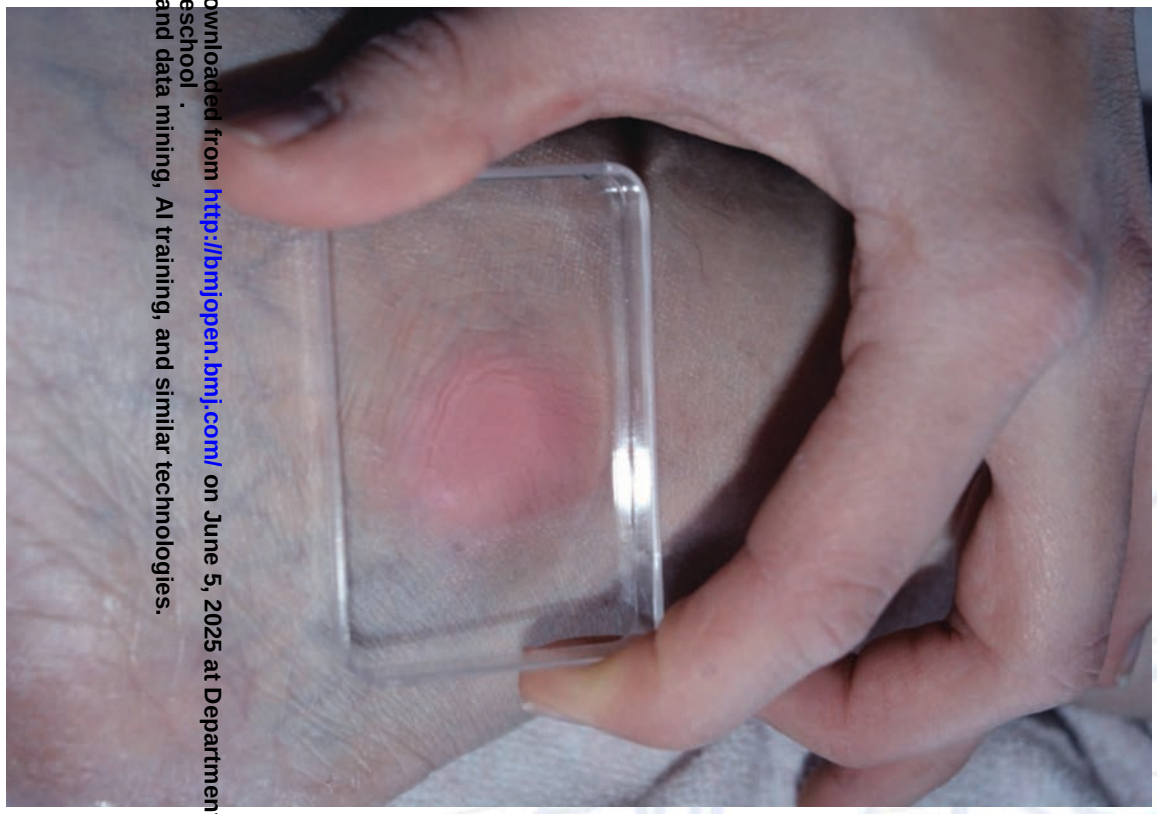
*For convenience sake, the term "Stage" is used in this educational module when referring to the term "Category/ Stage" used in the NPUAP/EPUAP Clinical Practice Guideline

Stage I: Nonblanchable Erythema

Definition: intact skin with nonblanchable redness of a localized area, usually over a bony prominence

The area may be painful, firm, soft, warmer or cooler compared to surrounding tissue. Individuals with nonblanchable erythema are particularly at risk for developing higher stages of pressure injuries.

May be difficult to detect in individuals with darkly pigmented skin: it may be recommended to rely on assessment of skin temperature, changes in tissue consistency and pain rather than identification of nonblanchable erythema.

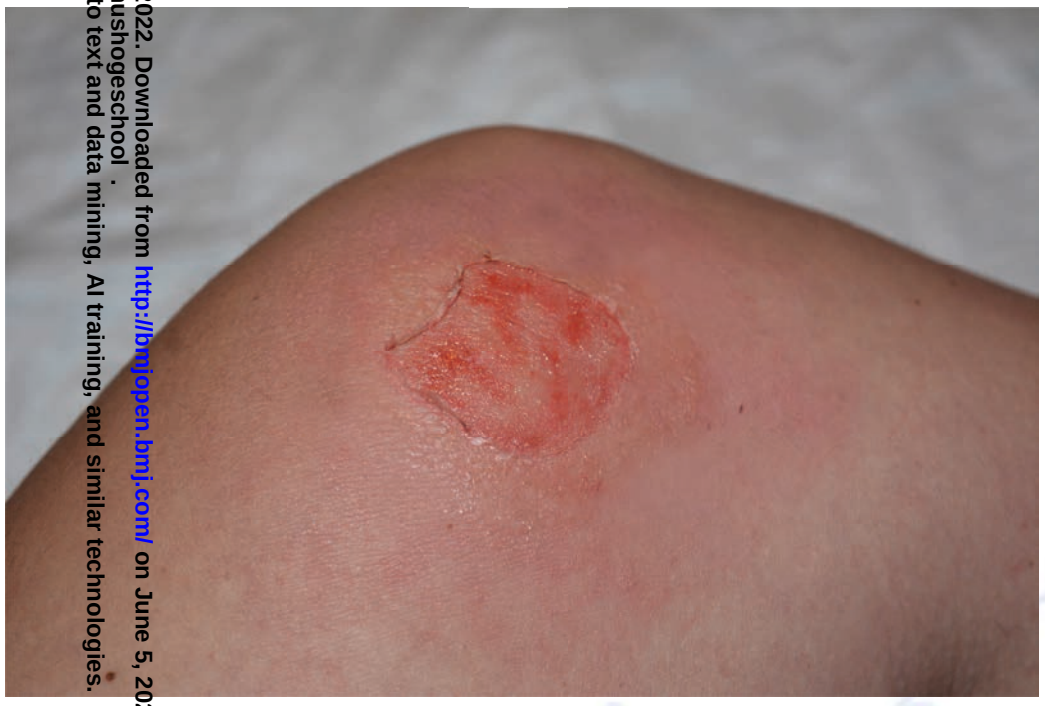


Stage II: Partial Thickness Skin Loss

Definition: partial thickness loss of dermis presenting as a shiny or dry shallow open ulcer with a red pink wound bed without slough or bruising. May also present as an intact or open/ruptured serum-filled blister

In individuals with darkly pigmented skin, assess:

- skin heat
- skin tenderness
- change in tissue consistency
- pain



This stage should **not be used** to describe skin tears, tape burns, perineal dermatitis, maceration or excoriation

Stage III: Full Thickness Skin Loss

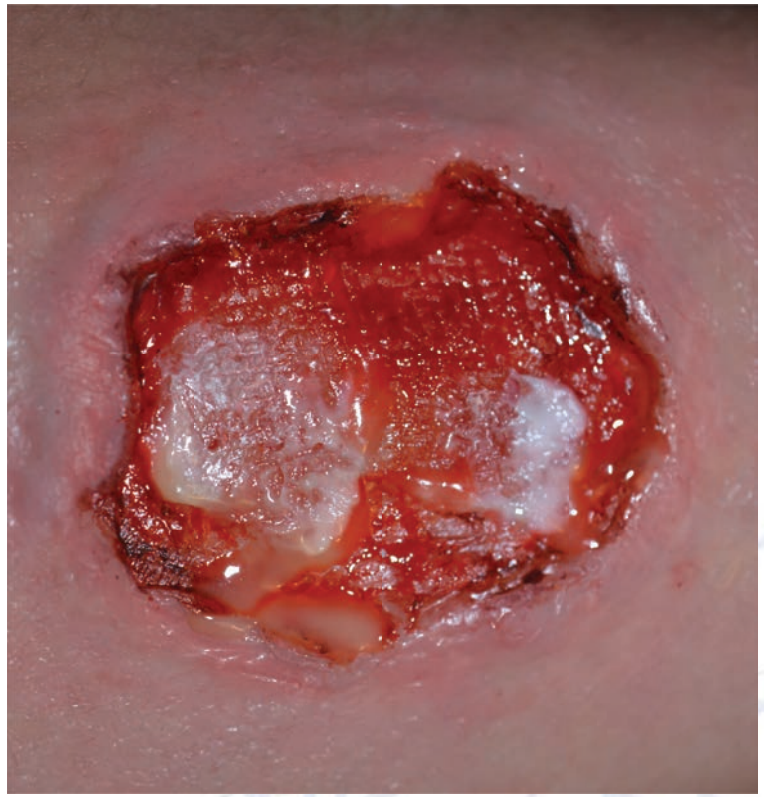
Definition: full thickness tissue loss

Subcutaneous fat may be visible; bone, tendon or muscle are not exposed. Slough may be present but does not obscure the depth of tissue loss. May include undermining and tunnelling

The depth of the injury varies by anatomical location:

- shallow Stage III: often in areas with little subcutaneous tissue e.g. bridge of the nose, ear, occiput and malleolus
- extremely deep Stage III: often in areas of significant adiposity

In individuals with darkly pigmented skin: assess skin heat, skin tenderness, change in tissue consistency and pain



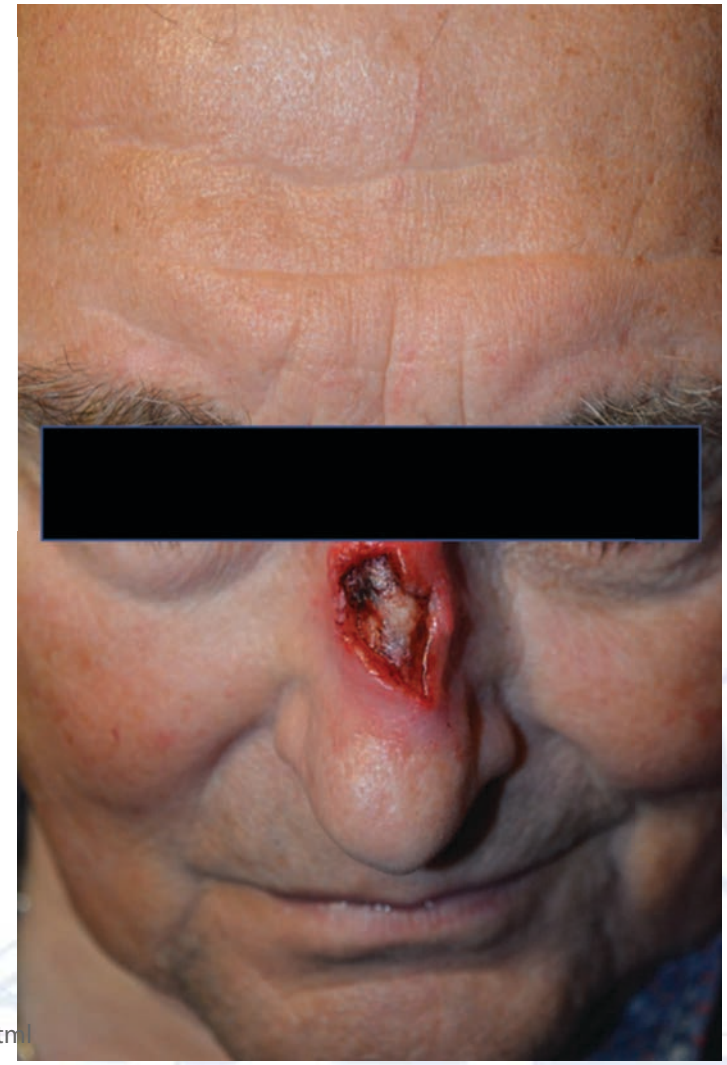
Stage IV: Full Thickness Tissue Loss

Definition: full thickness tissue loss with exposed bone, tendon, muscle (visible or directly palpable)

Depth varies by anatomical location with shallow Stage IV often observed in areas with little subcutaneous tissue e.g. bridge of the nose, ear, occiput and malleolus

Possible extension into muscle and/or supporting structures (fascia, tendon, joint capsule): risk of osteomyelitis. Slough or eschar may be present on parts of the wound bed; often with undermining and tunnelling

In individuals with darkly pigmented skin: assess skin heat, skin tenderness, change in tissue consistency and pain



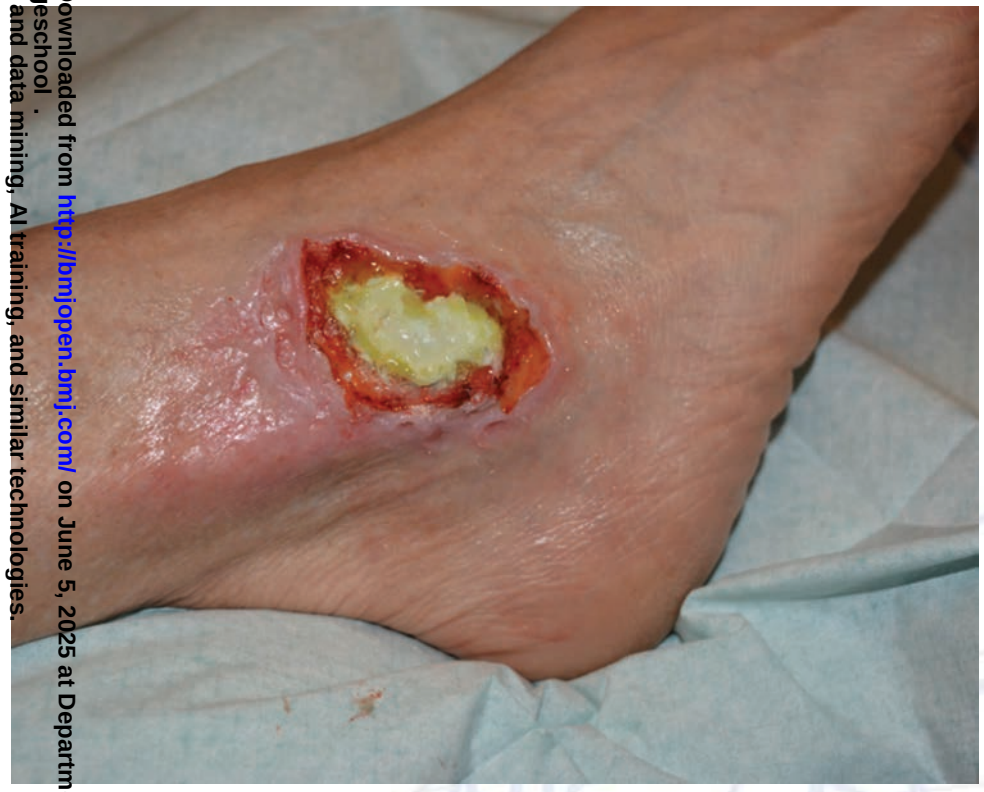
Unstageable: Depth Unknown

Definition: full thickness tissue loss in which the base of the injury is covered by slough (yellow, tan, grey, green or brown) and/or eschar (tan, brown or black) in the wound bed

Depth and stage are not to be determined until enough slough and/or eschar is removed to expose the base of the wound

Stable (dry, adherent, intact without erythema or fluctuance) eschar on the heels should not be removed ('the body's biological cover')

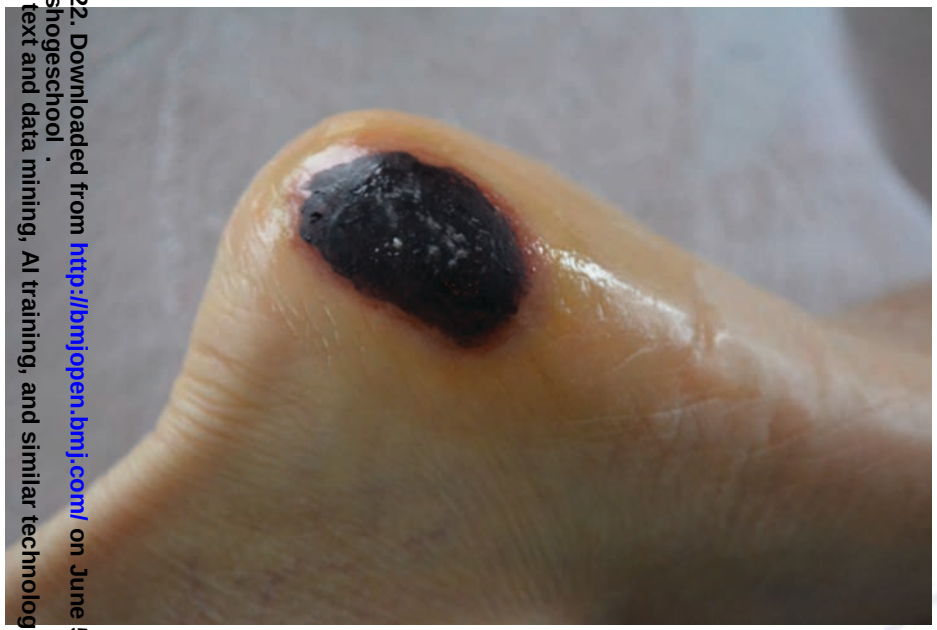
In individuals with darkly pigmented skin: assess skin heat, skin tenderness, change in tissue consistency and pain



Suspected Deep Tissue Injury: Depth Unknown

Definition: Purple or maroon localized area of discoloured intact skin or blood-filled blister due to damage of underlying soft tissue from pressure and/or shear

In individuals with darkly pigmented skin: assess skin temperature, change in tissue consistency and pain



Potential evolution of the wound:

- thin blister over a dark wound bed, covered by thin eschar
- rapid deterioration
- exposure of additional layers of tissue
- regardless of optimal treatment

Surrounding area:

- painful
- firm
- mushy
- boggy
- warmer/cooler

Inspection of the skin: Methods

Inspection of the skin for erythema in patients 'at risk' of developing a pressure injury:

- cause and extent of erythema
- skin redness: blanchable or nonblanchable? → finger or disc method

Finger pressure method:
a finger is pressed on the erythema for three seconds and blanching is assessed following removal of the finger

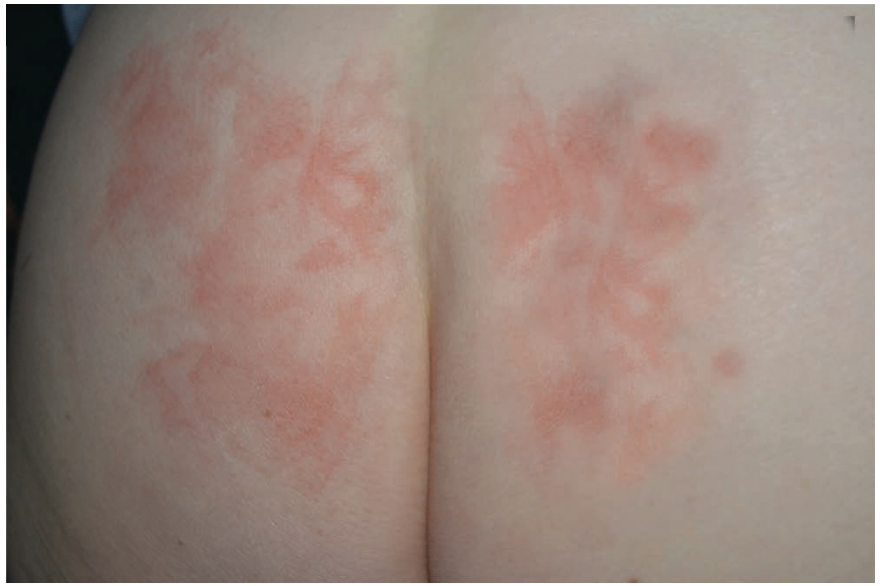
Transparent disk method:
a transparent disk is used to apply pressure equally over an area of erythema, and blanching can be observed underneath the disk during its application.

Attention: MASD is NOT pressure injury

Moisture-associated skin damage (MASD) is commonly confused with pressure injury, while origin and treatment differ completely.

Definition: MASD is inflammation and erosion of the skin caused by prolonged exposure to various sources of moisture, including urine or stool, perspiration, wound exudate, mucus, or saliva.

In relation to pressure injuries, MASD mostly appears as Incontinence Associated Dermatitis (IAD), which is typical for the sacral area.



	Pressure injury	Moisture-associated skin damage
Etiology	Pressure - shear	Prolonged exposure to sources of moisture
Location	Usually over a bony prominence	Anywhere moisture can accumulate
Distribution	Localized area, distinct edges	Diffuse different spots, diffuse irregular edges
Depth	Partial or full thickness skin loss	Superficial - partial thickness skin loss

Differentiate pressure injuries also from other wound types

Besides MASD, more wound types may be incorrectly classified as pressure injury. Some common examples are:

- venous ulcers
- neuropathic ulcers
- skin tears
- intertrigo

Literature

Gray M., Black J.M., Baharestani M. M. et al.; Moisture-Associated Skin Damage Overview and Pathophysiology. J Wound Ostomy Continence Nurs. 2011; 38(3): 233-241.

Gray M., Bliss D.Z., Doughty D.B. et al.; Incontinence-Associated Dermatitis. A Consensus. J Wound Ostomy Continence Nurs. 2007; 34(1): 45-54.

National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and Treatment of Pressure Ulcers: Quick Reference Guide. Emily Haesler (Ed.). Cambridge Media: Osborne Park, Western Australia; 2014.

Zulkowski K. Diagnosing and Treating Moisture-Associated Skin Damage. Adv Skin Wound Care. 2012; 25(5): 231-236.

Test your knowledge

The next slides will help you to check if you master the contents of this module.

There are 22 slides with pictures representing different stages of pressure injuries and moisture-associated skin damage (MASD). It is up to you to classify each pressure injury correctly according to the NPUAP/EPUAP classification and to recognize MASD as a non-pressure injury related wound type. Each slide with picture is followed by a slide that provides the correct answer.

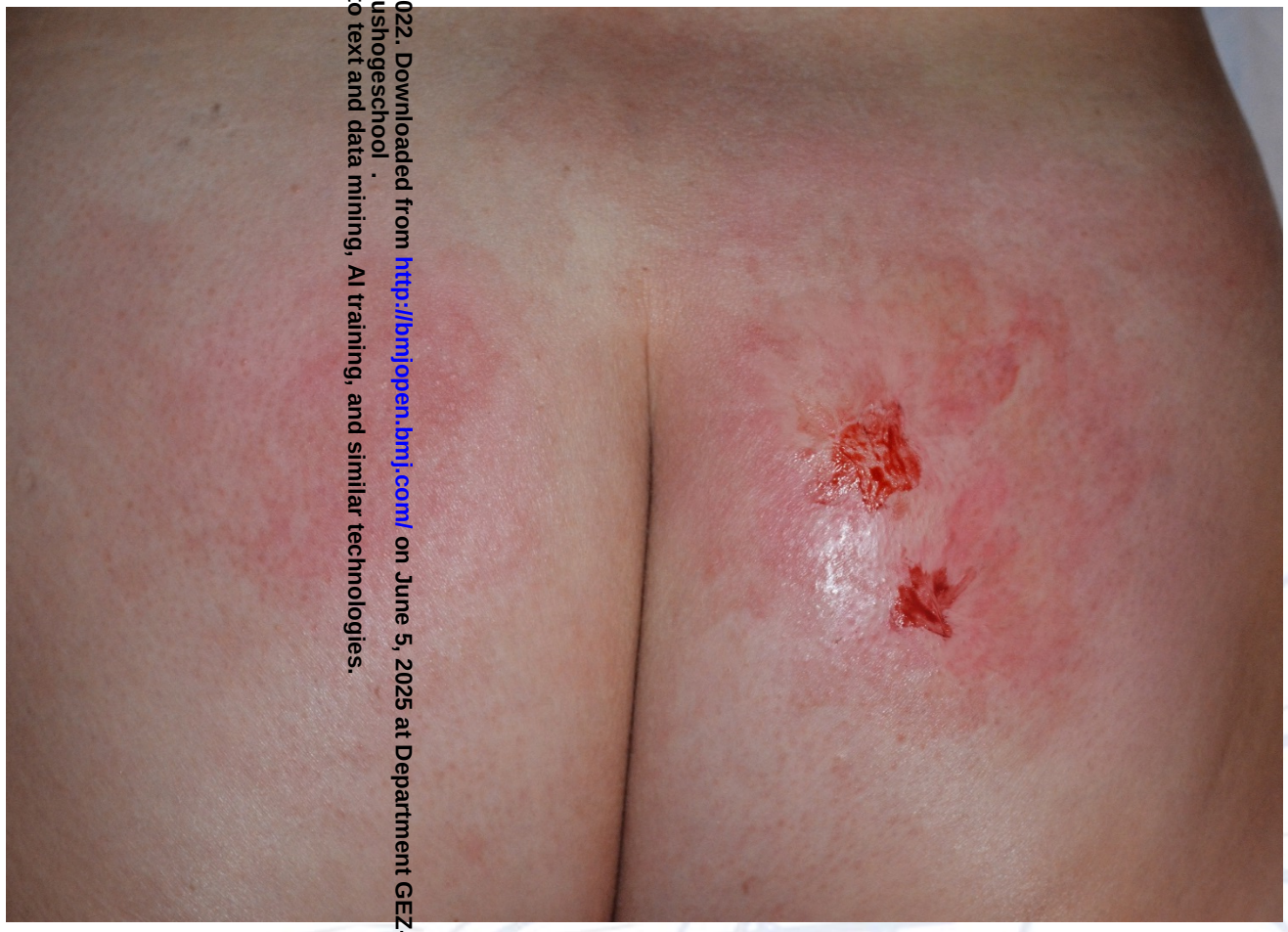
Although we tried to use representative photographs for this test, we are well aware that it is not obvious to evaluate stages of pressure injuries without relevant clinical information.

Good luck!

Question 1

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

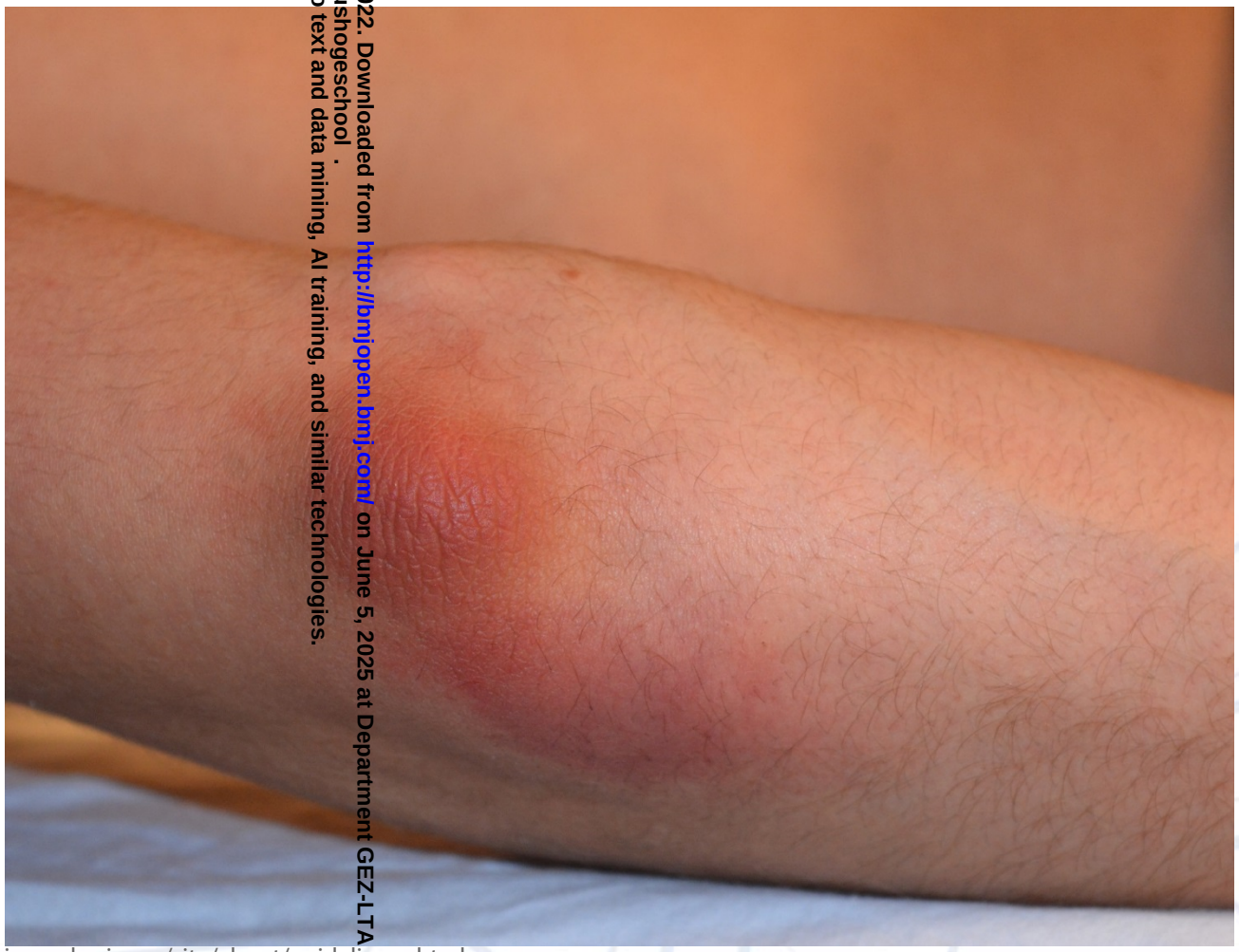
Correct answer: moisture-associated skin damage (MASD), possibly incontinence-related.

Explanation: there is a noticeable erythema of the skin. Skin damage is superficial and the edges are irregular. There is also some degree of maceration present, probably due to friction. The effects of friction on a wet skin are more damaging that on the dry skin.

Question 2

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

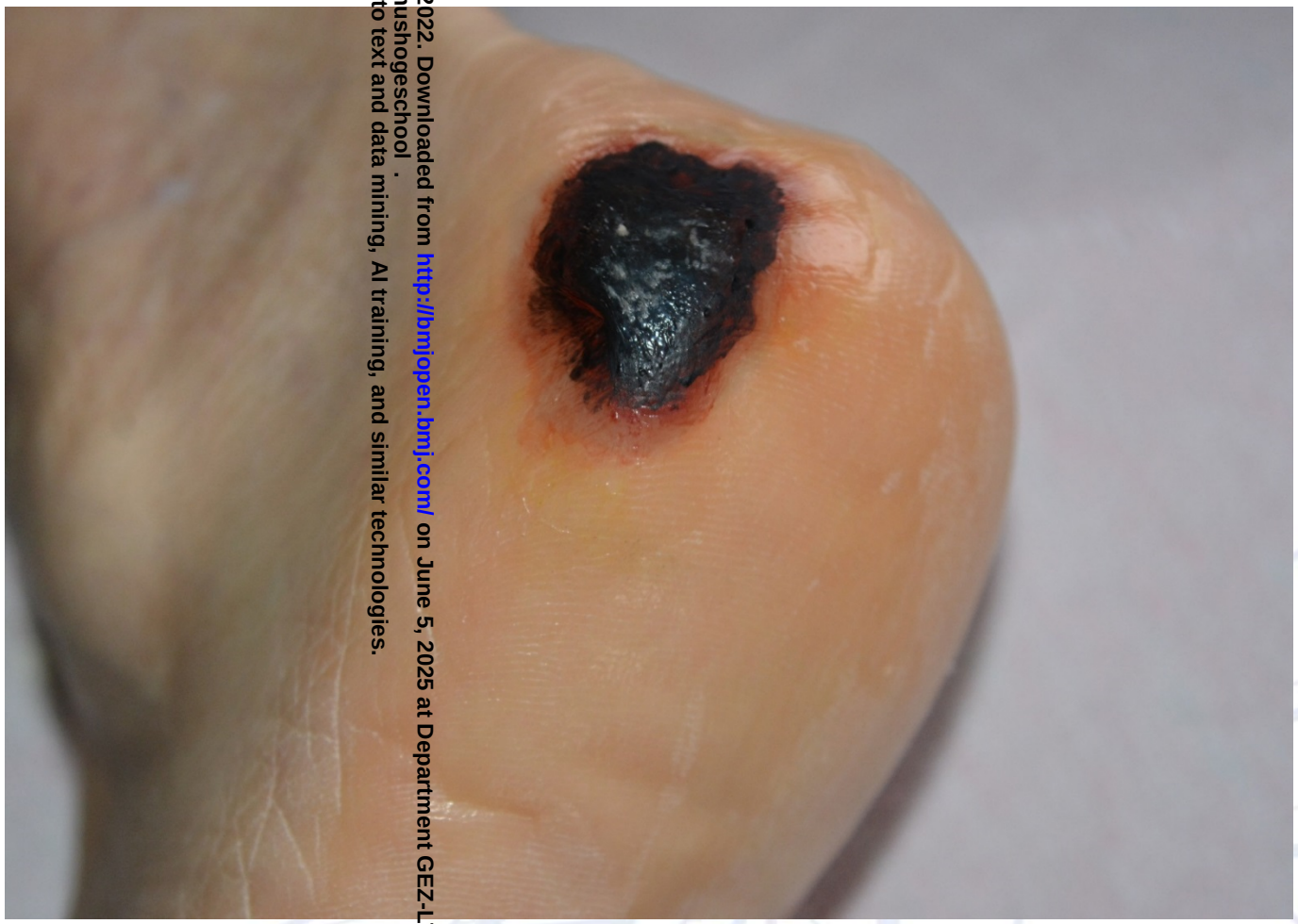
Correct answer: Stage I pressure injury

Explanation: the skin is intact and the erythema is nonblanchable.

Question 3

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

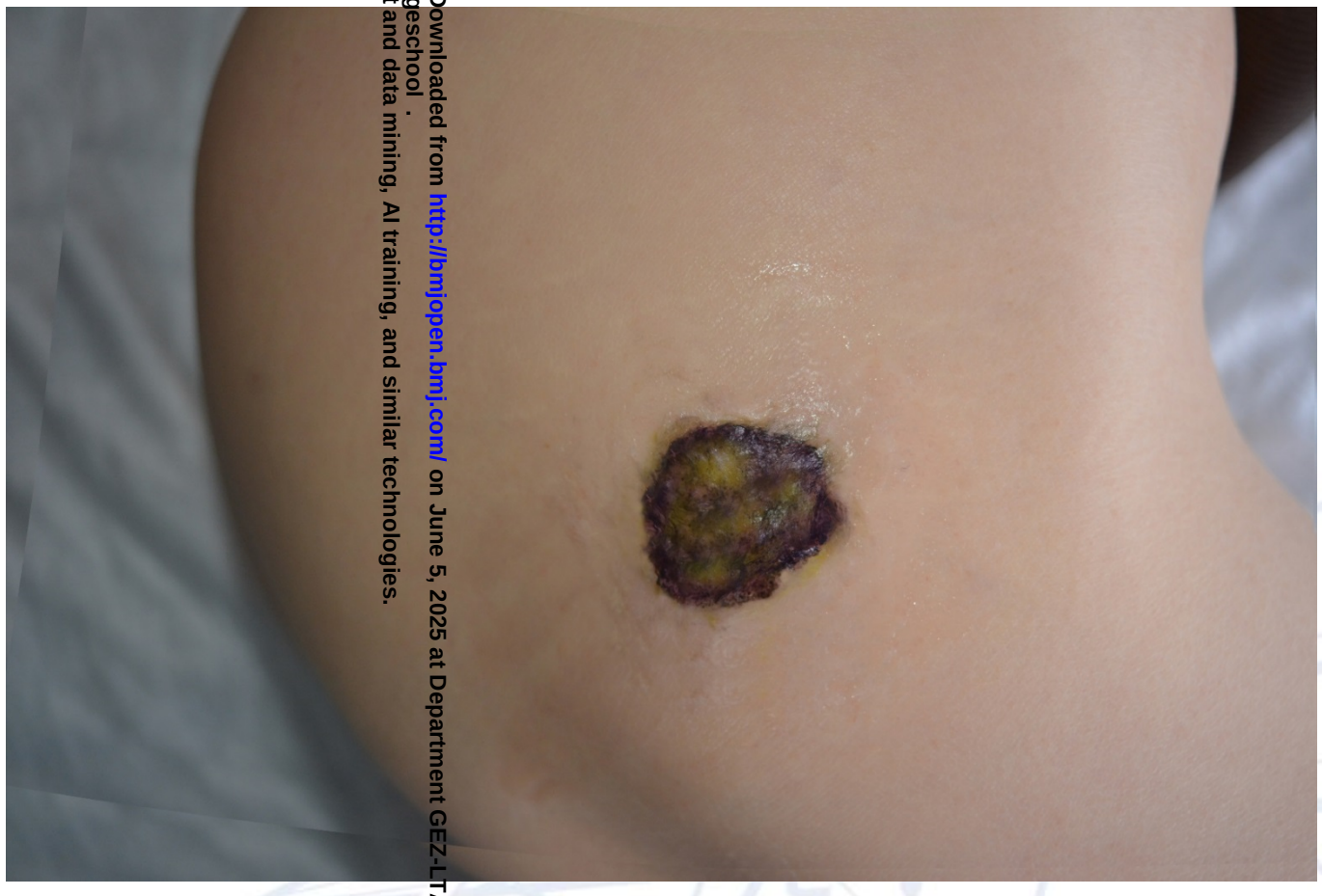
Correct answer: suspected deep tissue injury

Explanation: a dark eschar covers the localized wound area. The skin surrounding the eschar is coloured maroon. The visible skin is intact. We can assume that the underlaying soft tissue has been damaged.

Question 4

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

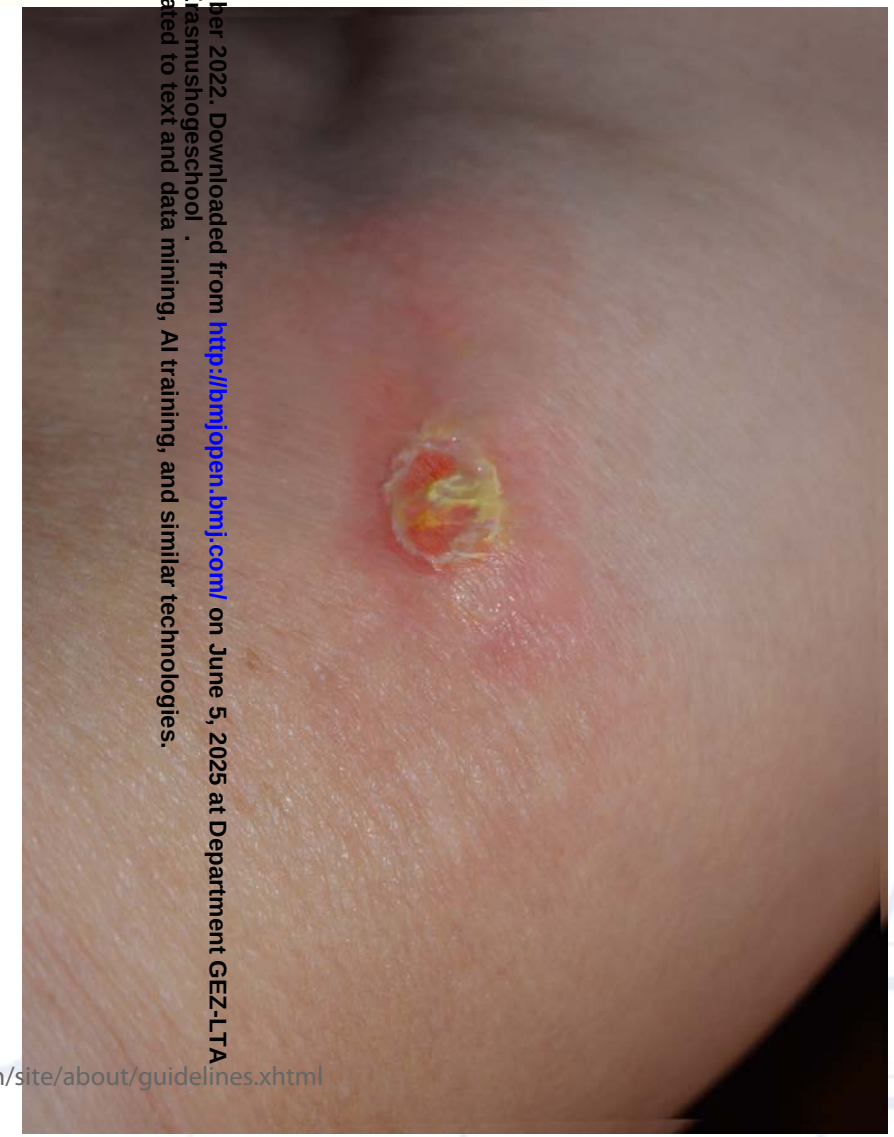
Correct answer: suspected deep tissue injury

Explanation: a necrotic eschar covers the injury. The visible skin is intact. We can assume that the underlaying soft tissue has been damaged. To determine the status of underlaying tissue, the eschar has to be removed first.

Question 5

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

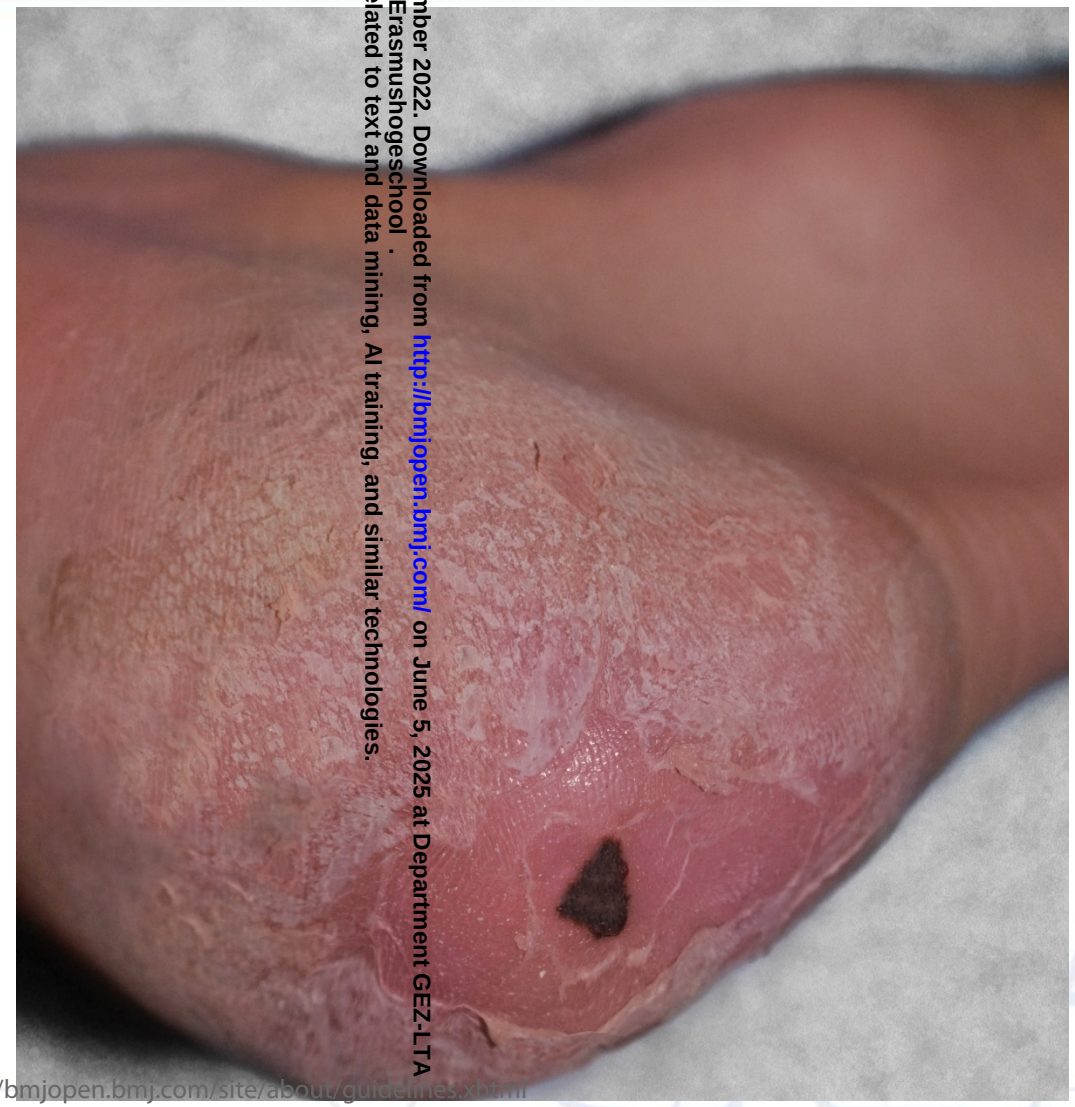
Correct answer: Stage III pressure injury

Explanation: there is a full thickness tissue loss with no exposition of the bone. Slough is present without interfering with the examination of the tissue loss. This is a shallow stage III injury because the tissue damage is on the iliac crest where there is little/no subcutaneous tissue.

Question 6

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

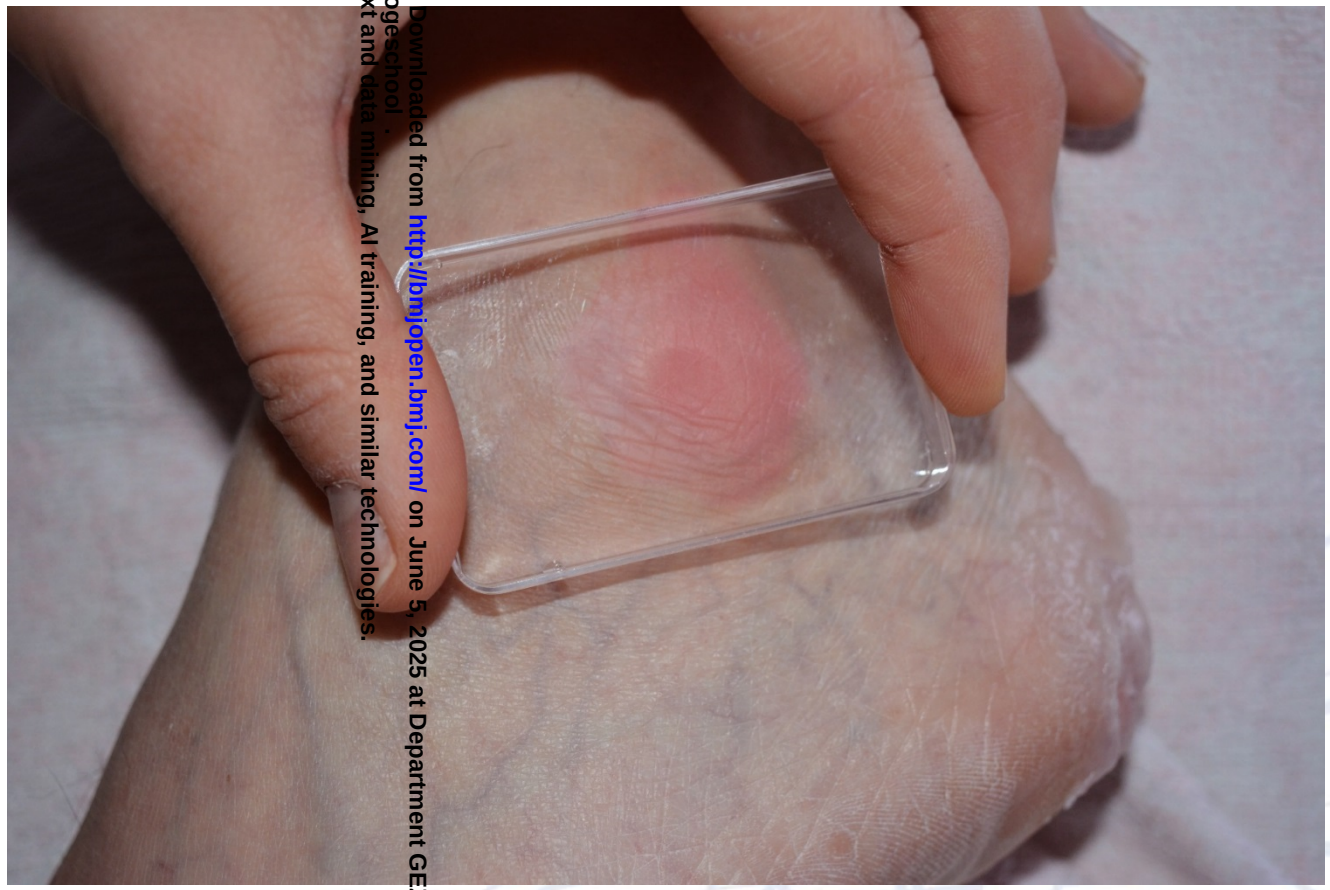
Correct answer: unstageable pressure injury

Explanation: a stable black eschar is covering the wound. It is impossible to determine how deep the wound is but probably there is a full thickness tissue loss.

Question 7

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

Correct answer: Stage I pressure injury

Explanation: the skin is intact and the erythema is nonblanchable as determined by the transparent disk method. The ankle is a typical area for developing Stage I pressure injury because of its bony prominence.

Question 8

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage

Answer

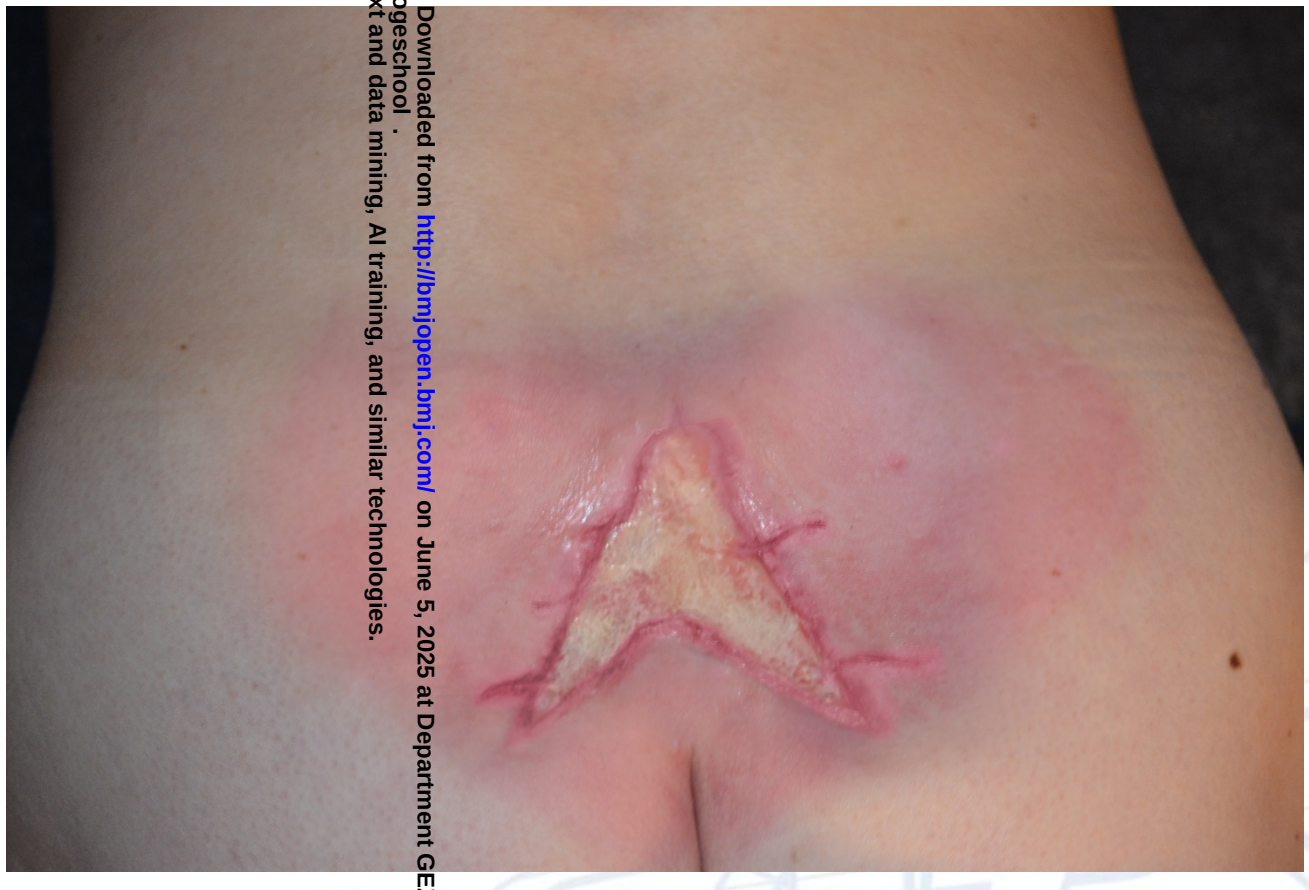
Correct answer: suspected deep tissue injury

Explanation: the entire wound area is coloured purple/maroon and the skin is intact. It can be assumed that the underlying soft tissue is damaged.

Question 9

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

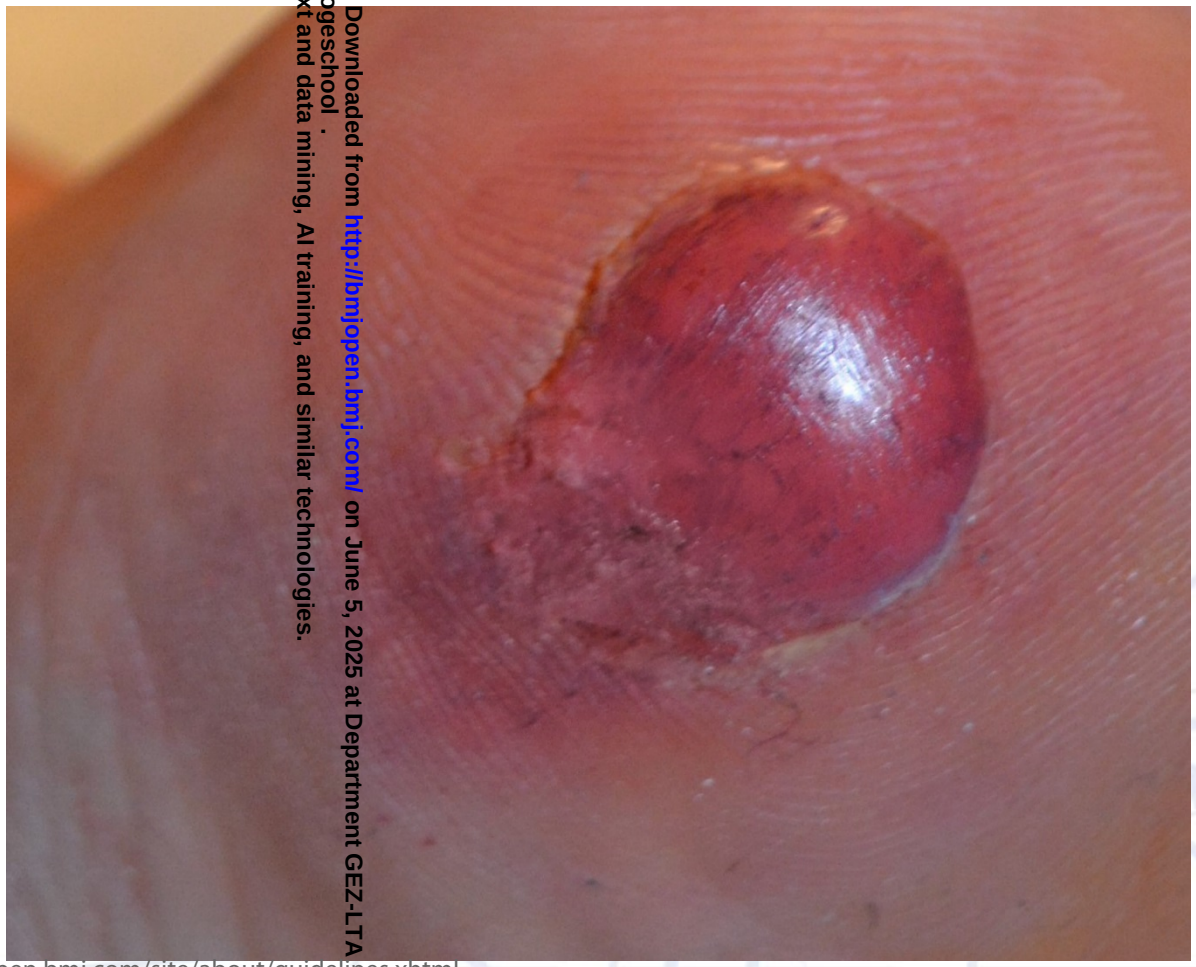
Correct answer: Stage III pressure injury

Explanation: there is a full thickness tissue loss without exposition of the bone. The slough does not interfere with the examination of the tissue loss.

Question 10

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

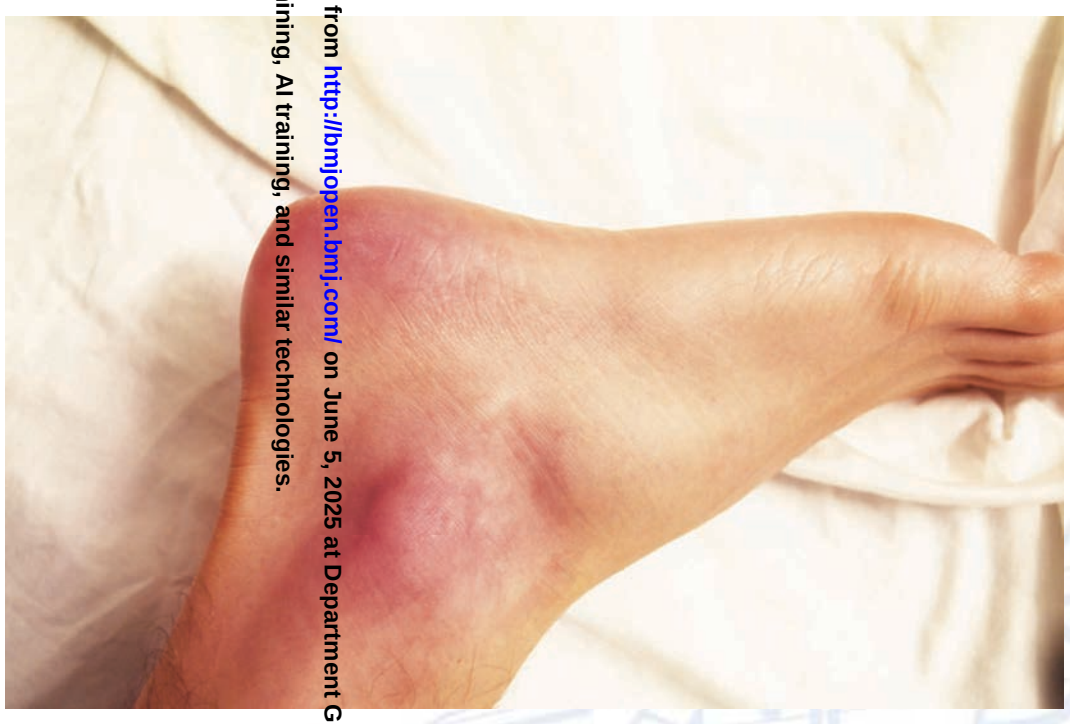
Correct answer: Stage II pressure injury

Explanation: there is a partial thickness skin loss without slough or necrosis. This intact blister indicates a Stage II pressure injury.

Question 11

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

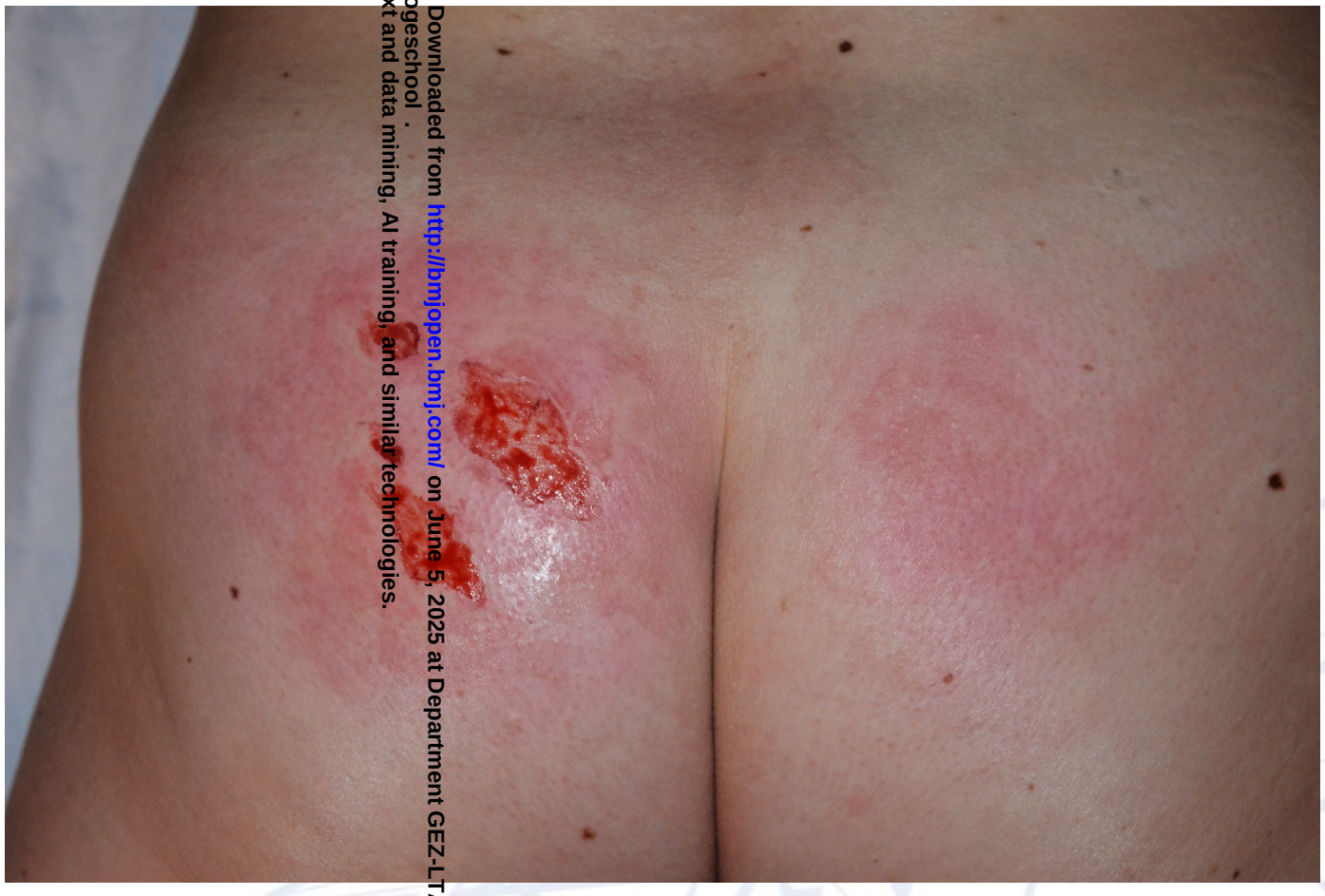
Correct answer: Stage I pressure injury

Explanation: the erythema is nonblanchable. The skin of the ankle is intact. The ankle is a typical area for Stage I pressure injury development because of its bony prominence.

Question 12

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

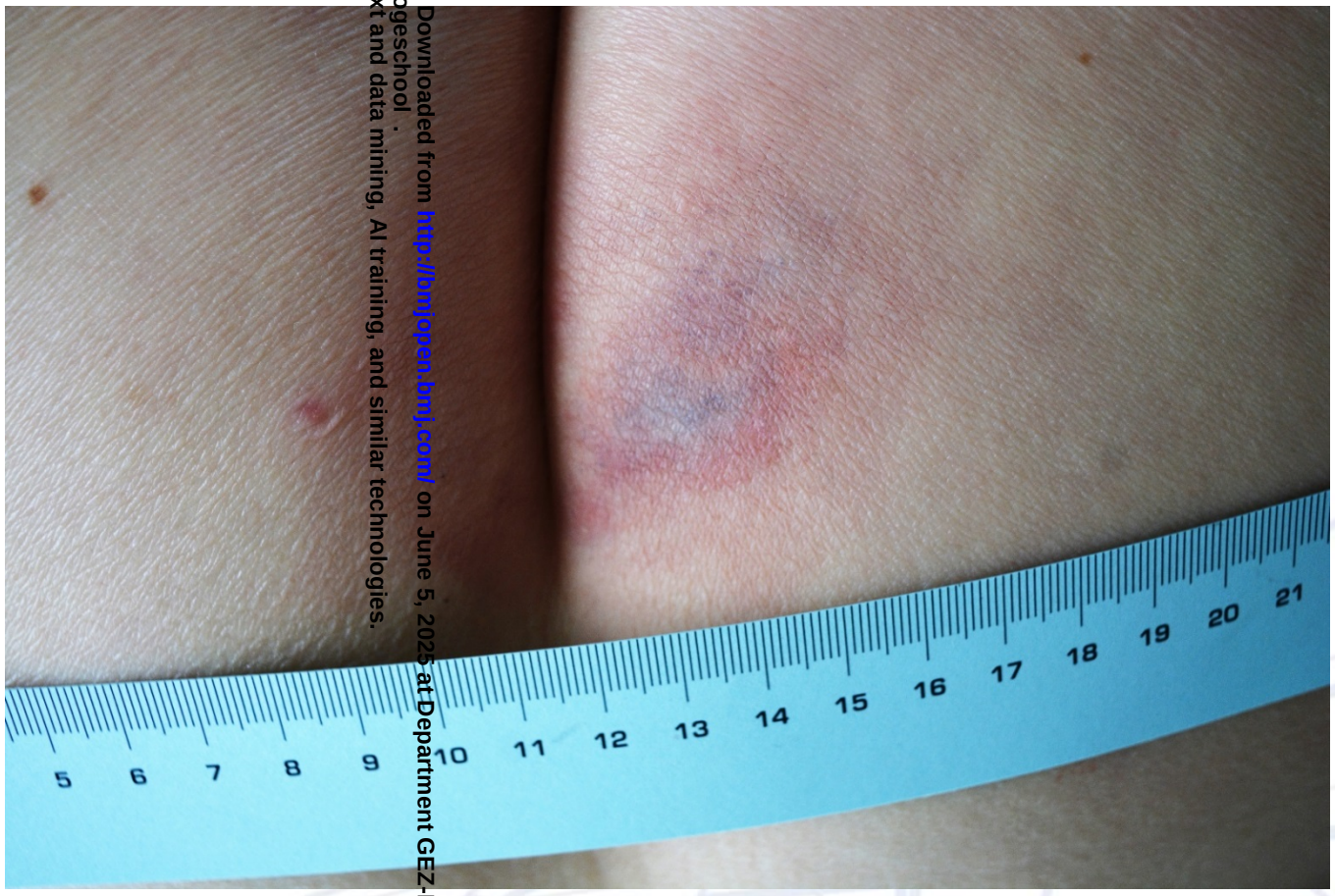
Correct answer: moisture-associated skin damage (MASD), possibly incontinence-related.

Explanation: there is a noticeable erythema of the skin. Skin damage is superficial and the edges are irregular. There is also some degree of maceration present, probably due to friction. The effects of friction on a wet skin are more damaging that on the dry skin.

Question 13

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

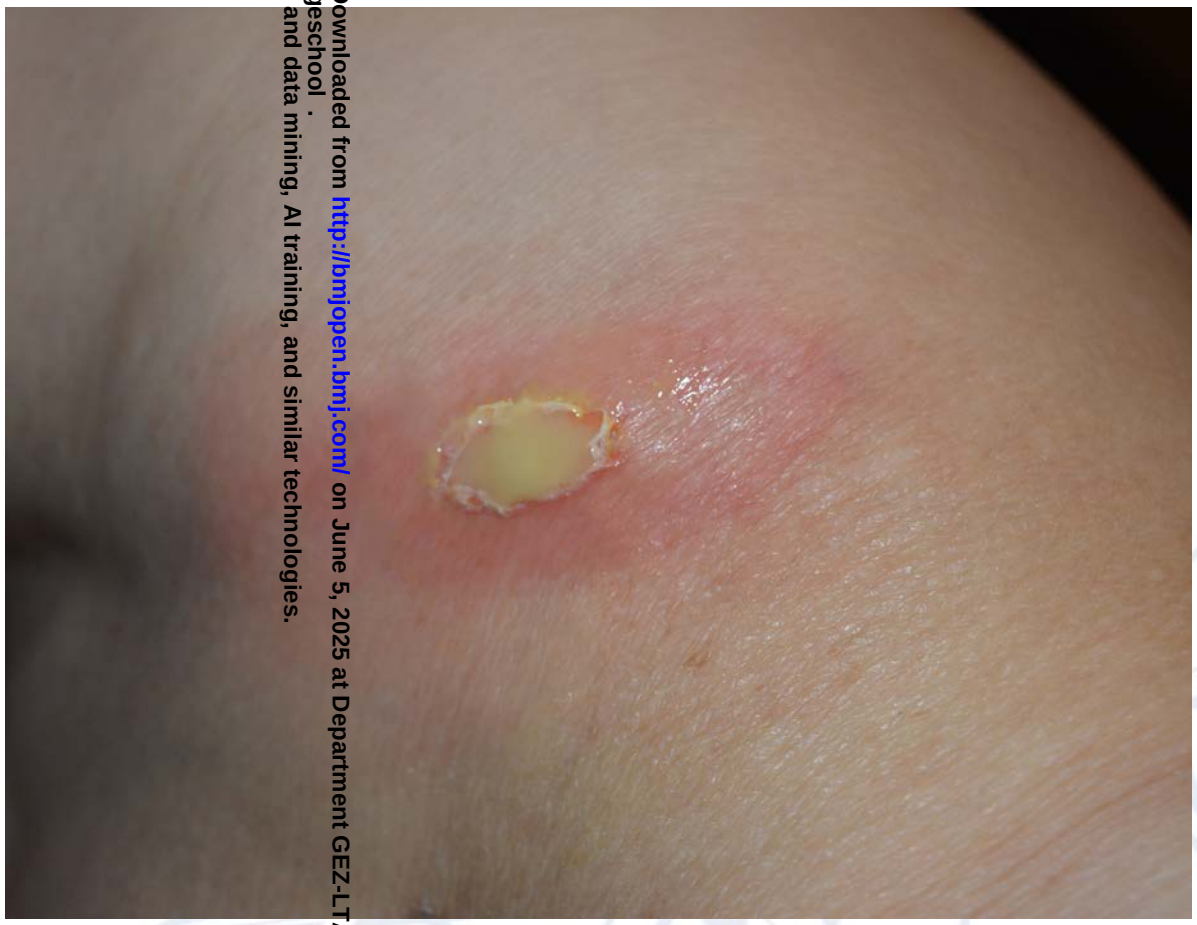
Correct answer: suspected deep tissue injury

Explanation: the area of the wound is purple/maroon and the skin is intact. We can assume that the underlying soft tissue has been damaged.

Question 14

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

Correct answer: Stage III pressure injury

Explanation: there is a full thickness tissue loss on the iliac crest with no exposition of the bone. Slough is excessively present.

Question 15

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage

Answer

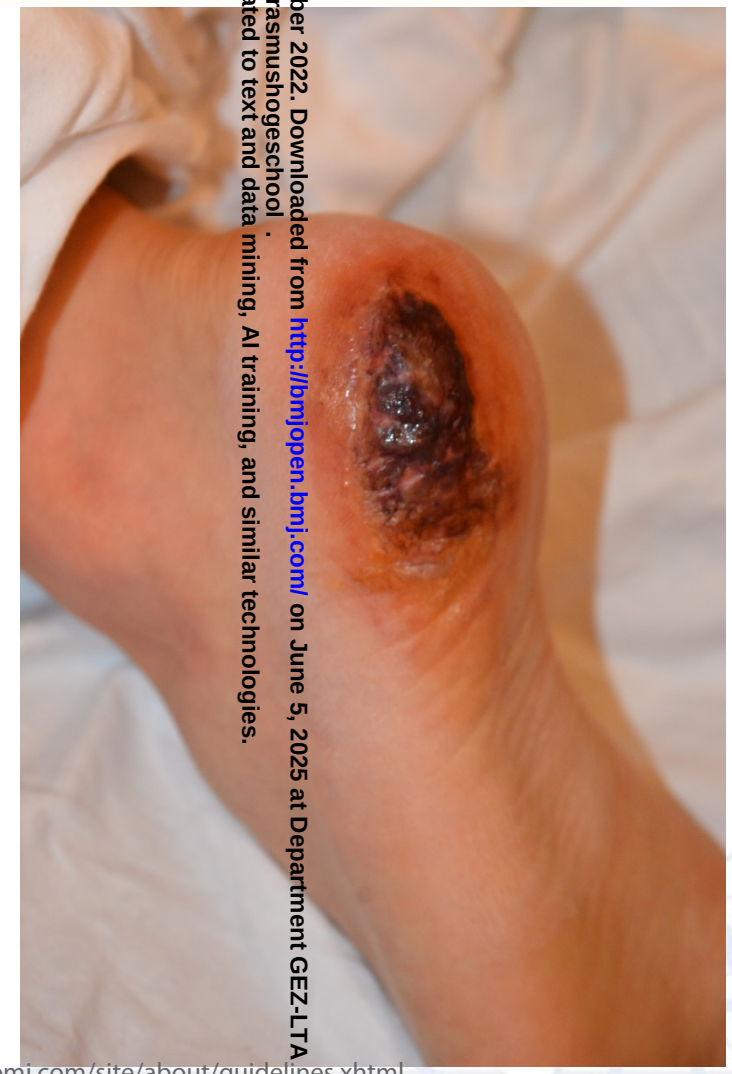
Correct answer: Stage IV pressure injury

Explanation: the tissue damage indicates a stage IV pressure injury. The tissue loss is extensive and the cartilage of the ear is directly exposed.

Question 16

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

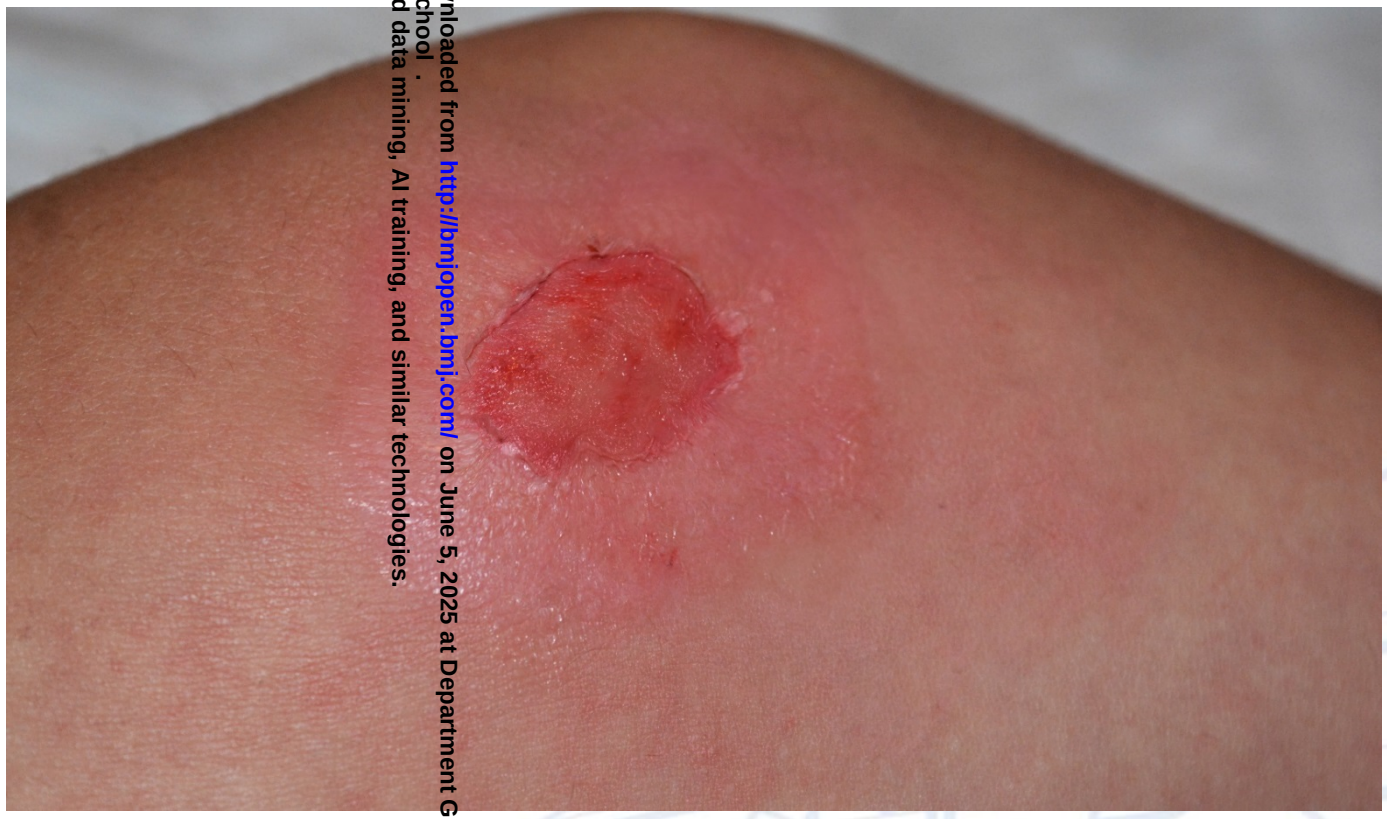
Correct answer: unstageable pressure injury

Explanation: a dark eschar covers the localized wound area. The skin around the eschar is dark (maroon/brown). Until the eschar has been removed, the depth of the injury and the extent of the damage is not to be determined.

Question 17

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

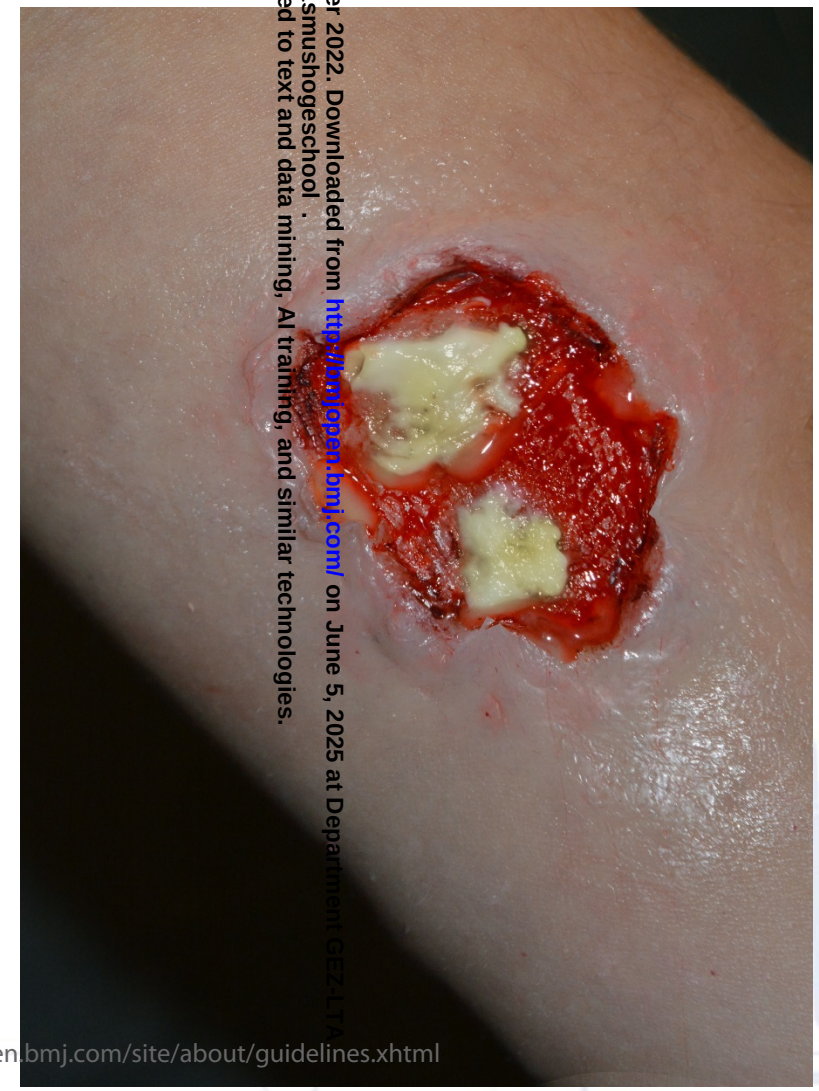
Correct answer: Stage II pressure injury

Explanation: there is a clear partial thickness loss of dermis. The wound is presented as a dry, shallow open ulcer with a red/pink wound bed. There is no slough visible.

Question 18

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

Correct answer: Stage III pressure injury

Explanation: extensive full tissue loss with slough and eschar on some parts of the wound. The tissue might be undermined. The supporting tissues are probably invaded

Question 19

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage

Answer

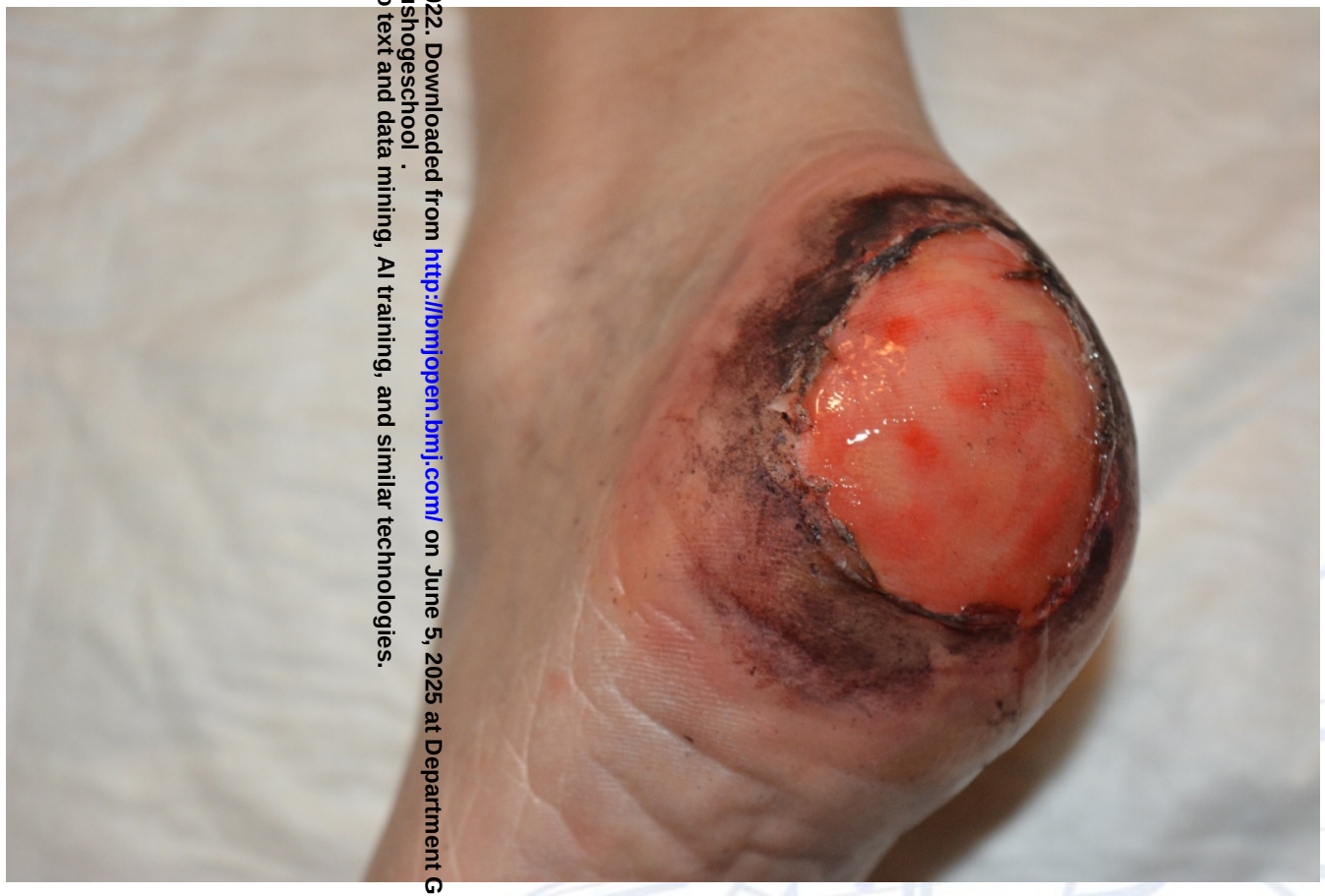
Correct answer: Stage IV pressure injury

Explanation: there is a full thickness tissue loss with exposed bone.

Question 20

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

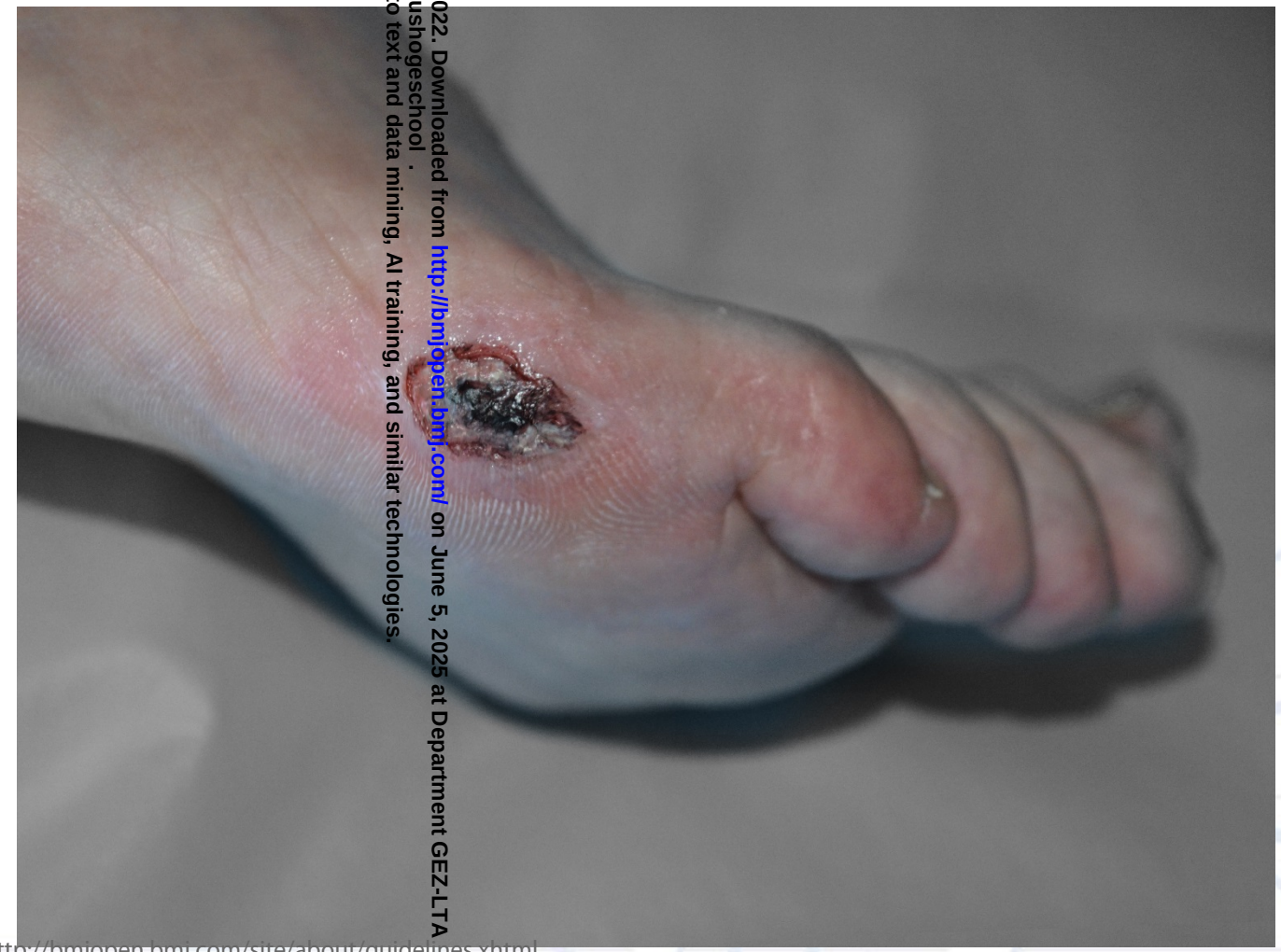
Correct answer: Stage II pressure injury

Explanation: there is an explicit partial thickness skin loss on the heel. The injury is presented as an open blister with a red pink wound bed. There is no slough detectable.

Question 21

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

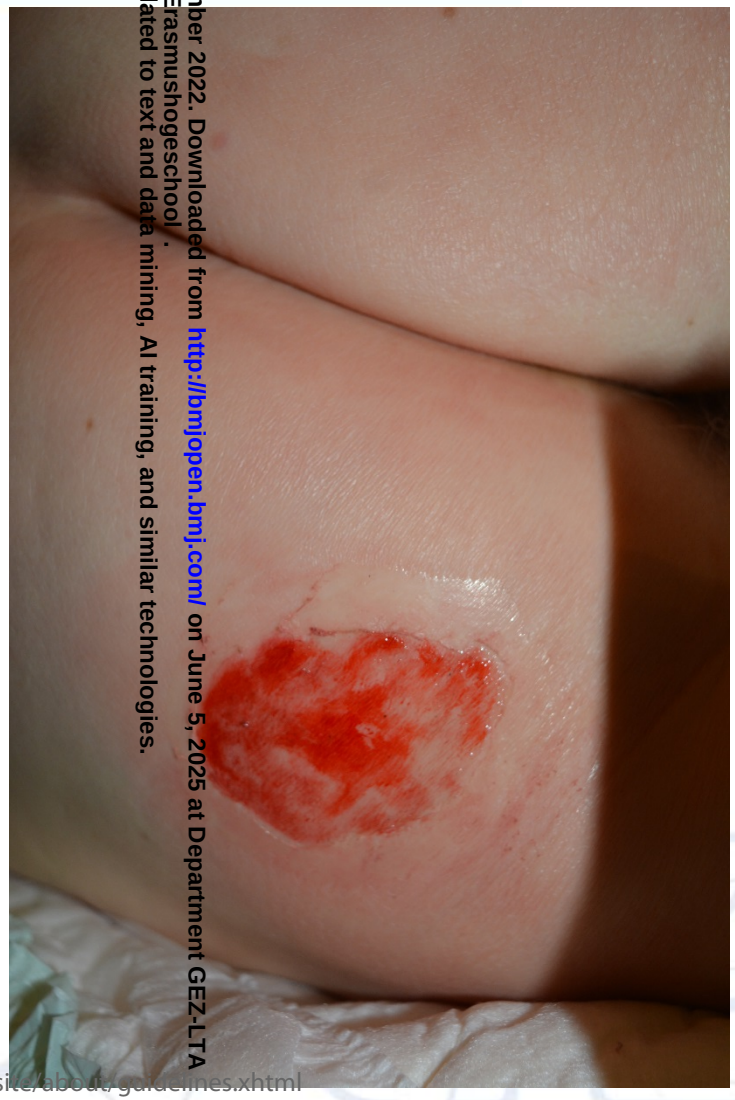
Correct answer: Stage IV pressure injury

Explanation: Stage IV pressure injury is characterised by full thickness tissue loss. The tissue loss is extensive. Removing the necrotic eschar would expose the underlying bone. There is a risk of osteomyelitis.

Question 22

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

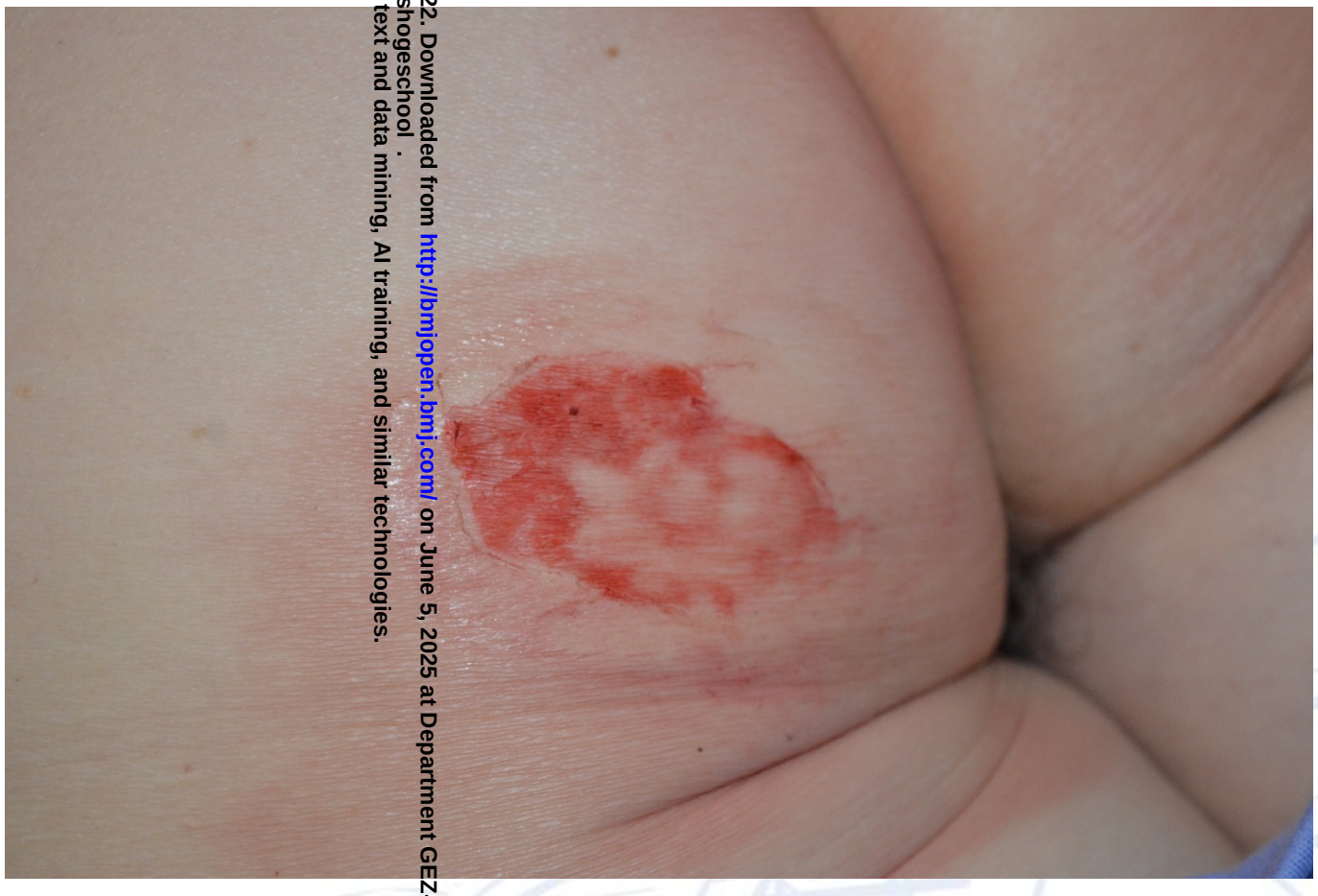
Correct answer: Stage II pressure injury

Explanation: the wound is presented as a partial thickness skin loss of the gluteal region. The injury is superficial. The blister is open and the wound bed red. There is no slough detectable.

Question 23

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

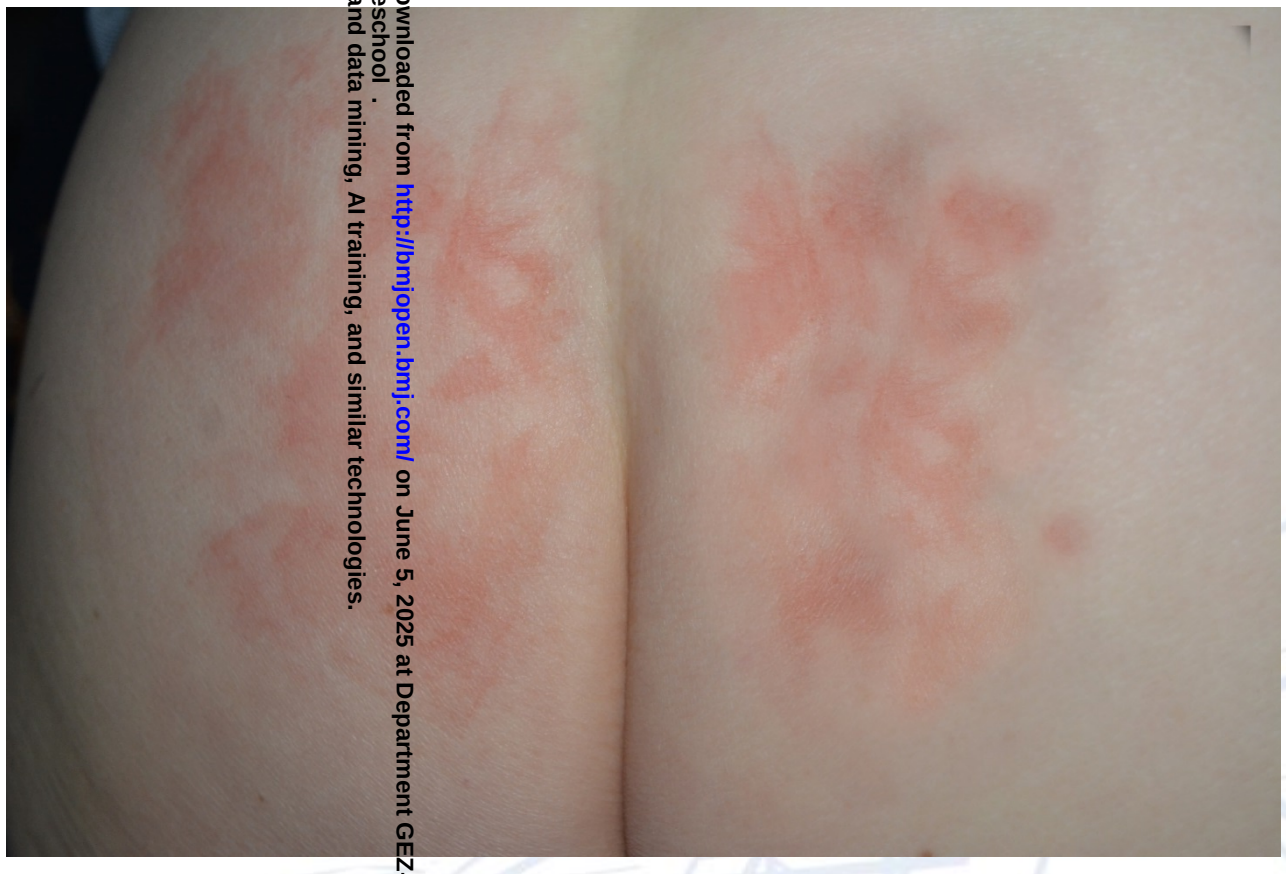
Correct answer: Stage II pressure injury

Explanation: there is a clear partial thickness loss of dermis. The wound is presented as a shallow open ulcer with a red/pink wound bed. There is no slough visible.

Question 24

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

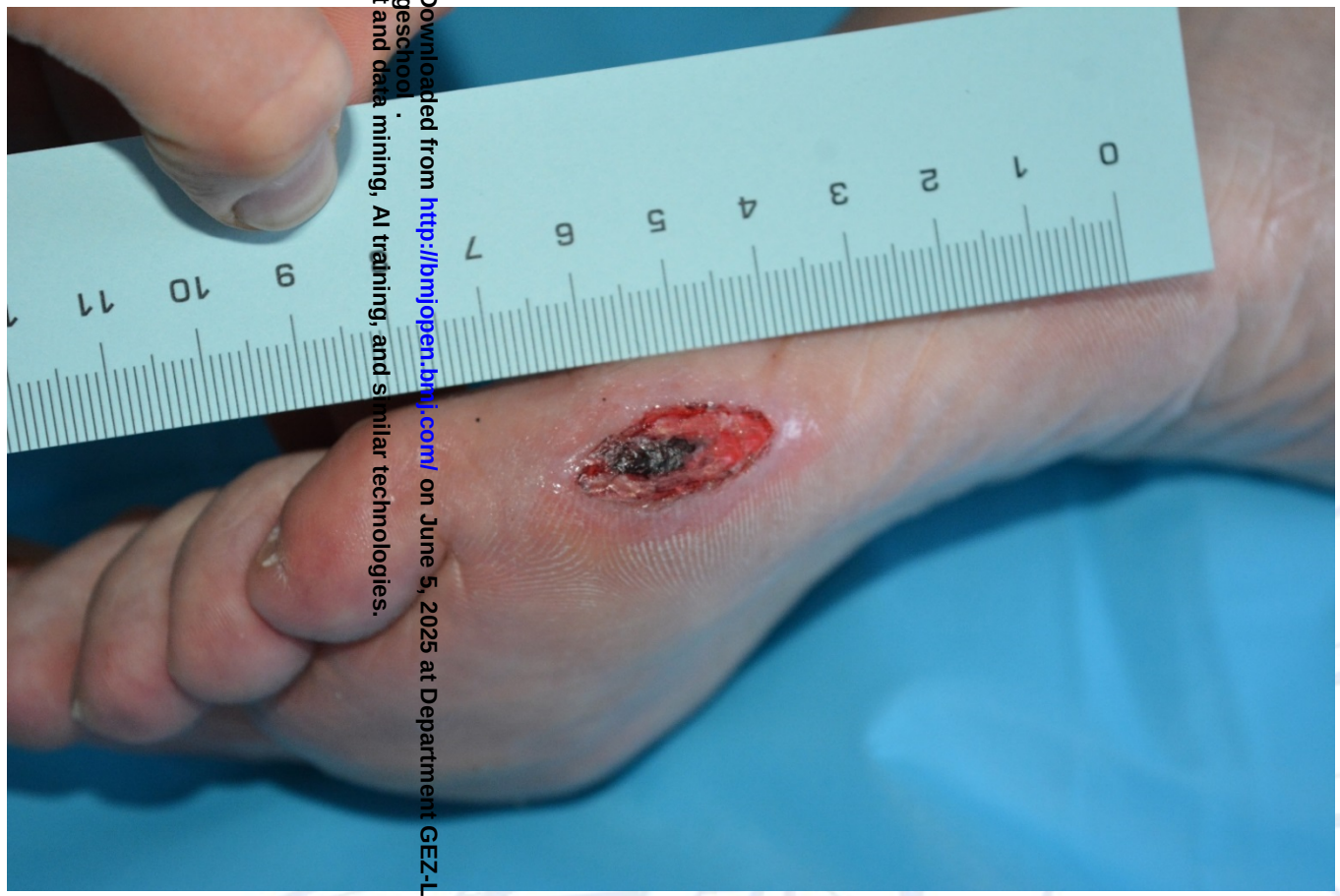
Correct answer: moisture-associated skin damage (MASD), possibly incontinence-related.

Explanation: there is a noticeable erythema of the skin. The skin redness is diffuse. The inflammation of the skin is caused by exposure to moisture.

Question 25

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

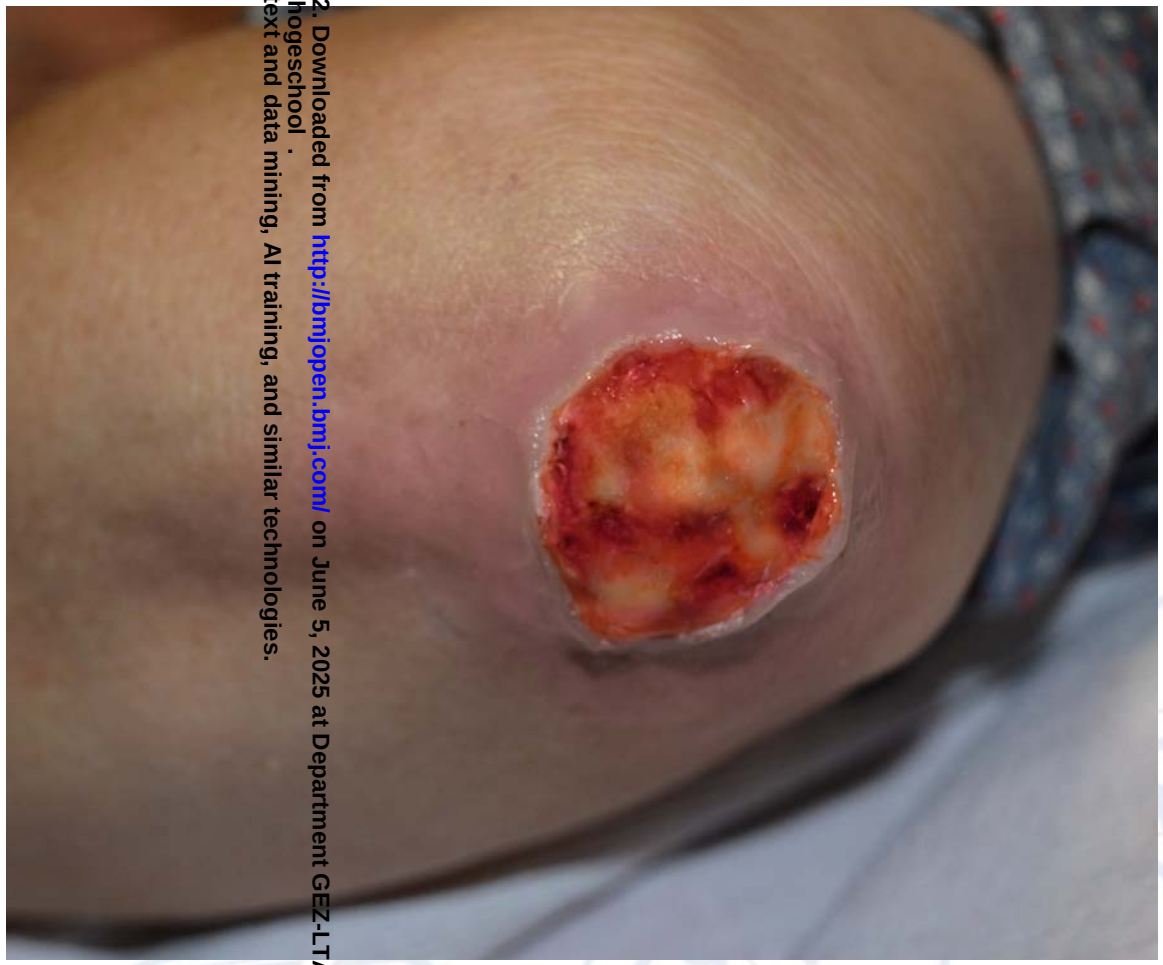
Correct answer: Stage IV pressure injury

Explanation: Stage IV pressure injury is characterised by full thickness tissue loss. The tissue loss is extensive. Removing the necrotic eschar would expose the underlying bone. There is a risk of osteomyelitis.

Question 26

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

Correct answer: Stage IV pressure injury

Explanation: The tissue loss is extensive, and the underlying bone is exposed. There is a risk of osteomyelitis.

Congratulations, you have finished the e-learning module.

Thank you for your time.

We hope that we have fulfilled your expectations and that this module will help you to correctly classify pressure injuries.

Authorship

This module was developed by Marta BORKOWSKA[1], Vincianne PLEITINCKX[2], Liesbet DEMARRE[3], Mireia LLAURADO-SERRA[4], Stijn BLOT[5] and Sonia LABEAU[6] .

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Disclaimer and acknowledgements

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The wounds presented in this e-learning module are simulations, based on representations of true skin lesions. They are shown on healthy adults, who voluntarily participate in this project after written informed consent.

We gratefully acknowledge Ms. Ellen Devos, (Bodypaint by Ellen), for the skillful simulations, and the volunteers represented on the photographs for their appreciated collaboration. We are also grateful to The Life Dignity Fund of the European Society for Intensive Care Medicine and the Flemish Society for Critical Care Nurses for funding this project.

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SUPPLEMENTARY APPENDIX C: Tables

Supplementary Table 1- Preventative measures

Preventive measures	***Not used***	***Available***	*Used in all patients*	*Data not available*
Standard foam mattresses	47.9% (n. 45)	43.6% (n. 41)	4.3% (n. 4)	4.3% (n. 4)
Alternative foam mattresses or overlays	77.7% (n. 73)	17% (n. 16)	1.1% (n. 1)	4.3% (n. 4)
Gel filled mattresses	92.6% (n.87)	3.2 % (n. 3)		4.3% (n. 4)
Fibre filled mattresses	94.7% (n. 89)	1.1% (n. 1)		4.3% (n. 4)
Air filled mattresses	47.9% (n. 45)	27.7% (n. 26)	20.2% (n. 19)	4.3% (n. 4)
Water filled mattresses	95.7% (n.90)			4.3% (n. 4)
Bead filled mattresses	93.6% (n. 88)	2.1% (n. 2.2)		4.3% (n. 4)
Foam cushions	45.7% (n.43)	47.9% (n.45)	2.1% (n.2)	4.3% (n. 4)
Non-foam cushions	77.7% (n.73)	17% (n.16)	1.1% (n.1)	4.3% (n. 4)
Ring cushions	91.5% (n.86)	1.1% (n.1)	3.2% (n.3)	4.3% (n. 4)
Sheepskins	89.4% (n.84)	4.3% (n.4)	2.1% (n.2)	4.3% (n. 4)
Alternating pressure mattresses	16 % (n.15)	43.6% (n.41)	36.2% (n.34)	4.3% (n. 4)
Air fluidised beds	88.3% (n. 83)	6.4% (n. 6)	1.1% (n. 1)	4.3% (n. 4)
Low air loss beds	84% (n.79)	10.8% (n.10)	1.1% (n.1)	4.3% (n. 4)
Continuous bedside pressure mapping	91.5% (n.86)	4.3 % (n.4)		4.3% (n. 4)
Turning beds	47.9% (n.45)	42.8% (n.40)	5.3% (n.5)	4.3% (n. 4)
Patient repositioning	3.2% (3)	23.4% (22)	69.1% (65)	4.3% (n. 4)
Ice friction	95.7 % (n.90)			4.3% (n. 4)
Blow drying	94.7% (n.89)	1.1% (n.1)		4.3% (n. 4)
Bolstering of the heels	47.9% (n. 45)	43.6% (n. 41)	4.3% (n. 4)	4.3% (n. 4)
Floating heels	38.3% (n.36)	52.1% (n.49)	5.3% (n.5)	4.3% (n. 4)
Hydrating body moisturizers	24.5% (n.23)	60.6% (n. 57.4)	1.1% (n. 1)	4.3% (n. 4)
Soft silicone multi layered foam dressing	37.2% (n.35)	57.4% (n.54)	1.1% (n.1)	4.3% (n. 4)
Other preventive measures	63.8% (n.60)	31.9% (n.30)		4.3% (n. 4)

Supplementary Table 2 - Primary diagnosis

Primary diagnosis	n	frequency (%)
Gastro-intestinal perforation/obstruction/rupture	97	7.39
Community-acquired bacterial pneumonia	84	6.4
Cardiac arrest	66	5.03
Other respiratory diseases	45	3.43
Other digestive tract diseases	43	3.28
Other diseases	38	2.9
Other neurological diseases	35	2.67
Other trauma- and skin-related diseases	35	2.67
Pancreatitis	32	2.44
Healthcare-associated bacterial pneumonia	31	2.36
Valvular heart surgery	31	2.36
CABG	31	2.36
Drug overdose, intoxication	31	2.36
Polytrauma, without brain trauma	31	2.36
Seizures	30	2.29
Subarachnoid haemorrhage	29	2.21
Intercerebral haemorrhage	27	2.06
Other (cardio)vascular diseases	27	2.06
Acute kidney injury	26	1.98
Hepatic failure	23	1.75
Urosepsis	22	1.68
Neoplasm of the upper digestive tract	21	1.6
Stroke by ischemic or haemorrhagic mechanism	19	1.45
Exacerbation of chronic pulmonary disease	19	1.45
Neoplasm of the lower digestive tract	19	1.45
Gastro-intestinal bleeding due to varices, ulcer or diverticulitis	18	1.37
Neurologic infection	17	1.3
Acute myocardial infarction	17	1.3

Head trauma (isolated)	17	1.3
Polytrauma, with brain trauma	17	1.3
Spinal cord injury	17	1.3
Aortic aneurysm	16	1.22
Diabetic ketoacidosis	16	1.22
Burn injury	14	1.07
Inhalation pneumonia	12	0.91
Other metabolic diseases	12	0.91
Mechanical airway obstruction	11	0.84
Malignant gynaecological diseases	11	0.84
Spinal cord surgery	10	0.76
Pulmonary embolism	10	0.76
Cardiopathy	10	0.76
Polyneuritus and polyradiculoneuritis	9	0.69
Respiratory neoplasm	9	0.69
Malignant haematological disease	9	0.69
Inflammatory disease of the digestive tract	9	0.69
Skin lesions requiring intensive care, non-traumatic	9	0.69
Respiratory arrest	8	0.61
Rhythm disturbance	8	0.61
Dissecting/ruptured aorta	8	0.61
Other renal/genito-urinary tract diseases	8	0.61
Pulmonary edema	7	0.53
Viral pneumonia	7	0.53
Elective abdominal aneurysma repair	7	0.53
Chronic renal failure	7	0.53
Neuromuscular disease	6	0.46
Pleural effusion	6	0.46
Cardiogenic shock	6	0.46
Neutropenic sepsis	6	0.46
Peripheral vascular surgery	5	0.38
Endocrinopathy	5	0.38
Asthma attack	4	0.3
Congestive heart failure	4	0.3

Peripheral artery bypass graft	4	0.3
Renal neoplasia	4	0.3
Neurologic neoplasm	3	0.23
Unstable angina	3	0.23
Hypertension	3	0.23
Endocarditis	3	0.23
Non-malignant gynaecological diseases	3	0.23
Thrombocytopenia, coagulopathy	3	0.23
Non-malignant haematological disease	3	0.23
Other haematological diseases	3	0.23
Metabolic coma	3	0.23
Other pregnancy-related diseases	2	0.15
Pressure injury requiring surgical debridement or extensive wound care	2	0.15
Severe surgical wound infection	2	0.15
Fungal pulmonary infection	1	0.08
Near-drowning	1	0.08
Perivascular disease	1	0.08
Carotid endarterectomy	1	0.08
Transfusion reaction	1	0.08
Eclampsia, preeclampsia	1	0.08
Delivery haemorrhage	1	0.08

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	5-6
Methods			
Study design	4	Present key elements of study design early in the paper	7-9
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7-10
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	7-10
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-10
Bias	9	Describe any efforts to address potential sources of bias	*N/A*
Study size	10	Explain how the study size was arrived at	N/A
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	N/A
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	8-9
		(*c*) Explain how missing data were addressed	8-9
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9 et seq.
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1, 26 et seq Supplementary Table 2
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	9-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-10 Mixed model is in Table 3, page 31
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	See above
Discussion			
Key results	18	Summarise key results with reference to study objectives	10-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	12-14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	21

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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THE PREVALENCE OF SKIN PRESSURE INJURY IN CRITICAL CARE PATIENTS IN THE UNITED KINGDOM; RESULTS OF A SINGLE DAY POINT PREVALENCE EVALUATION

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THE PREVALENCE OF SKIN PRESSURE INJURY IN CRITICAL CARE PATIENTS IN THE UNITED KINGDOM; RESULTS OF A SINGLE DAY POINT PREVALENCE EVALUATION

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ABSTRACT:

Objectives: Hospital acquired pressure injuries (PIs) are a source of morbidity and mortality, many are potentially preventable. This study prospectively evaluated the prevalence and associated factors of PIs in adult critical care patients admitted to Intensive Care Units (ICU) in the United Kingdom (UK). This service evaluation was part of a larger, international single day point-prevalence study of PIs in adult ICU patients. Training was provided to health care givers using an electronic platform to ensure standardised recognition and staging of PIs across all sites. Characteristics of the ICUs were recorded before the survey; deidentified patients' data were collected using a case report form and uploaded onto a secure online platform. Factors associated with ICU-acquired PIs in the UK were analysed descriptively and using generalised linear mixed-effects regression analysis.

Results**:** Data from 1312 adult patients admitted to 94 UK ICUs were collected. The proportion of individuals with at least one PI was 16% (211/1312 patients) of whom 8.8% (n=115/1312) acquired one or more PIs in the ICU and 7.3% (96/1312) prior to the ICU admission. The total number of PIs was 311, of which 148 (47.6%) were acquired in the ICU. A little over half of patients (n=163; 52.4%) had acquired a PI prior to ICU admission. The location of the majority of these PIs was the sacral area followed by the heels, which was also tended to be the site of the more severe. Braden score and prior length of ICU stay were associated with PI development.

Conclusions**:** The prevalence and the stage of severity of PIs were generally low in adult critically ill patients admitted to participating ICUs during the study period. However, PIs are a problem in an important minority of patients. The sacral area and the heels were most vulnerable in terms of severity and numbers. Lower Braden score and longer lengths of ICU-stay were associated with the development of injuries; most intensive care units that participated assess risk using tools which do not account for this.

KEY WORDS:

Pressure sores, pressure injury, critical care, intensive care, risk factors, 'pressure ulcer'

The study was registered at ClinicalTrials.gov (NCT03270345).

Strengths and limitations of this study (article summary)

Strengths:

- This is the first study exploring the scope of pressure ulceration in adult ICU population admitted to Intensive Care Units in the UK.
- It is a robustly planned and executed study.

Limitations:

- Limitations are mainly due to the low incidence and severity of PIs.
- The inability of linking preventative measures used in patients to the prevalence of PIs.
- The study was conducted in the pre-COVID-19 era and majority of patients were nursed in the supine position.

INTRODUCTION:

In 2014, the UK National Institute for Health and Care Excellence (NICE) published a document for the prevention and management of pressure injuries (PIs) in primary and secondary care in the United Kingdom (UK).[1,2] This document was revised in 2019 and states that "pressure ulcers are serious and distressing adverse events that can represent a failure of care".[3] PIs are generated in many circumstances which are all common to adult critically ill patients. These include when an area of skin and / or the underlying tissues are damaged due to being placed under sufficient pressure for a period long enough to impair blood supply. PIs can occur when shearing forces generate friction on the skin during manual handling.[1,2] The tissue distortion occurs and cell deformation is considered to be a very important component of the genesis of PIs. Tissues suffers either because the soft area are compressed and/or sheared between the skeleton and a support, such as a bed or chair when the person is sitting or lying, or because something is pressing into the body, such as a prosthesis, a surgical appliance or clothing elastic. Blood vessels within the distorted tissue are compressed, angulated or stretched out of their usual shape and blood is unable to pass through them. Multiple factors including cell deformation and shear forces cause tissue ischaemia and this is directly associated with the onset of PIs as well as patient outcomes.

An international classification categorises the injuries into Stages I to IV, Unstageable, and Suspected Deep Tissue Injury according to the extent of the tissue damage. [3,4]

Pressure ulcers caused by both pressure and shear stress, are directly associated with the quality of care provided as well as patient outcomes.[1-4] NICE guidelines[2] state that PIs consume significant resources, and that these should be preventable in the National Health Service (NHS), which has therefore employed tissue viability nurses (TVN) in the majority of hospitals. TVNs provide expert advice in the prevention and the treatment of wounds including PIs.

Unfortunately, critically ill patients in intensive care units (ICUs) are extremely vulnerable due to the severity of their illness, immobility, sedation, poor tissue perfusion, hypoxia and frequently haemodynamic instability. The current prevalence of PIs in the UK ranges widely with estimates from 4.7% to 32.1% in ward areas, while in the ICUs it is not known.[2,5,6] The aim of this service evaluation was to provide up to date information on PIs within UK adult ICUs. The specific objectives were to offer a picture of (a) the prevalence of pressure injury in adult critically ill patients, specifically in relation to presence of PIs on admission and PIs acquired within ICU; (b) the characteristics of the PIs in terms of severity and anatomical distribution; and (c) to contribute data to the international DecubICUs study, of which this project formed a part.[1]

METHODS:

Study design and participants

This service evaluation was conducted using a single day (midnight to midnight) point prevalence survey in all adult ICU patients. The study protocol was reviewed by the Joint Research Compliance Office at Imperial College Healthcare NHS Trust London and by the Health Research Authority. These bodies deemed the survey a Service Evaluation. All participating Trusts/Hospitals confirmed registration as a Service Evaluation according to their local protocols and non-objection from the relevant local Caldicott Guardian. A full description of the methods can also be found in the DecubICUs global study report.[1] The study was registered at ClinicalTrials.gov (NCT03270345).

Data collection

The study website provided the protocol and an electronic Case Report Form (CRF; Supplementary Electronic Appendix). Data were collected from all participating centres before the study day. Anonymous data were collected in the CRF on all adult patients present in participating ICUs on the 15th May 2018 (Supplement A). Admission data included patients' demographic, type of ICU admission (i.e. medical, elective or emergency surgical, or trauma/burns), principal diagnosis leading to ICU admission, mechanical ventilation on admission, and whether the patient already had pressure injuries at the time of ICU admission. Data included PI assessment which included site and stage (generally referred to as "grade" in the UK),[3-6] and whether injuries were present at ICU admission (specifically these were *areas exhibiting pressure injuries*, rather than discrete injuries; referred to as PIs for simplicity). The injury risk was evaluated using the Braden scale.[7] This scale combines six subscales (mobility, activity, sensory perception, skin moisture, nutritional state, and friction/shear) and ranges 6 to 23, with lower scores reflecting higher risk. Follow-up data gathered were survival status and

length of ICU and hospital stay until hospital discharge, maximally at 12 weeks following the study day (7 August 2018). An online training module was developed for all clinical data collectors and published on the study website (https://www.esicm.org/trials-group-2/decubicus/; Supplement B) prior to initiation in order to assist with consistency of data collection. Hospital and follow up data were collected by clinical and research nurses and the site study coordinator. Individual patient data were collected by the bedside nurse by direct skin observation according to the international staging definitions.[3-6]

Statistics

Data were summarised as mean (standard deviation; SD) or median (interquartile range; IQR) as appropriate, categorical data were summarised as proportions (%). Overall PI prevalence was calculated as the proportion of the sample who had at least one pressure injury on the study day. ICU-acquired prevalence was calculated as the proportion of the sample who had at least one PI determined to be acquired in the ICU present on the study day. Prevalence is reported as percentage with 95% confidence interval (CI). Statistical significance was set at $p<0.05$. Associations with ICU-acquired PI were explored using a generalised linear mixed-effects regression analysis with the logit link function and including a random effect for site. This method was chosen to balance potential effects resulting from variability in care processes across the participating sites. We avoided data transformations to ensure that the model results remained realistic rather than optimal but unrealistic[8]. All demographic variables as well as those related to acute illness and chronic conditions were included. The variable 'length of ICU stay before study day' was included based on both clinical judgement and the literature on pressure injury risk factors.[9,10] As such, all variables were included following an exploratory approach, irrespective of their relationship with pressure injury in univariate analysis. Results are reported as odds ratios (OR) with 95% confidence intervals (CI). Statistical analysis was

performed using IBM SPSS for Windows 26.0 (IBM Corp., NY, US) and R statistical software 3.6.1.[12]

RESULTS:

Ninety-four adult ICUs distributed across the whole of the UK participated to this study. In 2018, the Scottish Intensive Care Society audit group (SICS) collected data from 72 adult ICUs,[13] while ICNARC report was based on data from 263 NHS adult ICUs in the rest of the United Kingdom.[14] The definition of an ICU can be broad, however for the purpose of this study the authors assumed that 28% (94/335) of ICUs participated to this study in the UK; 51% declared themselves to be university affiliated. The majority of ICUs were mixed medical and surgical (75; 80%), the remainder were surgical of one type or another with one specialist burns unit. Four participating units did not submit descriptive data. The ICUs had a median of 14 beds (IQR 10-20) and 68% declared themselves to be "closed". There were six very large units with more than 40 beds.

Local investigators collected data from 1312 critically ill patients, the majority of whom were cared for in University-affiliated centres (67.3% of patients). The median nurse to patient ratio for the night shift on the survey day was 1:1 (IQR 0.8-1), reflecting the UK national standard of 1:1 nursing for level 3 patients (these are individuals requiring ventilatory and multiple organ support) and 1:2 for level 2 "high dependency" patients. Only one hospital reported that neither physiotherapy nor dietic support was available on the study day. Four units did not report on this specification. A list of preventive measures used is listed in the Supplementary Appendix. C, (Supplementary Table 1) Four units reported that they did not have a section in the patient record for describing pressure injury, and four units entered no data; 59 (63%) units employed

the Waterlow Scale, 11 (12%) used the Braden Scale and 19 (20%) reported using a different PI risk assessment scale and one unit reported not using a scale (four units entered no data).

Overall, 211 patients (16%) exhibited PIs (Table 1). **O**f these, 96 (7.3%) had at least one PI present before ICU admission and 115 (8.8%) acquired PIs following admission (Table 2). The characteristics of the patients included are in Table 1; the majority were men (59.7%) and the median age was 62 years (IQR 50-72). The median number of days in the ICU before the study day was 4 (IQR 1-10) and 51% of these patients were requiring invasive mechanical ventilation on ICU admission. The source of admission to the ICU was in 34.2% of cases the operating theatre followed by the emergency room (30.5%) and the general ward (23.3%). Nine hundred and ninety-two patients (76%) were known to be alive at 84 days, with 271 (20.7%) known to have died (missing data on 49 patients).

The total number of PIs was 311, of which 148 (47.6%) were acquired in the ICU and 154 (52.4%) prior to ICU admission. Thus 54.5% of patients with PIs acquired those following their ICU admission. The number of PIs per patient varied from 1 to 9 sites (Table 2) The sacral area, along with the heels, mouth and nose appeared most vulnerable, with the sacral and heels accounting for most of the higher-grade injuries (figure 1a and 1b); of 97 areas with injuries classified as Grade 3 or above, 33 (34%) were sacral areas and 28 (29%) were heels.

The generalized linear mixed-effects regression analysis identified the following factors as independently associated with ICU-acquired PIs: decreasing Braden scores and increasing prior duration of ICU stay (Table 3). 90 units measured the primary trigger for extra preventative measures and results are reported in Table 4.

DISCUSSION:

This service evaluation identified that 16% of 1312 patients in a large sample of UK intensive care units had an area exhibiting pressure damage on the study day. Although 96 patients already had injuries on admission, 115 had acquired them during their ICU stay. Generally, these injuries were not severe, however there were some that were, and these injuries come with a human and institutional cost. The impact of PIs is not easy to measure in terms of patients' outcome and totals costs. In 2004, the estimated annual cost paid by the NHS for the treatment of PIs was between £1.4 billion and £2.1 billion a year. A more recent estimate suggests that the cost of treating a PI varies from £1214 (stage 1) to £14,108 (stage 4 more severe).[2]

Recently, Labeau et al. conducted a worldwide prospective, point-prevalence study comprising 1,117 ICUs in 90 countries and found 6,747 pressure injuries in 3,526 patients[1]. The proportion of ICU-acquired PIs was 59.2%. They identified several factors associated with ICU-acquired pressure injuries including older age, presence of organ support and high severity of illness scores. This analysis of the UK data identified a low prevalence of generally low severity of PIs.. However, having a lower Braden score and a longer length of prior ICU stay were associated with a greater likelihood of acquiring a pressure injury in ICU. The global study (including data from many significantly lower resource settings) identified numerous risk-factor associations, but the overall prevalence was greater (26.6%), as was the total sample (n=13,254)[1]. Importantly, the global cohort was able to identify that local factors, case-mix, and especially type of ICU admission (i.e., medical, elective or emergency surgery), were associated with ICU-acquired PI risk.[15]

The locations of PIs were mainly the sacral area and the heels and the more severe injuries tended to be in these areas. This clearly needs continuous focus in equipment and practice development and education, along with communication amongst the multidisciplinary team. It is a reasonable assumption that the overwhelming majority of the patients were nursed in the supine position on the study day, nevertheless there were injuries reported to nose, mouth and ears. Specific risk of injuries to the face associated with devices and positioning will not be identified with current scoring systems- and thus detailed inspection of skin under such circumstances should be part of clinical routine. The results might have been different had the study been conducted during the COVID-19 pandemic, during which there was a widespread need for nursing patients in the prone position. [16-24] The prevalence and location of PIs likely would reflect staff experience and training, positioning of patients and workload.[21] The mouth and the nose may be damaged when using NIV with limited options for interface or suctioning. [23] The nurse to patient ratio was 1:1 for level 3 patients and this is a reflection of UK standards of good care. Due to limitations of data collected we cannot comment on the detailed acuity which contributing units experienced in the period running up to the study day, similarly we cannot infer that staffing has an impact on the prevalence of PIs; the impact of a period of inadequate staffing will be reflected in pressure injuries sometime later.

The study sought information on preventative measures used. [2,4] The NICE guidance does not cover the specific issues relating to the critically ill patient, [2-4] however a list of preventive measures used in the ICUs is in Supplementary Appendix C (Supplementary Table 1). Data in this table are reflective of current NICE guidelines, but the lack of longitudinal data and low prevalence of PI precluded exploration of the relative effectiveness of such measures.

In the UK the presence of ICU PIs generates a mandatory investigation generally initiated via adverse event reporting systems, such as "Datix" (https://rldatix.com). This triggers investigation and challenge but may not account the specific issues relevant to the critically ill. The ability to differentiate which PIs were preventable with appropriate measures and those which were not, due to acuity, nutrition, vasopressors, hydration status etc. would ensure appropriate attention but cannot be evaluated with this study methodology. It has been acknowledged that some pressure injuries, particularly in a critical care setting, are unavoidable.[23]

The generalized linear mixed-effects regression analysis identified decreasing Braden scores as associated with ICU-acquired pressure injuries. The Braden scale includes largely static factors and a dynamic system which adjust risk as time goes on may be worth evaluating. This is even more relevant given that prior LOS has a significant association with the incidence of PIs demonstrated in both this and other studies.[24] The development of such a scale including elapsed-time as a variable would require an extensive longitudinal study; it is not currently clear whether the effort would be justified. Of note, the majority of sites reported using the Braden or Waterlow scales; such scales would be the primary trigger for additional measures (Supplement C, Supplementary Table 3); neither Braden or Waterlow has notion of prior length of stay. The importance of length of stay has been highlighted previously but this seems not to have translated into current risk assessment.[25] Although better risk prediction can be valuable for comparative audit as part of quality improvement, we do not know if an improved risk prediction score would translate into fewer pressure injuries. Thus, current scoring systems should not be relied upon for assessment of risk, and detailed examination by experienced nursing staff is required; they may have some role in identifying patients who merit more detailed assessment.

One potential limitations of the study include the sample of intensive care units contributing; we estimate 28% of UK services contribute and we cannot assume this to be a representative sample. However, the site data submitted, and the patient diagnostic data are in line with broader UK critical care (Supplement C, Supplementary Table 2).[26] Conceivably participating sites may have had greater interest in pressure injury or evaluative practice, which may be different from non-contributing sites, and be reflected in quality of care. Bedside nurses may perhaps have been inhibited from reporting injuries over anxieties that this would be regarded badly by managers. An important mitigation of this is that pressure injury reporting is mandatory in the UK and has arguably become routine. There are many issues related to current scoring tools which fail to consider the complexities of the ICU population in particular in the UK.

Other study limitations include the use of the patient, as the unit of analysis rather than the anatomical location; No consideration was given to the impact of multiple PIs per patient; no distinction in the modelling made between PIs of different stages; no transparent modelling strategy.

CONCLUSION:

The prevalence and the stage of severity of PIs, both ICU-acquired and non-ICU-acquired, were low in adult critically ill patients admitted to UK ICUs. Nevertheless, 16% of patients had evidence of pressure injury on the study day, and this clearly represents an opportunity for improvement. Decreasing Braden scores and increasing ICU stay were identified as risk factors associated with the prevalence of ICU-acquired PIs. The sacral area and the heels are clearly very vulnerable areas with greater numbers and the site of more severe injuries.

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Contributors

FR, SJB, CB, BB were responsible for coordinating the study in the UK

FR and SJB drafted the manuscript

MD, SOL, SIL produced a UK extract of data from the global study database

FR, SJB, BB, MD and SOL conducted the analysis

SOL and SIB were the lead investigators for the global study

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Competing interests

SIB received grants of honoraria from Pfizer and 3M outside the submitted work. The other authors declare they have no conflicts of interest.

Patient and public involvement

NONE

Data availability statement

Study protocol, statistical analysis plan, and informed consent forms will be shared upon request with any researcher. Local DecubICUs investigator have the right to use the data collected from their respective units. The complete global DecubICUs database is only transferred to the primary investigators, SOL and SIB. They cannot share the database as they are bound to a broad variety of Data User Agreements. Information requests are to be addressed to stijn.blot@ugent.be and sonia.labeau@hogent.be. Information requests concerning the UK data should be addressed to SJB.

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REFERENCES:

1. Labeau S O, Afonso E , Benbenishty J, et al. Prevalence, associated factors and outcomes of pressure injuries in adult intensive care unit patients: the DecubICUs study. *Intensive Care Medicine* 2021;47:160-9.. https://doi.org/10.1007/s00134-020-06234-9.
2. NICE. Pressure ulcer prevention. The prevention and management of pressure ulcers in primary and secondary care. Clinical Guidelines 179. Methods, evidence and recommendations April 2014 https://www.nice.org.uk/guidance/cg179/evidence/full-guideline-prevention-pdf-547610509 . (Accessed August 2021)
3. National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel, and Pan Pacific Pressure Injury Alliance. Prevention and treatment of pressure ulcers: Clinical practice guideline. Emily Haesler ed. Osborne Park, Australia: Cambridge Media; 2014.
4. National Pressure Injury Advisory Panel, European Pressure Ulcer Advisory Panel, and Pan Pacific Pressure Injury Alliance. Prevention and treatment of pressure ulcers: Clinical practice guideline. Emily Haesler ed. Osborne Park, Australia: Cambridge Media; 2019.
5. Edsberg LE, Black JM, Goldberg M, et al. National Pressure Ulcer Advisory Panel pressure injury staging system: Revised pressure injury staging system. *J Wound Ostomy Continence Nur*s 2016;43:585-97.
6. National Pressure Injury Advisory Panel. Position statement on staging – 2017 clarifications. https://npuap.org/page/PositionStatements. (Accessed August 2021)
7. Bergstrom N, Braden B, Laquzza A, Holman V. The Braden scale for predicting pressure sore risk - reliability studies. *Nurs Res* 1985;36:205–10. http://www.ncbi.nlm.nih.gov/pubmed/3299278.

8. Lo S, Andrews S. To transform or not to transform: using generalized linear mixed models to analyse reaction time data. *Front Psychol* 2015; 6:1171
9. El-Marsi J, Zein-El-Dine S, Zein B, et al. Predictors of Pressure Injuries in a Critical Care Unit in Lebanon: Prevalence, Characteristics, and Associated Factors. *J Wound Ostomy Continence Nurs*. 2018; 45:131-136.
10. Cox J, Predictors of pressure ulcers in adult critical care patients. *Am J Crit Care*. 2011;20: 364-75.
11. Society of Critical Care Medicine. Critical Care Statistics. https://www.sccm.org/Communications/Critical-Care-Statistics. (Accessed August 2021)
12. R Core Team (2018) R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Available at https://www.R-project.org/.
13. The Scottish Intensive Care Society audit group. Audit of Critical Care in Scotland 2018, reporting on 2017. https://www.sicsag.scot.nhs.uk/publications/_docs/2018/SICSAG-report-2018-2609-final.pdf?55 . (Accessed August 2021)
14. Intensive Care national audit & research centre. Annual Quality Report 2018/19 for adult critical care. https://onlinereports.icnarc.org/Reports/2019/12/annual-quality-report-201819-for-adult-critical-care . (Accessed August 2021)
15. Deschepper M, Labeau SO, Waegeman W, et al. Heterogeneity hampers the identification of general pressure injury risk factors in intensive care populations: A predictive modelling analysis. *Intensive Crit Care Nurs* 2021 12:103117 (on line ahead of print)

16. Shearer S C, Parsa K M, Newark A, et al. Facial Pressure Injuries from Prone Positioning in the COVID-19 Era. *Laryngoscope* 2021;131:E2139-2142 PMID: 33389768 DOI: 10.1002/lary.29374

17. Perrillat A, Foletti JM, Lacagne AS, et al. Facial pressure ulcers in COVID-19 patients undergoing prone positioning: How to prevent an underestimated epidemic? *J Stomatol Oral Maxillofac Surg*. 2020;121:442–444. doi: 10.1016/j.jormas.2020.06.008.

18. Kim RS, Mullins K. Preventing facial pressure ulcers in Acute Respiratory Distress Syndrome (ARDS) *J Wound Ostomy Continence Nurs*. 2016;43:427–429. doi: 10.1097/WON.0000000000000247.

19. Lucchini A, Bambi S, Mattiussi E.et al. Prone position in acute respiratory distress syndrome patients: a retrospective analysis of complications. *Dimens Crit Care Nurs*. 2020;39:39–46. doi: 10.1097/DCC.0000000000000393.

20. Nazerali RS, Song KR, Wong MS. Facial pressure ulcer following prone positioning. *J Plast Reconstr Aesthetic Surg*. 2010;63:e413–e414. doi: 10.1016/j.bjps.2009.11.001.

21. Azoulay E, Timsit JF, Sprung CL, et al. Prevalence and Factors of Intensive Care Unit Conflicts: The Conflicus Study. *Am J Respir Crit Care Med*. 2009;180:853-60.

22. Alqahtani JS, AlAhmari MD. Evidence based synthesis for prevention of noninvasive ventilation related facial pressure ulcers. *Saudi Med J*. 2018;39:443-452. doi: 10.15537/smj.2018.5.22058.PMID: 29738002 .

23. Edsberg LE, Langemo D, Baharestani MM, et al. Unavoidable pressure injury: state of the science and consensus outcomes. *J Wound Ostomy Continence Nurs* 2014; 41:313-334

24. Zhang Y, Zhuang Y, Shen J, et al. Value of pressure injury assessment scales for patients in the intensive care unit: Systematic review and diagnostic test accuracy meta-

analysis. *Intensive & Critical Care Nursing*. 2021;64;103009. doi: 10.1016/j.iccn.2020.103009

25. Cox J. Risk factors for pressure injury development among critical care patients. *Crit Care Nurs Clin N Am* 2020;32;473-488
26. Intensive Care National Audit and Research Centre. On line reports available at https://onlinereports.icnarc.org/Home (accessed August 2021)

TABLE 1: Characteristics of patients

Characteristic	All patients (n = 1312; 100%)[a]	No pressure injuries (n = 1101; 83.9%)[a]	With pressure injuries (n = 211; 16%)[a]	ICU-acquired pressure injuries (n = 115; 8.8%)[a]
Age, years (M, IQR)	62 (50–72)	62 (49–72)	65 (54–74)	62 (52–73)
Sex (male) n (%)	783 (59.7)	656 (59.6)	127 (60.2)	68 (59.1)
Body Mass Index class[b] n (%)				
Underweight (<18.5)	57 (4.3)	42 (3.8)	15 (7.1)	10 (8.7)
Normal weight (18.5–24.9)	464 (35.4)	381 (34.6)	83 (39.3)	49 (42.6)
Pre-obesity (25–29.9)	3910 (29.8)	341 (31.0)	50 (23.7)	27 (23.5)

Obesity class I (30–34.9)	227 (17.3)	195 (17.7)	32 (15.2)	12 (10.4)
Obesity class II (35–40)	90 (6.9)	75 (6.8)	15 (7.1)	11 (9.6)
Obesity class III (>40)	83 (6.3)	67 (6.1)	16 (7.6)	6 (5.2)
Mechanical ventilation on ICU admission n (%)	669 (51.0)	555 (50.4)	114 (54.0)	77 (67.0)
Type of admission n (%)				
Medical	617 (47.0)	495 (45.0)	122 (57.8)	63 (54.8)
Elective surgery	279 (21.3)	260 (23.6)	19 (9.0)	11 (9.6)
Emergency surgery	309 (23.6)	255 (23.2)	54 (25.6)	31 (27.0)
Trauma and burns	107 (8.2)	91 (8.3)	16 (7.6)	10 (8.7)
Comorbidities n (%)				
Acquired Immune Deficiency Syndrome	6 (0.5)	5 (0.5)	1 (0.5)	1 (0.9)
Chronic Obstructive Pulmonary Disease	173 (13.2)	143 (13.0)	30 (14.2)	17 (14.8)
Malignancy	164 (12.5)	137 (12.4)	27 (12.8)	14 (12.2)
Cancer, solid tumour	118 (9.0)	102 (9.3)	16 (7.6)	8 (7.0)
Metastatic cancer	32 (2.4)	27 (2.5)	5 (2.4)	1 (0.9)
Haematologic cancer	27 (2.1)	19 (1.7)	8 (3.8)	5 (4.3)
Immunocompromised	104 (7.9)	79 (7.2)	25 (11.8)	15 (13.0)

Corticosteroid therapy	57 (4.3)	39 (3.5)	18 (8.5)	10 (8.7)
Immunosuppression	33 (2.5)	24 (2.2)	9 (4.3)	5 (4.3)
Chemotherapy	37 (2.8)	34 (3.1)	3 (1.4)	2 (1.7)
Cirrhosis	39 (3.0)	27 (2.5)	12 (5.7)	7 (6.1)
Diabetes	239 (18.2)	193 (17.5)	46 (21.8)	25 (21.7)
Heart failure	130 (9.9)	102 (9.3)	28 (13.3)	15 (13.0)
Impaired mobility	120 (9.1)	95 (8.6)	25 (11.8)	10 (8.7)
Malnutrition	45 (3.4)	27 (2.5)	18 (8.5)	12 (10.4)
Peripheral vascular disease	41 (3.1)	27 (2.5)	14 (6.6)	5 (4.3)
Renal failure	106 (8.1)	93 (8.4)	13 (6.2)	5 (4.3)
Simplified Acute Physiology Score II category n (%)				
≤23	385 (29.3)	353 (32.1)	32 (15.2)	16 (13.9)
24–33	327 (24.9)	283 (25.7)	44 (20.94)	26 (22.6)
34–44	290 (22.1)	220 (20.0)	70 (33.2)	37 (32.2)
≥45	310 (23.6)	245 (22.3)	65 (30.8)	36 (31.3)
Braden score category[d] n (%)				
Very High Risk (≤ 9)	110 (8.4)	79 (7.2)	31 (14.7)	18 (15.7)
High Risk (10–12)	370 (28.2)	284 (25.8)	86 (40.8)	51 (44.3)
Moderate Risk (13–14)	236 (18.0)	194 (17.6)	42 (19.9)	27 (23.5)
Mild Risk (15–18)	396 (30.2)	349 (31.7)	47 (22.3)	19 (16.5)
No Risk (19–23)	193 (14.7)	189 (17.2)	4 (1.9)	/

Length of stay in ICU prior to study day (Median, IQR)	4 (1–10)	3 (1–9)	8 (3–20)	12 (6–26)
Length of stay in ICU (M, IQR)	9 (4–24)	8 (3–20)	19.5 (8–45.75)	26.5 (12–53)
Length of stay from ICU admission to hospital discharge (M, IQR)	18 (8–40)	16 (8–35)	33 (14.25–61.75)	42 (18–63.75)
Length of stay in hospital after study day (M, IQR)	11 (6–28)	10 (5–24)	21 (9–41)	22 (10–42)
Patients still in ICU 3 months after study day	2 (0.2)	1 (0.1)	1 (0.5)	/
Patients still in non-ICU ward 3 months after study day	93 (7.1)	59 (5.4)	34 (16.1)	22 (19.1)
Deceased during hospital stay	271 (20.7)	210 (19.1)	61 (28.9)	29 (25.2)
28-days mortality	196 (14.9)	157 (14.3)	39 (18.5)	15 (13.0)

Abbreviations: ICU, intensive care unit; M, median; IQR, interquartile range

[a]Totals may not sum to 1312, 1101, 211 and 115, respectively, owing to missing values.

[b]Body Mass Index is body weight in kilograms divided by body height in meters squared

[c]Range of possible scores is 0–163; a higher SAPS II score indicates a higher severity of disease and acute illness; scores are categorized according to the sample's quartiles

[d]Range of possible scores is 6–23

TABLE 2: Number of PIs acquired before and after ICU admission and number of sites per patient. This reflects only the PIs documented as present on admission and those acquired in ICU. The data collected does not support effective extrapolation of number of PIs acquired on ICU in those patients with PIs present on admission.

Number of body sites affected	Patients with ICU-acquired PIs (n=115 patients, 148 sites)	Patients with PIs acquired prior to ICU admission (n=96 patients, 154 sites)
1	95 (82.6%)	68 (70.8%)
2	13 (11.3%)	11 (11.5%)
3	4 (3.5%)	12 (12.5%)
4	1 (0.9%)	1 (1.0%)
5	1 (0.9%)	3 (3.1%)
6	1 (0.9%)	-
9	-	1 (1.0%)

TABLE 3: Generalized Linear Mixed model with SITE as random effect.

Variable		Odds ratio	Conf low	Conf high	p.value
Days in ICU before study day					
	0–3 days	Reference			
	4–6 days in ICU before study day	2,2946	1,0633	4,9515	0,0343
	7–9 days in ICU before study day	2,2990	0,9055	5,8371	0,0799
	10–12 days in ICU before study day	7,7737	3,4155	17,6928	0,0000
	>12 days in ICU before study day	7,7284	3,9435	15,1459	0,0000
Age		1,0097	0,9927	1,0270	0,2651
Male sex		0,9774	0,6130	1,5584	0,9235
Body Mass Index					
	18.5–24.9: normal weight	Reference			
	<18–5: underweight	1,9729	0,8023	4,8512	0,1388
	25–29.9: pre-obesity	0,5647	0,3186	1,0008	0,0503
	≥30: obesity	0,6029	0,3409	1,0666	0,0821
Braden Score		0,7654	0,6924	0,8462	0,0000
Admission type: medical		1,1058	0,4702	2,6003	0,8177
Admission type: elective surgery		0,8344	0,2815	2,4734	0,7440
Admission type: emergency surgery		1,0251	0,4132	2,5435	0,9573
Chronic Obstructive Pulmonary Disease		0,9644	0,4957	1,8764	0,9151
Acquired Immune Deficiency Syndrome		3,6742	0,2691	50,1720	0,3292
Heart failure		1,0690	0,5139	2,2238	0,8582
Peripheral vascular disease		0,9658	0,3048	3,0599	0,9528
Diabetes		1,2216	0,6954	2,1459	0,4863
Cirrhosis		2,2538	0,8236	6,1680	0,1136
Malignancy		0,9043	0,4233	1,9319	0,7950
Immunocompromised		1,9557	0,9106	4,2003	0,0855
Vasopressor use		0,6427	0,3418	1,2086	0,1701
Sedation		0,7703	0,4045	1,4668	0,4271
Muscle relaxant use		1,1277	0,3088	4,1182	0,8557
Mechanical ventilation on admission		1,3380	0,7887	2,2699	0,2803
Renal replacement		1,6310	0,8266	3,2183	0,1583
Simplified Acute Physiology Score II score		0,9927	0,9735	1,0123	0,4616

TABLE 4: Primary trigger for extra preventative measures (90 units responded)

Trigger	Frequency	% of sites reporting
High risk profile as indicated by a risk assessment scale	69	76.6
Mechanical ventilation	4	4.4
Anticipated ICU stay>3days	1	1.1
Coma/sedation	2	2.2
Malnutrition	1	1.1
Obesity	1	1.1
Presence of pressure injury	7	7.7
Other	5	5.5
Total	90	

Figure 1a

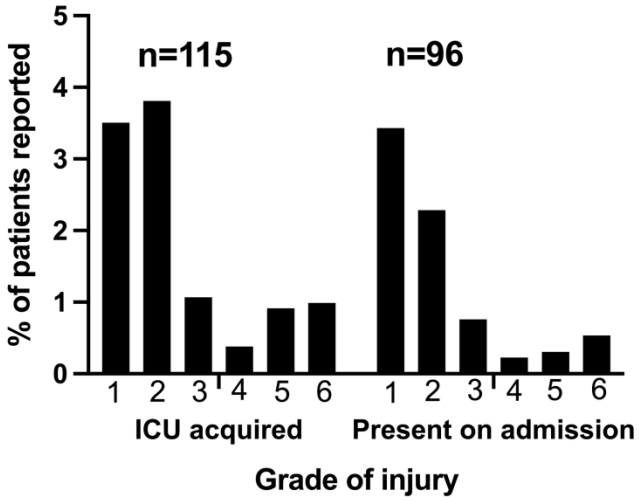
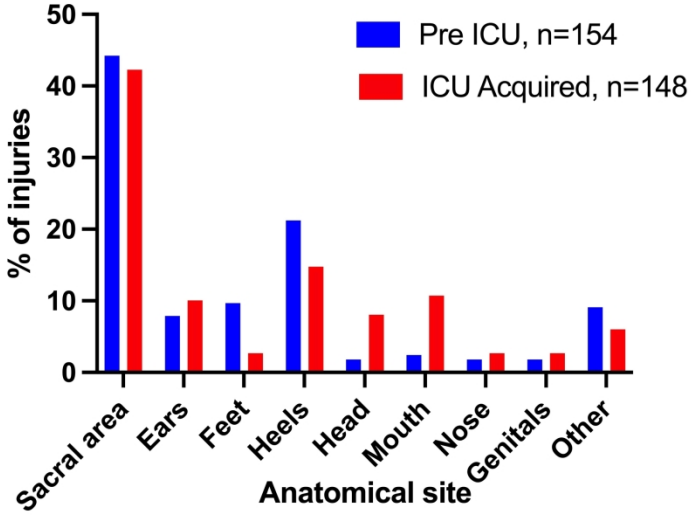


Figure 1b



1a grade of injury 1b anatomical site

176x284mm (300 x 300 DPI)

Online Resource 4. Study protocol

Decub*ICU*s

Decubitus in Intensive Care Units

A Multicenter International One-Day Prevalence Study

1 Organisational information

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Coordinating center: Ghent University, Belgium (Prof. Dr. S. Blot)

National representatives:

The role of the national representatives can be summarized as follows:

(1) Advertise the study in the individual countries and identify participating hospitals and local investigators in their country.
(2) Apply for regulatory approval in a national level where applicable and ensure that ethical committee (EC) approvals or waivers for all the participating hospitals in the country are in place prior to the initiation of the study.
(3) Assist with the translation of the study protocol/CRF where required.
(4) Ensure good communication with the participating sites in the respective country and to animate local investigators to achieve optimal recruitment and follow up during the period of the study. During the period of database quality control (data 'cleaning') the national representative should animate the individual to reply in possible queries.

Local co-ordinators:

Local co-ordinators in individual institutions will have the following responsibilities:

(1) Provide leadership for the project in their institution
(2) Ensure all relevant regulatory approvals are in place and communicated with the coordinating center
(3) Ensure adequate data collection and act as guarantor for the integrity and quality of the data
(4) Ensure timely completion of the e-CRFs
(5) Ensure collaboration to solve possible queries that may arise during the database quality control process.

2 Protocol summary

Study title:	Decubitus in Intensive Care Units
Acronym:	Decub*ICU*s
Design:	multicentre, international one-day prevalence study
Target population:	all patients present on **15 May 2018**

Interventions: no interventions – observational study

Outcomes:

- major risk factors for pressure injury development;
- preventive measures used in distinct ICU populations and countries;
- identifying shortages in the availability of evidence-based measures to prevent pressure injuries;
- occurrence rates of pressure injuries with/without accurate adjustment for risk profile and preventive measures taken;
- benchmarking between regions/countries;
- clinical outcomes associated with pressure injuries (major organ derangements and 12 week mortality);
- economic outcomes associated with pressure injuries (length of ICU stay) and linking these outcomes with local practice regarding prevention measures applied/available.

Subanalyses:

- country and regional differences in prevalence of pressure injuries and outcome;
- age, sex and morphology-related differences in prevalence of pressure injuries and outcome;
- comorbidities, prevalence and outcome of pressure ulcers;
- relationship of ICU organisational issues with prevalence of pressure ulcers and outcome;
- prevalence and outcome in specific subgroups (trauma, surgical, medical, etc…).

Study duration: one-day prevalence [**15 May 2018**]

Follow-up period: until hospital discharge or at 12 weeks to evaluate ICU and hospital outcomes [**7 August 2018**]

3 Description of the study

3.1 Introduction

Pressure injuries remain among the most important complications of hospitalisation. They are associated with an increased infection risk, pain and disability, high level of dependence, longer hospitalisation, and as such higher hospital costs. The total annual cost for pressure injuries in the UK has been estimated to range 1.4 to 2.1 billion pounds [1].

Because severe pressure injuries are generally considered preventable, the occurrence rate of pressure injuries has increasingly been used as a quality indicator in hospital care. In addition, and in accordance with the ruling on Inpatient Prospective Payment System by the Centers for Medicare and Medicaid, hospitals in the US are no longer reimbursed for hospital costs related to severe pressure injuries (stage III or higher). These evolutions have put substantial emphasis on the prevention of pressure injuries.

In the past decades increasing efforts to prevent pressure injuries have been made, but –contrariwise– the challenge of pressure injury prevention seems to become harder as medicine progresses. Indeed, favourable evolutions in emergency medicine and organ support have led to an increasing pool of long-term intensive care (ICU) patients. Patients admitted to ICUs are at particular high risk for pressure injuries because of their debilitated physical condition and exposure to numerous risk factors. Risk factors for ICU patients are generally the same as those in a general hospital population. Yet, in ICU patients they are exaggerated in terms of both a stronger effect and the presence of more factors at the same time [2]. Also, the proportion of elderly admitted to ICU is on the rise. In a university hospital the number of patients aged >75 years increased by one third over a 15-year period [3].

Although many studies reporting on pressure injuries in ICU settings are outdated single-center or regional initiatives [4-7], a recent randomized trial conducted in the United Kingdom found a prevalence of new or substantially worsened pressure injuries of 15% in intensive care (ICU) patients with an anticipated stay of at least 36 hrs [8]. A 58% prevalence was identified in a Brazilian single center study among adult ICU patients of which 55.5% were estimated to be at high risk of developing a pressure injury according to the Braden scale, while 40% actually developed one [9].

The changing ICU patient profile, the high prevalence and the substantial economic impact make large-scaled international studies necessary to keep up with present epidemiology of pressure injuries in ICUs.

3.2 Objectives

Our objective is to provide an up-to-date, international “global” picture of the extent and patterns of pressure injuries in ICUs. Thereto we plan to perform a 1-day, prospective, multicenter point-prevalence study. The large scale of the project should allow thorough epidemiological analyses. More precisely the study will enable to identify:

- major risk factors for pressure injury development;

- preventive measures used in distinct ICU populations and countries;
- shortages in the availability of evidence-based measures to prevent pressure injuries;
- malpractice in pressure injury prevention in particular regions or countries;
- occurrence rates of pressure injuries with/without accurate adjustment for risk profile and preventive measures taken;
- benchmarking between regions/countries; clinical outcomes associated with pressure injuries (major organ derangements and mortality);
- economic outcomes associated with pressure injuries (length of ICU stay) and linking these outcomes with local practice regarding prevention measures applied/available.
- country and regional differences in prevalence of pressure injuries and outcome.

3.3 Methods

3.3.1. Network development

Steering committee

Point prevalence studies are only of value when performed on a vast scale. To sample a representative cohort, we intend to recruit about 1200 ICUs with all continents covered and as many countries as possible within each continent. Thereto an international steering committee will be established. Following our extensive experience in international research projects (see profile of the principal investigators) we currently have research contacts in all continents. Clinicians/researchers with a high ability to recruit centres will be invited in the steering committee.

Recruitment strategy

To maximize the recruitment of centers, different approaches to invite ICUs for participation will be used:

- development of a dedicated informative website including an extensive Frequently Asked Questions (FAQs) section. In all recruitment initiatives the website will be mentioned;
- our current network of researchers and participants in other studies will be contacted (e.g., all 3587 participants in the EVIDENCE-project, representing 79 countries);
- members of the steering committee will contact their personal network;
- endorsement of the European Society of Intensive Care Medicine (ESICM), will be pursued. The ESICM facilitates spread of their projects through blast mails to all their members. In the past, we succeeded in gaining endorsement from the ESICM for three of our research projects;
- for countries currently lacking from our network, embassies will be contacted to obtain a list of hospitals with intensive care activity (this strategy has been successfully used for the development of the EVIDENCE project). Especially for African and Eastern European countries this can be an important approach;
- advertisement on websites of critical care societies such as the ESICM, the Society of Critical Care Medicine (SCCM), and the American Association for Critical Care Nurses (AACCN);
- flyers will be distributed at national and international critical care symposia and congresses.

3.3.2. Organizing the point-prevalence study

For the point prevalence study a date will be picked (**15 May 2018**). Centers prepared to participate must obtain approval of the local ethics committee or review board. A local investigator with email contact is a prerequisite. Centers will be alerted by repeated email in the weeks before the study date. At that time, they will be asked to provide minimal data regarding the organisation of the unit (e.g. staffing and number of ICU beds).

3.3.3. Data recording

Pressures injury stages will be graded following the classification system jointly developed by the National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel, and Pan Pacific Pressure Injury Alliance [10]. A concise educational web-base training package will be available to optimally prepare participating ICUs for data recording.

Data will be recorded using electronic or pre-printed case report forms. Electronic forms (e-CRFs) can be consulted and submitted online. For countries with restricted digital resources, pre-printed forms will be available. These will be downloadable via the dedicated website or sent via fax, postal mail or email two weeks preceding the point prevalence measurement. After data input, pre-printed forms can be submitted through the channel best suiting the participating centers' commodities. Besides the FAQs section on the study website, a dedicated telephone hotline will be available for any queries during the study follow-up period.

Data to be recorded include patient demographics, data on severity of underlying disease and acute illness, organ failure, pressure ulcers, major risk factors for pressure ulcers, and measures taken to prevent pressure uinjuries. For more detail, see the case report form.
Participating ICUs will be asked to provide patient follow up until hospital discharge or for 84 days. At that time point survival status and length of ICU and hospital stay will be recorded.

3.3.4. Analyses & reporting of the study results
The principal investigators will perform data analyses. Data will be analysed as a whole and per continent, the latter to allow defining benchmark thresholds per continent. Initial data will be presented at international congresses as abstract and published in an international peer reviewed medical journal.

4 Study population

4.1 Inclusion criteria
All adult patients (>18 years of age) present on **15 May 2018**

4.2 Exclusion criteria
There are no exclusion criteria. All patients should be included. Patients with severe clinical conditions not allowing safe pressure injury identification should not be evaluated for the respective risk zones. If it is known that the patient has a pressure injury at the body sites that cannot be safely evaluated, the stage of the pressure injury should be recorded as previously known. If it is unknown whether the patient has a pressure injury at these body sites, this should be indicated with a '?' (See also case report form).

5 Study course

5.1 Patients' enrolment
Patients' enrolment will be limited to **15 May 2018** (from 00:00 until 24:00).

5.2 Ethics committee approval
Even though this is an epidemiological study with entirely anonymous data collection, it is advised to submit the protocol to the local ethics committee for approval.

5.3 Therapeutic intervention
The study is purely observational in nature; no interventions are planned.

5.4 Daily documentation
Data collection includes three stages:
a. on admission: see center report form;
b. on the study day: see case report form;
c. during follow up period: outcome at ICU and hospital discharge.

6 Organisation

6.1 Documentation
Data will be recorded using electronic or pre-printed case report forms by the attending intensivist, a trained research nurse, or an appropriately instructed nurse.

6.2 Collecting data
Data should be submitted digitally, faxed or (e-)mailed periodically to the coordinating center (See contact information).

6.3 Data management and archiving

6.3.1 Data property
The individual data provided by a participating ICU are primarily the property of the ICU who generated the data. All investigators have the right to access their data at any time.

6.3.2 Data control
Data control will involve the following levels:

- all participants are provided with detailed information (See instructions form). The coordinating center will provide a rapid response for any query throughout the study period (See contact information);
- data plausibility check will start at the entry level, setting validity limits for each variable. Investigators will be queried in case of outliers, excessive numbers of missing values.

6.3.3 Subsequent use of data

The steering committee, on behalf of the investigators, has the right to use all data that are pooled in the databank for scientific purposes. Investigators will be regularly informed about ongoing study activities. All participants have the right to access the data, pooled in the databank, for research purposes after the research project has been terminated, and with the approval of the steering committee. A copy of the databases generated by the project can only be provided to third-part entities after specific approval by the participating ICUs.

6.3.4 Archiving

A copy of the electronic databank will be kept in the coordinating centers and preserved for 15 years for subsequent use by the steering committee and investigators. It is recommended that a copy of all case report forms be kept at each center for future reference.

6.3.5 Publication rules

The executive committee will appoint a writing committee to draft the scientific report(s). Authorship will take the following elements into account: study design, study organisation, data collection, patient enrolment, data analysis, and contribution to the manuscript. All national representatives and local coordinators will have their efforts recognized by being mentioned as 'collaborator' in the authorship of the paper and as such listed in PUBMED. Members of the executive committee, national representatives and local coordinators may suggest research questions for secondary manuscripts and take initiative in drafting the paper after approval by the head investigators. In this regard, the head investigators control the risk of potential overlap between manuscripts.

6.4 Sponsorship

The DecubICUs project is in part supported by the LIFE Priority Fund of the European Society of Intensive Care Medicine, and the Flemish Society of Critical Care Nurses.

6.5 Statistical analysis

A single final analysis is planned at the end of the study; no interim analyses are planned. Study cohort characteristics will be described as proportions for categorical variables and for continuous variables as mean and standard deviation if normally distributed or median and inter-quartile range if not normally distributed (according to the Kolmogorov-Smirnov test for normality). Relationships with binary outcome variables (e.g. pressure ulcers, mortality) will be assessed by means of unadjusted and adjusted logistic mixed (multi-level) effects modelling in order to consider a centre effect. Likewise, linear mixed-effect modelling will be used to assess unadjusted and adjusted relationships with continuous outcome variables (e.g. length of ICU stay, organ failure score). Covariates that will be evaluated on their relationship with the presence of pressure ulcers encompass various organizational aspects of the ICU (e.g. nurse-to-patient ratio), pressure ulcer prevention measures (e.g. type of matrasses used), and severity of underlying disease and acute illness (co-morbidities, SAPS2 score, organ failure,…).

Covariates with an association with the outcome variable at a statistical level <0.25 in unadjusted logistic/linear mixed-effects analysis will be considered for adjusted analysis. A stepwise approach will be used to eliminate terms into the regression model where $p<0.15$ or $p<0.10$ (depending on the more favorable Hosmer-Lemeshow goodness-of-fit test) was set as the limit to keep covariates in the model. Results of logistic regression will be reported as adjusted odds ratios with 95% confidence intervals. If of value, pressure ulcer rates will be provided for large geographic regions (e.g. continent). Eventual differences in pressure ulcer rates might offer the opportunity to evaluate variances in prevention measures on a large scale.

Statistical analysis will be performed using SPSS for windows version 23.0 (Chicago, US). The head investigator (SB) is in charge of all statistical analysis and he is backed by the team of the Dept. of Biostatistics at the Faculty of Medicine & Health Sciences, Ghent University. In case unusual statistical challenges are faced, Dr. Ellen Deschepper of the Dept. of Biostatistics will be consulted.

Initial data will be presented at international congresses as abstract and published in an international peer reviewed medical journal.

7 References

1. Bennett G, Dealey C, Posnett J, (2004) The cost of pressure ulcers in the UK. Age Ageing 33: 230-235
2. Keller BP, Wille J, van Ramshorst B, van der Werken C, (2002) Pressure ulcers in intensive care patients: a review of risks and prevention. Intensive Care Med 28: 1379-1388
3. Blot S, Cankurtaran M, Petrovic M, Vandijck D, Lizy C, Decruyenaere J, Danneels C, Vandewoude K, Piette A, Verschraegen G, Van Den Noortgate N, Peleman R, Vogelaers D, (2009) Epidemiology and outcome of nosocomial bloodstream infection in elderly critically ill patients: a comparison between middle-aged, old, and very old patients. Critical care medicine 37: 1634-1641
4. Iranmanesh S, Rafiei H, Sabzevari S, (2012) Relationship between Braden scale score and pressure ulcer development in patients admitted in trauma intensive care unit. Int Wound J 9: 248-252
5. Manzano F, Navarro MJ, Roldan D, Moral MA, Leyva I, Guerrero C, Sanchez MA, Colmenero M, Fernandez-Mondejar E, (2010) Pressure ulcer incidence and risk factors in ventilated intensive care patients. J Crit Care 25: 469-476
6. Nijs N, Toppets A, Defloor T, Bernaerts K, Milisen K, Van Den Berghe G, (2009) Incidence and risk factors for pressure ulcers in the intensive care unit. J Clin Nurs 18: 1258-1266
7. Terekeci H, Kucukardali Y, Top C, Onem Y, Celik S, Oktenli C, (2009) Risk assessment study of the pressure ulcers in intensive care unit patients. Eur J Intern Med 20: 394-397
8. Harvey SE, Parrott F, Harrison DA, Bear DE, Segaran E, Beale R, Bellingan G, Leonard R, Mythen MG, Rowan KM, Investigators CT, (2014) Trial of the route of early nutritional support in critically ill adults. N Engl J Med 371: 1673-1684
9. Matos LS, Duarte NLV, Minetto RdCs, (2010) Incidence and prevalence of ulcer for pressure in CTI of a Public Hospital of DF. Revista Eletronica de Enfermagem 12: 719-726
10. National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and Treatment of Pressure Ulcers: Quick Reference Guide. Emily Haesler (Ed.). Cambridge Media: Osborne Park, Australia; 2014.

8 Contact details

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Appendix 1: Center Report Form

CENTER REPORT FORM Center: __ __ __

Did the data collectors consult an educative module on the correct staging of pressure injuries prior to data collection?
□ No □ Yes, the module provided by the ESICM □ Yes, another module

Section 1: general data

Institution: ……………………………………………………………………………………………….

Type of hospital: ☐ University/academic ☐ Non-university

Hospital capacity: __ __ __ __ beds
ICU capacity: __ __ __ __ beds

Type of ICU: ☐ Closed ☐ Open (non-ICU doctors may write orders)

ICU speciality:
Surgical ☐ cardiac ☐ non-cardiac ☐ transplantation ☐ mixed ☐ burns ☐ trauma

Medical ☐ coronary ☐ neurologic ☐ respiratory ☐ mixed
Mixed medical/surgical ☐ Other ☐ Please, specify …………………………………...………

How many patients were (approximately) treated in your ICU in 2017? _ __ __ patients

Section 2: data pertaining to the study day

How many ICU beds are occupied at the day of the study? __ __ __ __ ICU beds

Number of nurses on the day of the study
Between 2 - 3 am: __ __ __
Between 8 - 9 am: __ __ __
Between 4 - 5 pm: __ __ __

Physiotherapist available on the day of the study? ☐ Yes ☐ No

Is your unit currently participating in an (inter)national study on pressure injuries? ☐ Yes ☐ No

Do patient files contain a specific section for reporting pressure injuries? ☐ Yes ☐ No

Dietician/nutrition specialist available on the day of the study? ☐ Yes ☐ No

Which preventive measures are used in your ICU? (see codes list)

__ __
__ __

Which of the **above** measures are used in **all** patients (irrespective of risk profile)? (see codes list)

__ __
__ __

Which risk assessment scale is used to estimate the risk of pressure injuries?
☐ No scale ☐ Norton scale ☐ Braden scale ☐ Waterlow scale ☐ Other scale (specify):

What is the primary trigger to use extra preventive measures?
☐ high risk profile as indicated by a risk assessment scale
Ulcer: ☐ stage I ☐ stage II ☐ stage III ☐ stage IV ☐ U (unstageable) ☐ S (depth unknown)
☐ mechanical ventilation ☐ anticipated ICU stay >3 days ☐ coma/sedation ☐ vasopressor use
☐ malnutrition ☐ incontinence ☐ obesity
☐ Other (specify): ………………………………………………………………

Appendix 2: Case Report Form

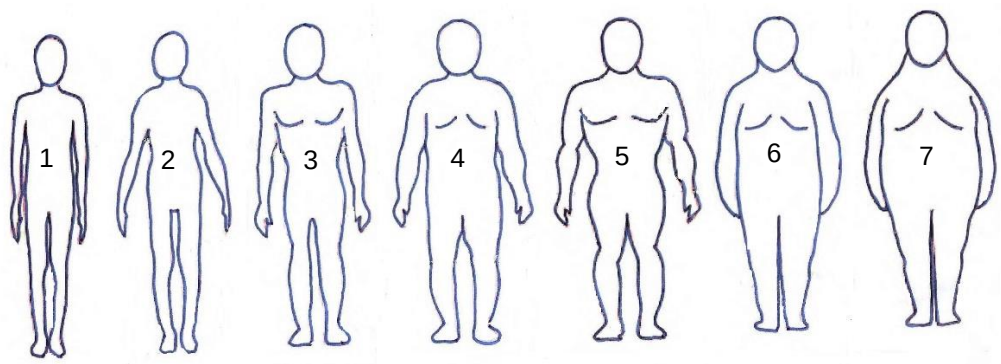
CASE REPORT FORM Center: __ __ __ __ __ Patient: __ __

Patient demographics & admission data

Date of ICU admission: __ __ / __ __ / __ __ __ __ (dd/mm/yyyy) **Sex:** ☐ male ☐ female

Age: __ __ __ years **Weight:** __ __ __ kg **Length:** __ __ __ cm

Morphological type: __



Type of admission: ☐ medical ☐ surgical ☐ elective ☐ emergency ☐ trauma ☐ burns

Mechanical ventilation on admission: ☐ yes ☐ no

Admission source: ☐ other hospital ☐ emergency room ☐ operating room ☐ general ward ☐ other

Primary diagnosis (only 1, see Codes list): __ __ __

Secondary diagnosis (max. 3, see Codes list): __ __ __ / __ __ __ / __ __ __

Comorbidities:

☐ COPD	☐ AIDS	☐ cancer (solid tumour)
☐ cirrhosis	☐ renal failure	☐ metastatic cancer
☐ heart failure	☐ diabetes	☐ hematologic cancer
☐ steroid therapy	☐ chemotherapy	☐ immunosuppression
☐ malnutrition	☐ impaired mobility	☐ peripheral vascular disease

Site(s) of surgery (max. 3, see Codes list): __ __ __ / __ __ __ / __ __ __

Study day parameters

Heart rate	(min.) __ __ __	(max.) __ __ __	bpm
Body temperature	(min.) __ __ __	(max.) __ __ __	°C
Therapeutic hypothermia	☐ yes	☐ no	
Systolic blood pressure	(min.) __ __ __	(max.) __ __ __	mmHg
Mean arterial pressure	(min.) __ __ __	(max.) __ __ __	mmHg
Lactate	(max.) __ __ __	mmol/L	
Vasopressor use	☐ yes	☐ no	
Sedation	☐ yes	☐ no	
Muscle relaxants	☐ yes	☐ no	
Respiratory rate	(min.) __ __ __	(max.) __ __ __	/minute
PaO_2/FiO_2	(min.) __ __ __	(max.) __ __ __	
Mechanical ventilation	☐ yes	☐ no	
Blood urea	(max.) __ __ __	☐ mg/dL or ☐ mmol/L or ☐ BUN (max.) __ __ __ mg/dL	
Blood creatinine	(max.) __ __ __	☐ mg/dL or ☐ mmol/L	
Leucocytes	(min.) __ __ __	(max.) __ __ __	$10^3/mm^3$
Platelets	(min.) __ __ __	$10^3/mm^3$	
Urine output	__ __ __	mL/24hours	
Renal replacement therapy	☐ yes	☐ no	
Serum potassium	(min.) __ __	(max.) __ __	mmol/L
Serum sodium	(min.) __ __ __	(max.) __ __	mmol/L
Total bilirubin	(max.) __ __ __	☐ mg/dL or ☐ mmol/L	
Serum bicarbonate	(min.) __ __	mmol/L	
Glasgow Coma Score	__ __		

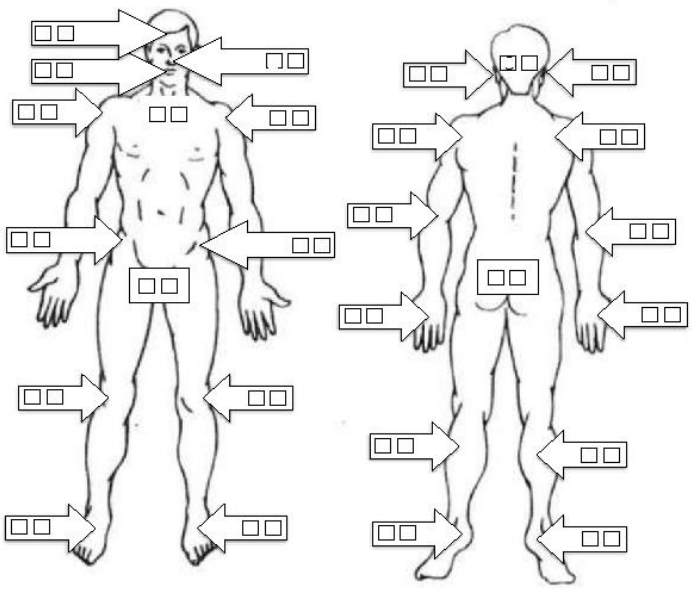
Device use on day of study (see Codes list)

__ __

Pressure injury prevention measures used (see figure and Codes list)

__ __ __ __ __ __ __ __ __ __ __ __

Pressure injuries (see Codes list)



Lesions following fixation of the patient: ☐ wrist(s) ☐ ankle(s) ☐ trunk

Pressure injury risk assessment

Sensory perception: ☐ completely limited ☐ very limited ☐ slightly limited ☐ no impairment

Moisture: ☐ constantly moist ☐ very moist ☐ occasionally moist ☐ rarely moist

Activity: ☐ bedfast ☐ chair-fast ☐ walks occasionally ☐ walks frequently

Mobility: ☐ completely immobile ☐ very limited ☐ slightly limited ☐ no limitation

Nutrition status: ☐ very poor ☐ probably inadequate ☐ adequate ☐ excellent

Friction and shear: ☐ problem ☐ potential problem ☐ no problem

Outcomes

Date of ICU discharge: __ __ / __ __ / __ __ __ __ (dd/mm/yyyy) ☐ alive
☐ dead

Date of hospital discharge:__ __ / __ __ / __ __ __ __ (dd/mm/yyyy) ☐ alive
☐ dead

Patient still in hospital on **7 August 2018** (= 15 May 2018 + 84 days) ☐

Appendix 3: Instructions to complete the center report form and case report form

Participants should register online on our webpage (www.esicm.org/research/decubICUs). Registration deadline is set to two weeks before the data collection date (1 May 2018). Enter the mailing address clearly. Providing a valid email is mandatory to facilitate correspondence during the study. Please inform us timely of any changes in your mailing address/email.
Upon completion of the online registration form, participating centers can chose to use either electronic either paper copy CRFs. To obtain paper copy CRFs, please contact the coordinating center (see contact information) by e-mail, postal mail or fax, specifying by which channel you wish to receive the CRFs (postal mail, fax, …). Please provide a valid postal address or fax number. To access the e-CRFs, each investigator will receive personalised login information to enter our secured website, where all data should be electronically entered. Each ICU will be assigned a code number. Please use this center number in all correspondence with the coordinating center. We invite the investigators to take some time in exploring the data entry area before the start of the study. Please feel free to contact the coordinating centre in case of any questions.

- -

Upon registration, the following data must be provided:

☐ Institution: name of the hospital
☐ Type of hospital: university/academic or non-university hospital
☐ Hospital capacity: the number of beds must be indicated
☐ ICU capacity: the number of beds must be indicated
☐ Type of ICU: the ICU is classified according to the majority (> 60 %) of regular admissions. Please indicate whether your ICU is open or closed.
☐ ICU specialty: the most appropriate choice must be marked. This should be based on the majority of admissions (> 60%). A free text can be added to report other specialties if applicable.
☐ Number of patients treated in 2015: if exact figures are lacking, provide a realistic estimate.

On the study day, two CRFs must be completed, i.e., (1) a CRF providing center-related data and (2) a CRF providing patient-related data.

1. CENTER REPORT FORM

This CRF consists of two sections

Section 1: the same data as upon registration must be provided. These are general data related to the identification of the hospital and participating ICU

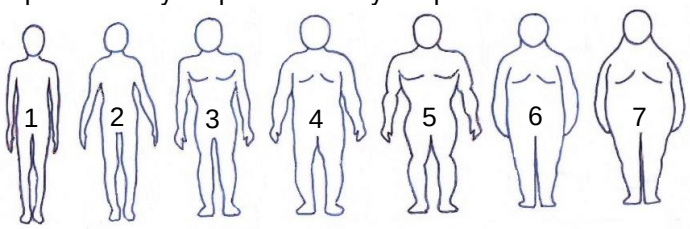
☐ Center nr.: center number provided by the coordinating center.
☐ Institution: name of the hospital
☐ Type of hospital: university/academic or non-university hospital
☐ Hospital capacity: the number of beds must be indicated
☐ ICU capacity: the number of beds must be indicated
☐ Type of ICU: the ICU is classified according to the majority (> 60 %) of regular admissions. Please indicate whether your ICU is open or closed.
☐ ICU specialty: the most appropriate choice must be marked. This should be based on the majority of admissions (> 60%). A free text can be filled in for other specialties if applicable.
☐ Number of patients treated in 2015: if exact figures are lacking, please provide a realistic estimate.

Section 2: pertains to center-related data on the study day

☐ Number of ICU beds occupied at the day of the study: provide number of beds.
☐ Number of nurses on the day of the study: provide the number of nurses per shift.
☐ Availability physiotherapist: take any time of availability during the study day into account.
☐ Participation in other study on pressure ulcers: all studies, even local or institutional, must be taken into account.
☐ Specific section in patient files: relates to any section dedicated to reporting pressure ulcers.
☐ Preventive measures that are used in the unit: use code list provided to indicate all measures used (if necessary) to prevent pressure ulcers in the unit.
☐ Measures used in all patients: from the measures reported in the above question, indicate which are always used in all patients (standard preventive measures).
☐ Risk assessment scales: check the scale(s) used in your unit. For other scales than Norton and Braden scale, please provide the scale's name.
☐ Primary trigger: check what is most appropriate (question not only pertaining to the day of study).

2. CASE REPORT FORM

- ☐ Center nr.: center number provided by the coordinating center.
- ☐ Patient nr.: provide sequential numbers from 1 to n for your center.
- ☐ Date of admission: the format day/month/year should be used.
- ☐ Sex: check the appropriate box.
- ☐ Age: patient's age (in years) at their last birthday.
- ☐ Weight: patient's weight in kilograms must be provided.
- ☐ Length: patient's length in centimetres should be provided.
- ☐ Morphological type: please refer to the figure below to choose the morphological type your patient matches best. Report the digit 1/2/3/4/5/6/7 on the case report form to indicate which of the types on the figure best corresponds with your patient's body shape.



- ☐ Type of admission: surgical is defined as surgery in the 4 weeks preceding admission. Elective surgery is defined as surgery scheduled >24 hours in advance; emergency surgery as scheduled within 24 hours of operation. Trauma is defined as ICU admissions directed related to, or as a complication of, a traumatic event in the 30 days preceding admission. Both trauma and surgical admissions could be chosen simultaneously if a trauma patient was operated on. All other admissions are considered medical. Codes for site of surgery are listed separately (up to 3 sites).
- ☐ Mechanical ventilation on admission: indicate whether the patient was on mechanical ventilation on ICU admission.
- ☐ Admission source: only one choice is possible.
- ☐ Primary diagnosis: the main reason for admission to the ICU. Only one primary diagnosis should be entered (see Codes list).
- ☐ Secondary diagnoses: defined as associated acute conditions on admission. Up to 3 secondary diagnoses are possible (see Codes list). If no relevant secondary diagnoses, please leave blank.
- ☐ Comorbidities: chronic diseases present prior to admission. More than one can be chosen according to the following definitions:
  - COPD: GOLD stage ≥ I.
  - Cirrhosis: defined as the histological development of regenerative nodules surrounded by fibrous bands in response to chronic liver injury, leading to portal hypertension and end stage liver disease.
  - Heart failure: New York Heart Association III-IV.
  - Steroid therapy: defined as immunosuppressive therapy where steroids are used to downregulate uncontrolled immune responses such as in autoimmunity or chronic inflammatory conditions
  - Malnutrition: defined as a state of nutrition in which a deficiency or excess (or imbalance) of energy, protein, and other nutrients causes measurable adverse effects on tissue/body form (body shape, size and composition) and function, and clinical outcome.
  - Cancer: solid tumour.
  - Metastatic cancer: metastases proven by surgery, computed tomography or magnetic resonance scan, or any other method.
  - Hematologic cancer: lymphoma, acute leukaemia, or multiple myeloma.
  - AIDS: HIV positive patients with clinical complications such as Pneumocystis pneumonia, Kaposi's sarcoma, lymphoma, tuberculosis, or toxoplasma infection.
  - Renal failure: defined as the need for chronic renal support or history of chronic renal insufficiency with a serum creatinine over 3.6 gm/dL (300 µmol/L).
  - Immunosuppression: administration in the 6 months prior to ICU admission of steroid treatment (at least 0.3 mg/kg/day prednisolone for at least one month), severe malnutrition, congenital immune-humoral or cellular immune deficiency state.
  - Chemotherapy: in the 6 months prior to ICU admission.
  - Insulin dependent diabetes mellitus: the need, prior to ICU admission, for insulin injections to control blood sugar levels.
  - Impaired mobility: underlying neurological or neuromuscular condition leading to impaired mobility, such as hemi-, para-, or quadriplegia or –paresis, or spasticity.
  - Peripheral vascular disease: defined as lower extremity arterial atherosclerosis.

- ☐ Study day parameters:
  - PaO2/FiO2 should be recorded simultaneously and the lowest value during the day is reported. In absence of respiratory support, use the conversion tables below to estimate the FiO2 and/or PaO2. Artefacts should be avoided (transient decrease during pneumothorax etc.).
  - Mechanical ventilation: indicate whether the patient was on mechanical ventilation on the study day.
  - Urine output: if the patient dies within the first 24 hours, the urine output should be estimated for the 24 hour period (e.g., if the patient dies after 8 hours and had 500 ml of urine during his ICU stay, the urine output would be 1.5 L).
  - Renal replacement therapy: any form of renal therapy (CVVH, CVVHD, etc.).
  - Glasgow Coma Score: report only the "assumed" Glasgow coma score. In other words, a patient who is in deep coma only because he is being treated with high doses of sedative agents should be considered to have a Glasgow coma score of 15.

Conversion tables for PaO_2 and FiO_2 estimation

Estimating PaO_2 from a given SO_2

SO_2 (%)	PaO_2 (mmHg)
80	44
81	45
82	46
83	47
84	49
85	50
86	52
87	53
88	55
89	57
90	60
91	62
92	65
93	69
94	73
95	79
96	86
97	96
98	112
99	145

FiO_2 estimation

Method	O_2 flow (l/min)	Estimated FiO2 (%)
Nasal cannula	1	24
	2	28
	3	32
	4	36
	5	40
	6	44
Nasopharyngeal catheter	4	40
	5	50
	6	60
Face mask	5	40
	6-7	50
	7-8	60
Face mask with reservoir	6	60
	7	70
	8	80
	9	90
	10	95

- ☐ Devices used: indicate all devices used on the day of the study (see Codes list).
- ☐ Pressure injury prevention measures used: indicate all prevention measures used in the patient on the day of the study (see Codes list).
- ☐ Pressure injuries: indicate any pressure injuries on the identification chart. Report pressure stage in one box and indicate whether the lesion is ICU-acquired by checking the second box (see Codes list for more information). If necessary, indicate any pressure injuries outside the arrows indicating high-risk zones. Patients with severe clinical conditions hampering safe pressure injury identification should not be evaluated for the respective risk zones. If it is known that the patient has a pressure injury at the body sites that cannot be safely evaluated, the stage of the pressure injury should be recorded as previously known. If it is unknown whether the patient has a pressure injury at these body sites, this should be indicated with a '?'.

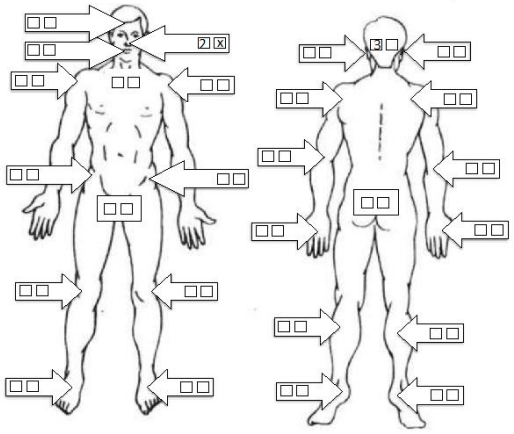


Figure – Exemplary pressure injury identification chart.
Stage 2 pressure injury at the nose; ICU-acquired as second box is checked.
Stage 3 pressure injury at the back of the head; not ICU-acquired as second box is not checked.

Pressure injury risk assessment: the risk for developing pressure ulcers is assessed by means of the six elements included in the Braden score (Bergstrom N, et al., Nurs Res 1987): sensory perception, skin moisture, activity, mobility, friction and shear. For each of the six elements, check the box that corresponds the best with the patients' condition. Find hereby a more detailed description of the boxes to check.

Sensory perception. Ability to respond meaningfully to pressure-related discomfort.

1. Completely limited. Unresponsive (does not moan, flinch, or grasp) to painful stimuli, owing to diminished level of consciousness or sedation. OR Limited ability to feel pain over most of the body.
2. Very limited. Responds only to painful stimuli. Cannot communicate discomfort except by moaning or restlessness. OR Has sensory impairment that limits the ability to feel pain or discomfort over half of the body.
3. Slightly limited. Responds to verbal commands but cannot always communicate discomfort or the need to be turned. OR Has some sensory impairment which limits ability to feel pain or discomfort in 1 or 2 extremities.
4. No impairment. Responds to verbal commands. Has no sensory deficit that would limit ability to feel or voice pain or discomfort.

Moisture. Degree to which skin is exposed to moisture.

1. Constantly moist. Skin is kept moist almost constantly by perspiration, urine, etc. Dampness is detected every time patient is turned.
2. Very moist. Skin is often, but not always, moist. Linen must be changed at least once per shift.
3. Occasionally moist. Skin is occasionally moist requiring an extra linen approximately once daily.
4. Rarely moist. Skin is usually dry. Linen requires changing only at routine intervals.

Activity. Degree of physical activity.

1. Bedfast. Confined to bed.
2. Chairfast. Ability to walk severely limited or non-existent. Cannot bear own weight and/or

must be assisted into chair or wheelchair.

3. Walks occasionally. Walks occasionally during day, but only for very short distances, with or without assistance. Spends majority of each shift in bed or chair.
4. Walks frequently. Walks outside room at least twice daily and inside room at least every 2 hours during walking hours.

Mobility. Ability to change and control body position.

1. Completely immobile. Does not make even slight changes in body or extremity position without assistance.
2. Very limited. Makes occasional slight changes in body or extremity position but unable to make frequent or significant changes independently.
3. Slightly limited. Makes frequent though slight changes in body or extremity position independently.
4. No limitation. Makes major and frequent changes in position without assistance.

Nutrition. Usual food intake pattern.

1. Very poor. Never eats a complete meal. Rarely eats more than half of any food offered. Eats 2 servings or lessof protein (meat or diary products) per day. Takes fluids poorly. Does not take a liquid dietary supplement. OR Has no oral intake and/or has been maintained on clear liquids or IV nutrition for more than 5 days.
2. Probably inadequate. Rarely eats a complete meal and generally eats only about half of any food offered. Protein intake includes only 3 servings per day. Occasionally will take a dietary supplement. OR Receives less than optimum amount of liquid diet or tube feeding.
3. Adequate. Eats more than half of most meals. Eats 4 servings of protein (meat or dietary products) per day. Occasionally will refuse a meal but will usually take a supplement when offered. OR Is receiving tube feeding or total parenteral nutrition that probably meets most of nutritional needs.
4. Excellent. Eats most of every meal. Never refuses a meal. Usually eats 4 or more servings of meat and dietary products. Occasionally eats between meals. Does not require supplementation.

Friction & shear.

1. Problem. Requires moderate to maximum assistance in moving. Complete lifting without sliding against sheets is impossible. Frequently slides down in bed or chair, requiring frequent repositioning with maximum assistance. Spasticity, contractures, or agitation leads to almost constant friction.
2. Potential problem. Moves feebly or requires minimum assistance. During a move, skin probably slides to some extent against the sheets, chair, restraints, or other devices. Maintains relatively good position in chair or bed most of the time, but occasionally slides down.
3. No apparent problem. Moves in bed and in chair independently and has sufficient muscle strength to lift up completely during move. Maintains good position in bed or chair.

Outcomes: Report date of ICU discharge and hospital discharge and survival status of the patient. If the patient is still in the hospital 84 days after the study date, check the box.
After completing both CRFs on the day of study, all completed forms should be kept in a safe place in the unit in order to be available for outcome registration 84 days after the day of study [7 August 2018].

All forms should be submitted before 18 September 2018.

Appendix 4: List of codes

PRIMARY and SECONDARY DIAGNOSES

Description: The primary and maximally 3 secondary diagnoses (acute or acute on chronic disease) should be recorded for all patients as they best reflect the reason(s) for ICU admission.

100 Neurological:

101 Stroke by ischemic or haemorrhagic mechanism (non-traumatic)
102 Intracerebral hemorrhage
103 Subarachnoid hemorrhage
104 Neurologic infection
105 Neurologic neoplasm
106 Neuromuscular disease
107 Dementia
108 Seizures
109 Polyneuritis and polyradiculoneuritis: includes polyneuritis due to infection, inflammation, toxic, Guillain-Barré syndrome
110 Post-anoxic coma
111 Delirium tremens
112 Spinal cord surgery
113 Other

200 Respiratory:

201 Exacerbation of chronic pulmonary disease (either obstructive or non obstructive)
202 Asthma attack
203 Pulmonary embolism
204 Pleural effusion
205 Mechanical airway obstruction
206 Inhalation pneumonitis: induced by gastrointestinal contents, blood, smoke, and/or gases
207 Respiratory neoplasm (include larynx and trachea)
208 Respiratory arrest
209 Pulmonary edema (non-cardiogenic)
210 Community-acquired bacterial pneumonia
211 Healthcare-associated bacterial pneumonia
212 Viral pneumonia
213 Fungal pulmonary infection
214 Near-drowning
215 Other

300 Cardiovascular / vascular:

301 Acute myocardial infarction
302 Unstable angina
303 Cardiac arrest
304 Cardiopathy: includes ischemic, valvular, hypertensive, alcoholic and other, non-infectious forms
305 Cardiogenic shock
306 Congestive heart failure
307 Rhythm disturbance
308 Perivascular disease
309 Hypertension
310 Aortic aneurysm
311 Dissecting/ruptured aorta
312 Elective abdominal aneurysm repair
313 Peripheral vascular surgery
314 Valvular heart surgery
315 CABG
316 Peripheral artery bypass graft
317 Carotid endarterectomy
318 Endocarditis
319 Other

400 Renal/genito-urinary tract:
- 401 Acute kidney injury
- 402 Chronic renal failure
- 405 Renal neoplasia
- 406 Non-malignant gynaecological diseases, non-malignant: lesions of ovary, uterus, cervix, vulvae, vagina not due to neoplasia
- 407 Malignant gynaecological diseases
- 408 Urosepsis
- 409 Other

500 Hematological:
- 501 Transfusion reaction
- 502 Neutropenia
- 503 Neutropenic sepsis
- 504 Thrombocytopenia, coagulopathy
- 503 Non-malignant disease (e.g. anaemia, aplastic anaemia, methemoglobinemia, congenital disorders of blood coagulation factors)
- 504 Malignant disease: lymphoma, acute leukaemia and multiple myeloma
- 505 Other

600 Digestive:
- 601 Hepatic failure
- 602 Gastro-intestinal perforation/obstruction/rupture
- 603 Gastro-intestinal bleeding due to varices, ulcer or diverticulitis
- 604 Inflammatory disease (ulcerative colitis, crohn's disease)
- 605 Neoplasia of the upper digestive tract (oesophageal, gastric or duodenal)
- 606 Neoplasia of the lower digestive tract (colon and rectum)
- 607 Pancreatitis
- 608 Other

700 Metabolic:
- 701 Drug overdose, intoxication
- 702 Diabetic ketoacidosis
- 703 Metabolic coma
- 704 Endocrinopathy
- 705 Other

800 Pregnancy-related:
- 801 Eclampsia, preeclampsia
- 802 HELLP syndrome
- 803 Delivery haemorrhage
- 804 Other

900 Trauma & skin:
- 901 Head trauma (isolated)
- 903 Polytrauma, without brain trauma
- 904 Polytrauma, with brain trauma
- 905 Spinal cord injury
- 905 Burn injury
- 907 Skin lesions requiring intensive care, non-traumatic (e.g. toxic epidermal necrolysis)
- 908 Pressure ulcer requiring surgical debridement or extensive wound care
- 909 Severe surgical wound infection
- 910 Other

000 Other diseases

SITE(S) OF SURGERY

Description: For patients undergoing surgery the anatomical site of surgery should be indicated. Up to three surgery sites can be reported on the case report form. Invasive radiological procedures or definitive pacemaker insertions should not be considered as surgical procedures.

000 No surgery in the current hospital stay

100 Neurosurgery:
- 101 Cerebrovascular accident: neurosurgery of intracranial hematoma or other non-traumatic accident (haemorrhage, aneurysm)
- 102 Intracranial tumour: neurosurgery for any type of tumour primary or secondary
- 103 Spinal surgery
- 104 Ear, nose and throat surgery
- 105 Maxillo-facial surgery
- 106 Other

200 Thoracic surgery:
- 201 Pneumonectomy
- 202 Lobectomy
- 203 Pleural surgery: includes all surgery on pleura either for tumour or talcage/abrasion for pneumothorax
- 204 Lung transplantation
- 205 Other

300 Cardiac surgery:
- 301 Valvular, without coronary artery by-pass graft (CABG): surgical treatment of valvulopathies without coronary surgery
- 302 Valvular with CABG: valvular repair with coronary surgery
- 303 CABG without valvular repair
- 304 Other: pericardial effusion, congenital anomaly, ventricular aneurysm, neoplastic disease, vena cava clipping/filter
- 305 Heart transplantation
- 306 Heart & lung transplantation
- 307 Major aortic surgery: includes all surgery on aorta for dissection, atheroma, aneurysm
- 308 Carotid endarterectomy: includes all surgery on the carotid artery
- 309 Other major vascular surgery: includes all surgery on intrathoracic or intraabdominal vessels
- 310 Peripheral vascular surgery: includes all surgery on non-intracranial, non-intrathoracic, non-intraabdominal vessels, either arteries or veins with or without by-pass graft
- 311 Other

400 Renal-urinary tract:
- 401 Renal surgery
- 402 Urologic surgery

600 Digestive:
- 601 Upper gastro-intestinal surgery (up to and including the jejunum)
- 602 Lower gastro-intestinal surgery
- 603 Biliary tract: surgery of gallbladder and/or biliary tract
- 604 Liver: partial hepatectomy, portal-systemic shunt surgery
- 605 Liver transplantation
- 606 Pancreas

700 Metabolic:
- 701 Endocrine surgery (thyroid, adrenal, pancreas etc.)

800 Obstetric/gynaecologic:
- 801 Obstetric surgery: Caesarean section, surgery for ectopic pregnancy, peri- or post-partum haemorrhage, intra-uterine death
- 802 Gynaecological surgery: surgery of uterus, ovaries, cervix, genitalia

900 Trauma:
- 901 Brain: surgery for subdural, epidural, intracerebral haematoma or skull fracture
- 902 Thorax: surgery of intra-thoracic organs (cardiac, respiratory or digestive tract) and vessels
- 903 Abdomen
- 904 Limb
- 905 Multiple
- 906 Other

DEVICES

Description: For patients in which devices are used the type of device should be indicated. Report all devices used.

100 Respiratory tract:
- 101 Oral endotracheal tube
- 102 Nasal endotracheal tube
- 103 Tracheostomy with cannula
- 104 Nasal oxygen cannula
- 105 Mask for non-invasive ventilation
- 106 Oxygen mask
- 107 Other

200 Peripheral intravascular catheters:
- 201 Right hand
- 202 Left hand
- 203 Right arm
- 204 Left arm
- 205 Right foot
- 206 Left foot
- 207 Other location

300 Central venous catheters:
- 301 Internal jugular vein right
- 302 Internal jugular vein left
- 303 Subclavian vein right
- 304 Subclavian vein left
- 305 Femoral vein right
- 306 Femoral vein left
- 307 Other location

400 Arterial line:
- 401 Radial artery, right
- 402 Radial artery, left
- 403 Femoral artery, right
- 404 Femoral artery, left
- 405 Other location

500 Urinary tract catheter:
- 501 Urethral
- 502 Suprapubic
- 503 Other

600 Feeding tubes:
- 601 Orogastric
- 602 Nasogastric
- 603 Percutane Endoscopic Gastrostomy (PEG)
- 604 Duodenal / jejunal

000 Other devices

PRESSURE INJURY STAGES

Description: Pressure injury stages definitions used are published as National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and Treatment of Pressure Ulcers: Quick Reference Guide. Emily Haesler (Ed.). Cambridge Media: Osborne Park, Western Australia; 2014.
The case report form includes a figure to report pressure injury development at different body sites. Each site is marked by two selection boxes. Use these boxes next to each corresponding body site to indicate :

- the category/stage of pressure injuries (first box, codes 1/2/3/4/U/S)
- whether the injury was present upon ICU admission (check second box if ICU acquired)

Box 1: category/stage of pressure injuries (codes 1/2/3/4/U/S)

1 - Category/Stage I: Non-blanchable erythema
Intact skin with non-blanchable redness of a localized area usually over a bony prominence. Darkly pigmented skin may not have visible blanching; its color may differ from the surrounding area. The area may be painful, firm, soft, warmer or cooler as compared to adjacent tissue. Category I/Stage I may be difficult to detect in individuals with dark skin tones. May indicate “at risk” individuals (a heralding sign of risk).

2 - Category/Stage II: Partial thickness skin loss
Partial thickness loss of dermis presenting as a shallow open ulcer with a red pink wound bed, without slough. May also present as an intact or open/ruptured serum-filled filled blister. Presents as a shiny or dry shallow ulcer without slough or bruising*. This Category/Stage should not be used to describe skin tears, tape burns, perineal dermatitis, maceration or excoriation. *Bruising indicates deep tissue injury.

3 – Category/Stage III: Full thickness skin loss
Full thickness tissue loss. Subcutaneous fat may be visible but bone, tendon or muscle are *not* exposed. Slough may be present but does not obscure the depth of tissue loss. *May* include undermining and tunneling. The depth of a Category/Stage III pressure ulcer varies by anatomical location. The bridge of the nose, ear, occiput and malleolus do not have subcutaneous tissue and Category/Stage III ulcers can be shallow. In contrast, areas of significant adiposity can develop extremely deep Category/Stage III pressure ulcers.
Bone/tendon is not visible or directly palpable.

4 - Category/Stage IV: Full thickness tissue loss
Full thickness tissue loss with exposed bone, tendon or muscle. Slough or eschar may be present on some parts of the wound bed. Often include undermining and tunneling. The depth of a Category/Stage IV pressure ulcer varies by anatomical location. The bridge of the nose, ear, occiput and malleolus do not have (adipose) subcutaneous tissue and these ulcers can be shallow. Category/Stage IV ulcers can extend into muscle and/or supporting structures (e.g., fascia, tendon or joint capsule) making osteomyelitis possible. Exposed bone/muscle is visible or directly palpable.

U - Unstageable/ Unclassified: Full thickness skin or tissue loss –: depth unknown
Full thickness tissue loss in which the base of the ulcer is covered by slough (yellow, tan, gray, green or brown) and/or eschar (tan, brown or black) in the wound bed. Until enough slough and/or eschar are removed to expose the base of the wound, and therefore Category/Stage cannot be determined. Stable (dry, adherent, intact without erythema or fluctuance) eschar on the heels serves as “the body’s natural (biological) cover” and should not be removed.

S - Suspected Deep Tissue Injury: depth unknown
Purple or maroon localized area of discolored intact skin or blood-filled blister due to damage of underlying soft tissue from pressure and/or shear. The area may be preceded by tissue that is painful, firm, mushy, boggy, warmer or cooler as compared to adjacent tissue. Deep tissue injury may be difficult to detect in individuals with dark skin tones. Evolution may include a thin blister over a dark wound bed. The wound may further evolve and become covered by thin eschar. Evolution may be rapid exposing additional layers of tissue even with optimal treatment.

Box 2: ulcer present upon ICU admission
Check the second box if ICU acquired.
Please refer to the instructions form for an exemplary pressure ulcer identification chart.

PREVENTIVE MEASURES
Description: All measures **used specifically in order to prevent pressure ulcers** on the study day should be reported. Measures listed which are commonly used on the ward but not specifically in order to prevent pressure ulcers should NOT be scored (e.g. use of body moisturizing products, massage).

100 Low-tech (non-powered) support surfaces
- 101 Standard foam mattresses
- 102 Alternative foam mattresses/overlays (e.g. convoluted foam, cubed foam)
- 103 Gel-filled mattresses/overlays
- 104 Fibre-filled mattresses/overlays
- 105 Air-filled mattresses/overlays
- 106 Water-filled mattresses/overlays
- 107 Bead-filled mattresses/overlays
- 108 Foam cushions
- 109 Non-foam cushions (except ring cushions)
- 110 Ring cushions
- 111 Sheepskins

200 High-tech support surfaces
- 201 Alternating-pressure mattresses/overlays: patient lies on air-filled sacs which sequentially inflate and deflate and relieve pressure at different anatomical sites for short periods; may incorporate a pressure sensor.
- 202 Air-fluidised beds: warmed air circulated through fine ceramic beads covered by a permeable sheet; allows support over a larger contact area.
- 203 Low-air-loss beds: patients are supported on a series of air sacs through which warmed air passes.
- 204 Continuous bedside pressure mapping devices indicating excessive pressures.

300 Various
- 301 Turning beds/frames: these devices work by either aiding manual repositioning of the patient, or by automatic motor-driven turning and tilting. They may have a static or an alternating support surface in conjunction with the frame.
- 302 Patient repositioning: patient is repositioned in the bed and / or chair within predefined fixed timeframes.
- 303 Ice friction
- 304 Blow-drying
- 305 Bolstering of the heels
- 306 Floating heels
- 307 Hydrating body moisturizers
- 308 Soft silicone multi-layered foam dressing

000 Other preventive measures

E-learning module: Stages of pressure injuries

Disclaimer

Classification of pressure injuries

The International Pressure Injury Category System (2009) was developed by:

- the National Pressure Ulcer Advisory Panel (NPUAP)
- the European Pressure Ulcer Advisory Panel (EPUAP)

and incorporated in the International Clinical Practice Guideline (2014)* developed by:

- the National Pressure Ulcer Advisory Panel (NPUAP)
- the European Pressure Ulcer Advisory Panel (EPUAP)
- the Pan Pacific Pressure Injury Alliance (PPPIA)

*This consensus guideline serves as basis for this educational module

Pressure injury

Definition

A pressure injury is a localized injury to the skin and/or underlying tissue usually over a bony prominence, as a result of pressure, or pressure in combination with shear.

A number of contributing or confounding factors are also associated with pressure injuries; the significance of these factors is yet to be elucidated.

Stages* of pressure injuries

- Stage I: Nonblanchable Erythema
- Stage II: Partial Thickness Skin Loss
- Stage III: Full Thickness Skin Loss
- Stage IV: Full Thickness Tissue Loss
- Unstageable: Depth Unknown
- Suspected Deep Tissue Injury: Depth Unknown

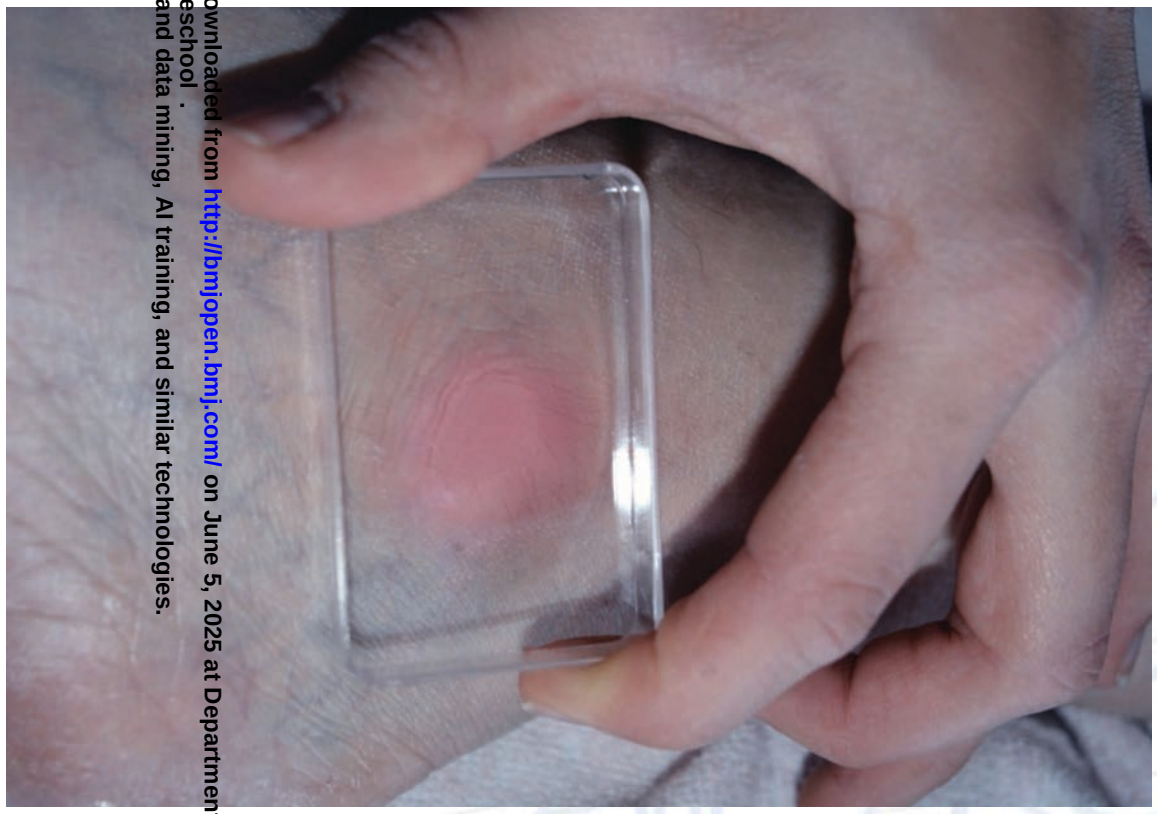
*For convenience sake, the term "Stage" is used in this educational module when referring to the term "Category/ Stage" used in the NPUAP/EPUAP Clinical Practice Guideline

Stage I: Nonblanchable Erythema

Definition: intact skin with nonblanchable redness of a localized area, usually over a bony prominence

The area may be painful, firm, soft, warmer or cooler compared to surrounding tissue. Individuals with nonblanchable erythema are particularly at risk for developing higher stages of pressure injuries.

May be difficult to detect in individuals with darkly pigmented skin: it may be recommended to rely on assessment of skin temperature, changes in tissue consistency and pain rather than identification of nonblanchable erythema.

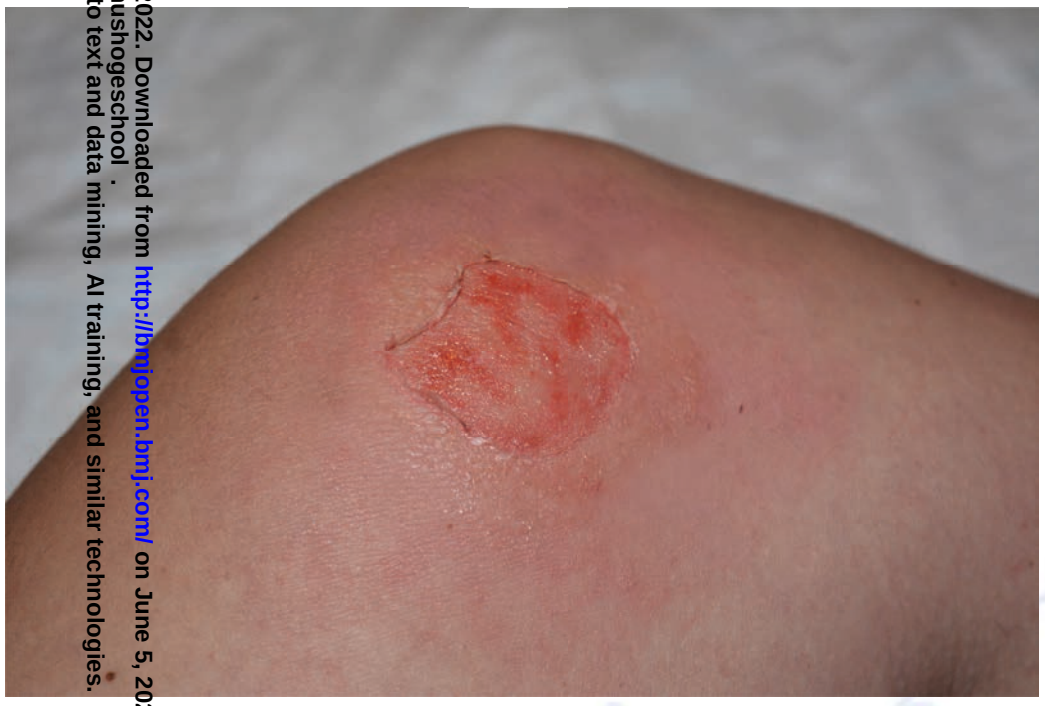


Stage II: Partial Thickness Skin Loss

Definition: partial thickness loss of dermis presenting as a shiny or dry shallow open ulcer with a red pink wound bed without slough or bruising. May also present as an intact or open/ruptured serum-filled blister

In individuals with darkly pigmented skin, assess:

- skin heat
- skin tenderness
- change in tissue consistency
- pain



This stage should **not be used** to describe skin tears, tape burns, perineal dermatitis, maceration or excoriation

Stage III: Full Thickness Skin Loss

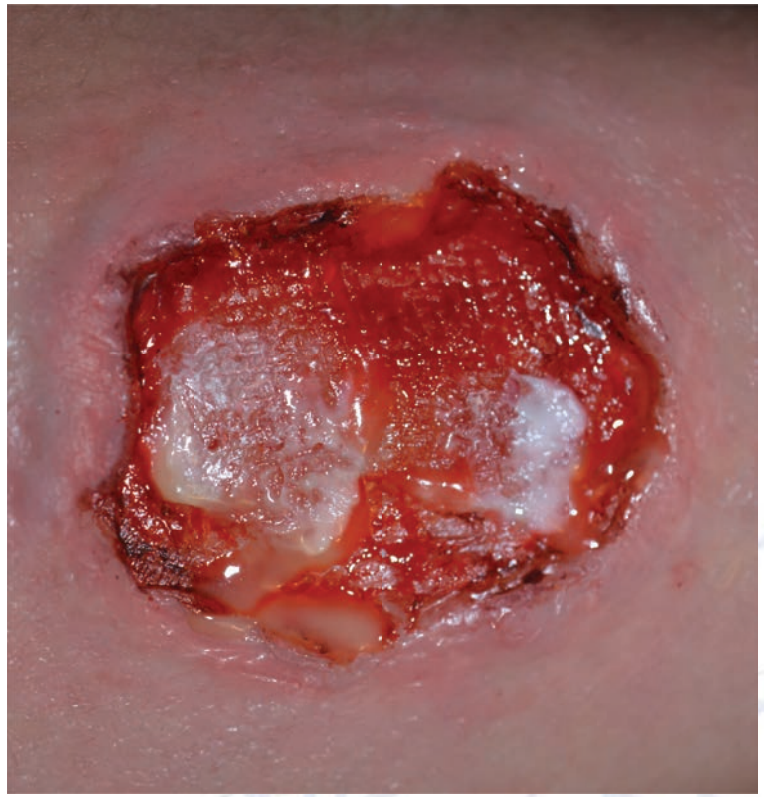
Definition: full thickness tissue loss

Subcutaneous fat may be visible; bone, tendon or muscle are not exposed. Slough may be present but does not obscure the depth of tissue loss. May include undermining and tunnelling

The depth of the injury varies by anatomical location:

- shallow Stage III: often in areas with little subcutaneous tissue e.g. bridge of the nose, ear, occiput and malleolus
- extremely deep Stage III: often in areas of significant adiposity

In individuals with darkly pigmented skin: assess skin heat, skin tenderness, change in tissue consistency and pain



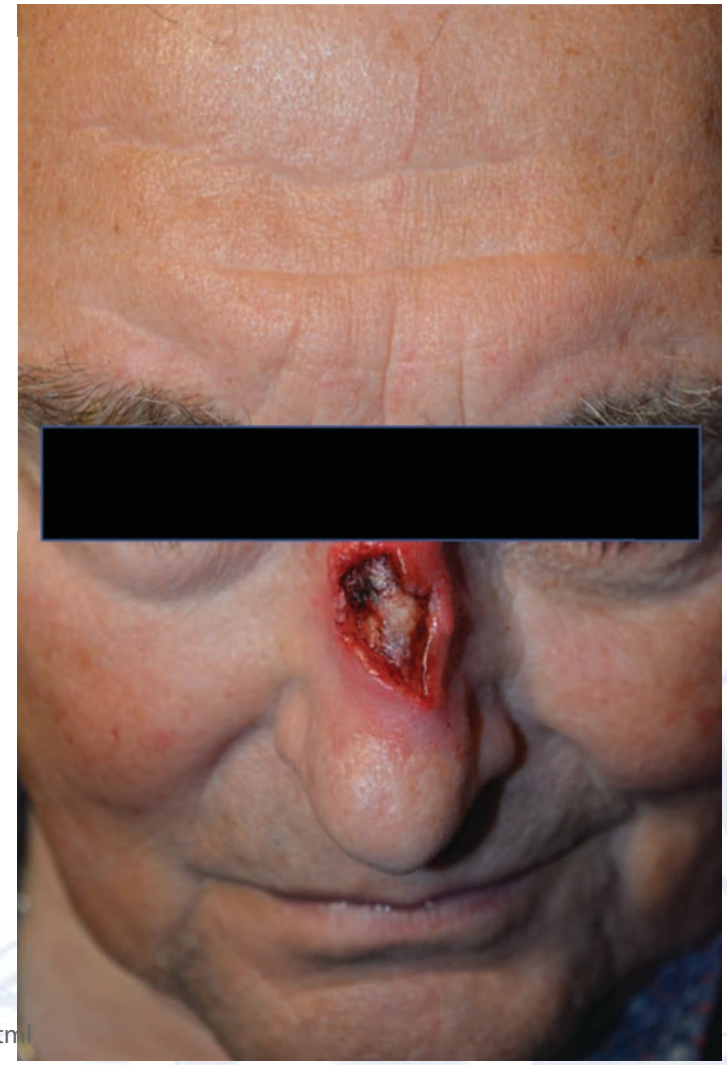
Stage IV: Full Thickness Tissue Loss

Definition: full thickness tissue loss with exposed bone, tendon, muscle (visible or directly palpable)

Depth varies by anatomical location with shallow Stage IV often observed in areas with little subcutaneous tissue e.g. bridge of the nose, ear, occiput and malleolus

Possible extension into muscle and/or supporting structures (fascia, tendon, joint capsule): risk of osteomyelitis. Slough or eschar may be present on parts of the wound bed; often with undermining and tunnelling

In individuals with darkly pigmented skin: assess skin heat, skin tenderness, change in tissue consistency and pain



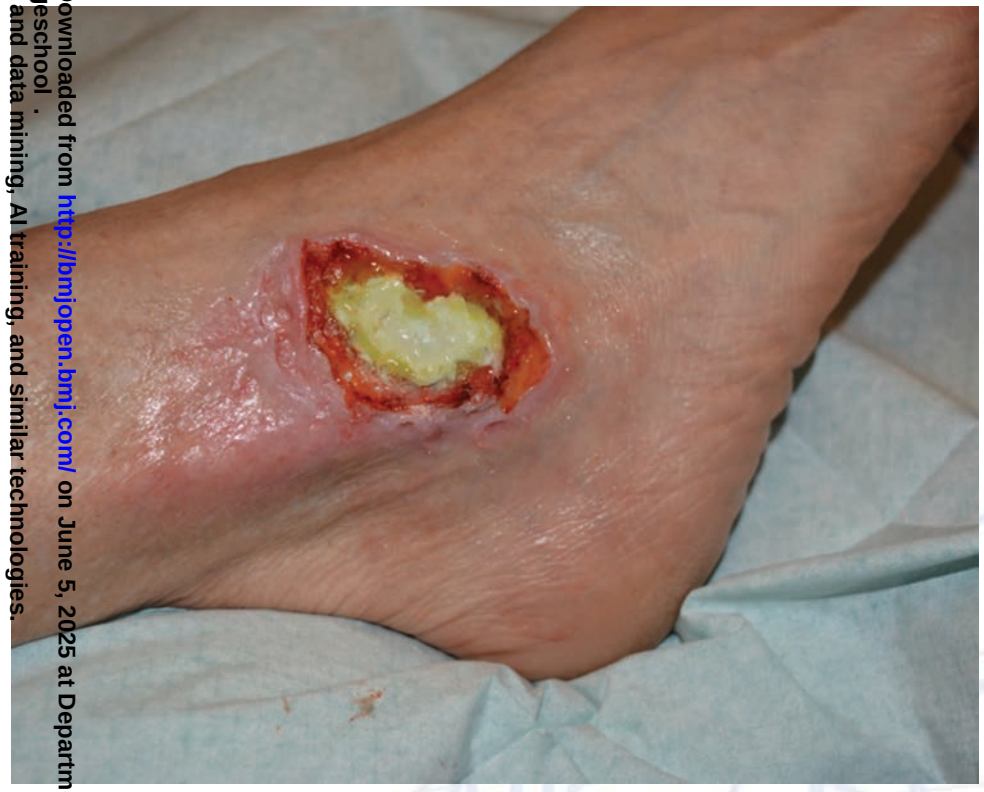
Unstageable: Depth Unknown

Definition: full thickness tissue loss in which the base of the injury is covered by slough (yellow, tan, grey, green or brown) and/or eschar (tan, brown or black) in the wound bed

Depth and stage are not to be determined until enough slough and/or eschar is removed to expose the base of the wound

Stable (dry, adherent, intact without erythema or fluctuance) eschar on the heels should not be removed ('the body's biological cover')

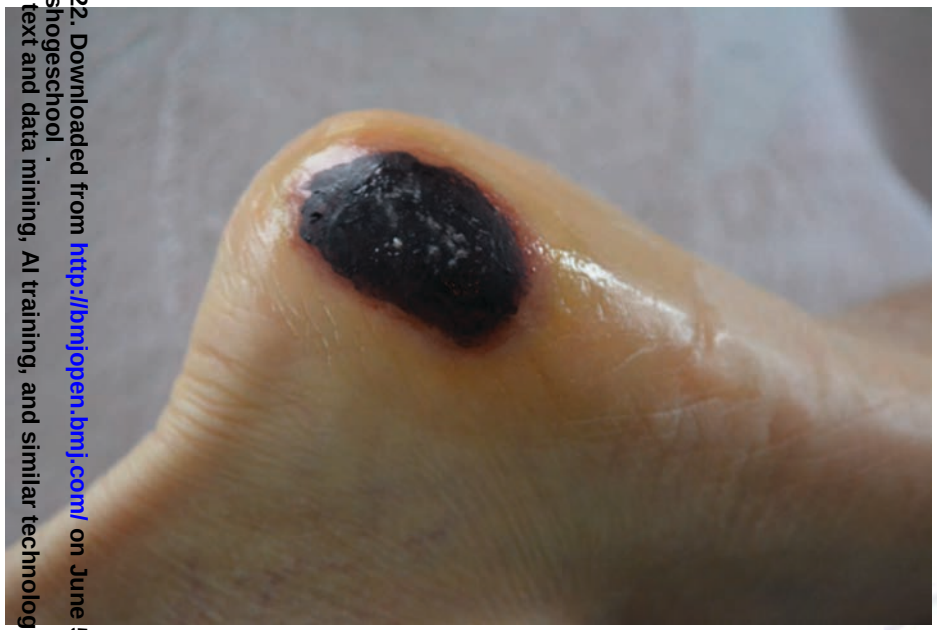
In individuals with darkly pigmented skin: assess skin heat, skin tenderness, change in tissue consistency and pain



Suspected Deep Tissue Injury: Depth Unknown

Definition: Purple or maroon localized area of discoloured intact skin or blood-filled blister due to damage of underlying soft tissue from pressure and/or shear

In individuals with darkly pigmented skin: assess skin temperature, change in tissue consistency and pain



Potential evolution of the wound:

- thin blister over a dark wound bed, covered by thin eschar
- rapid deterioration
- exposure of additional layers of tissue
- regardless of optimal treatment

Surrounding area:

- painful
- firm
- mushy
- boggy
- warmer/cooler

Inspection of the skin: Methods

Inspection of the skin for erythema in patients 'at risk' of developing a pressure injury:

- cause and extent of erythema
- skin redness: blanchable or nonblanchable? → finger or disc method

Finger pressure method:
a finger is pressed on the erythema for three seconds and blanching is assessed following removal of the finger

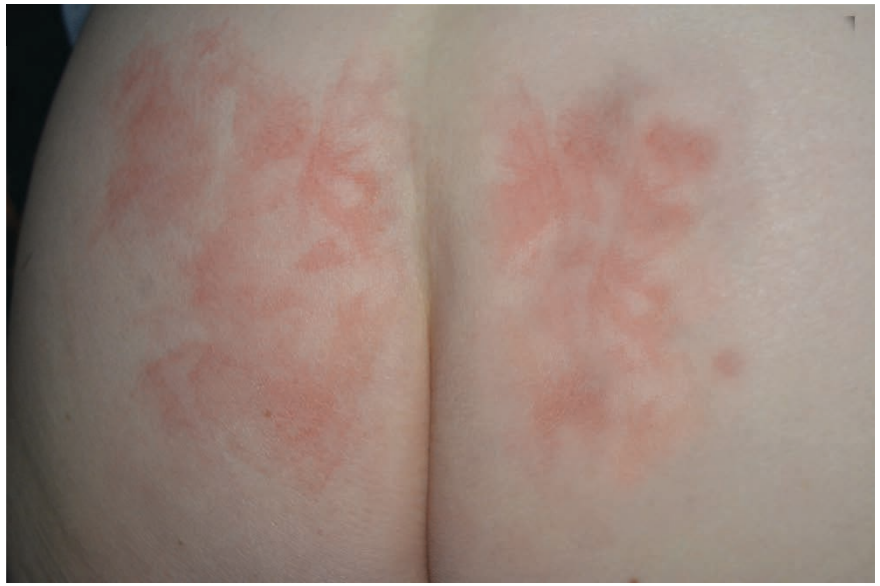
Transparent disk method:
a transparent disk is used to apply pressure equally over an area of erythema, and blanching can be observed underneath the disk during its application.

Attention: MASD is NOT pressure injury

Moisture-associated skin damage (MASD) is commonly confused with pressure injury, while origin and treatment differ completely.

Definition: MASD is inflammation and erosion of the skin caused by prolonged exposure to various sources of moisture, including urine or stool, perspiration, wound exudate, mucus, or saliva.

In relation to pressure injuries, MASD mostly appears as Incontinence Associated Dermatitis (IAD), which is typical for the sacral area.



	Pressure injury	Moisture-associated skin damage
Etiology	Pressure - shear	Prolonged exposure to sources of moisture
Location	Usually over a bony prominence	Anywhere moisture can accumulate
Distribution	Localized area, distinct edges	Diffuse different spots, diffuse irregular edges
Depth	Partial or full thickness skin loss	Superficial - partial thickness skin loss

Differentiate pressure injuries also from other wound types

Besides MASD, more wound types may be incorrectly classified as pressure injury. Some common examples are:

- venous ulcers
- neuropathic ulcers
- skin tears
- intertrigo

Literature

Gray M., Black J.M., Baharestani M. M. et al.; Moisture-Associated Skin Damage Overview and Pathophysiology. J Wound Ostomy Continence Nurs. 2011; 38(3): 233-241.

Gray M., Bliss D.Z., Doughty D.B. et al.; Incontinence-Associated Dermatitis. A Consensus. J Wound Ostomy Continence Nurs. 2007; 34(1): 45-54.

National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and Treatment of Pressure Ulcers: Quick Reference Guide. Emily Haesler (Ed.). Cambridge Media: Osborne Park, Western Australia; 2014.

Zulkowski K. Diagnosing and Treating Moisture-Associated Skin Damage. Adv Skin Wound Care. 2012; 25(5): 231-236.

Test your knowledge

The next slides will help you to check if you master the contents of this module.

There are 22 slides with pictures representing different stages of pressure injuries and moisture-associated skin damage (MASD). It is up to you to classify each pressure injury correctly according to the NPUAP/EPUAP classification and to recognize MASD as a non-pressure injury related wound type. Each slide with picture is followed by a slide that provides the correct answer.

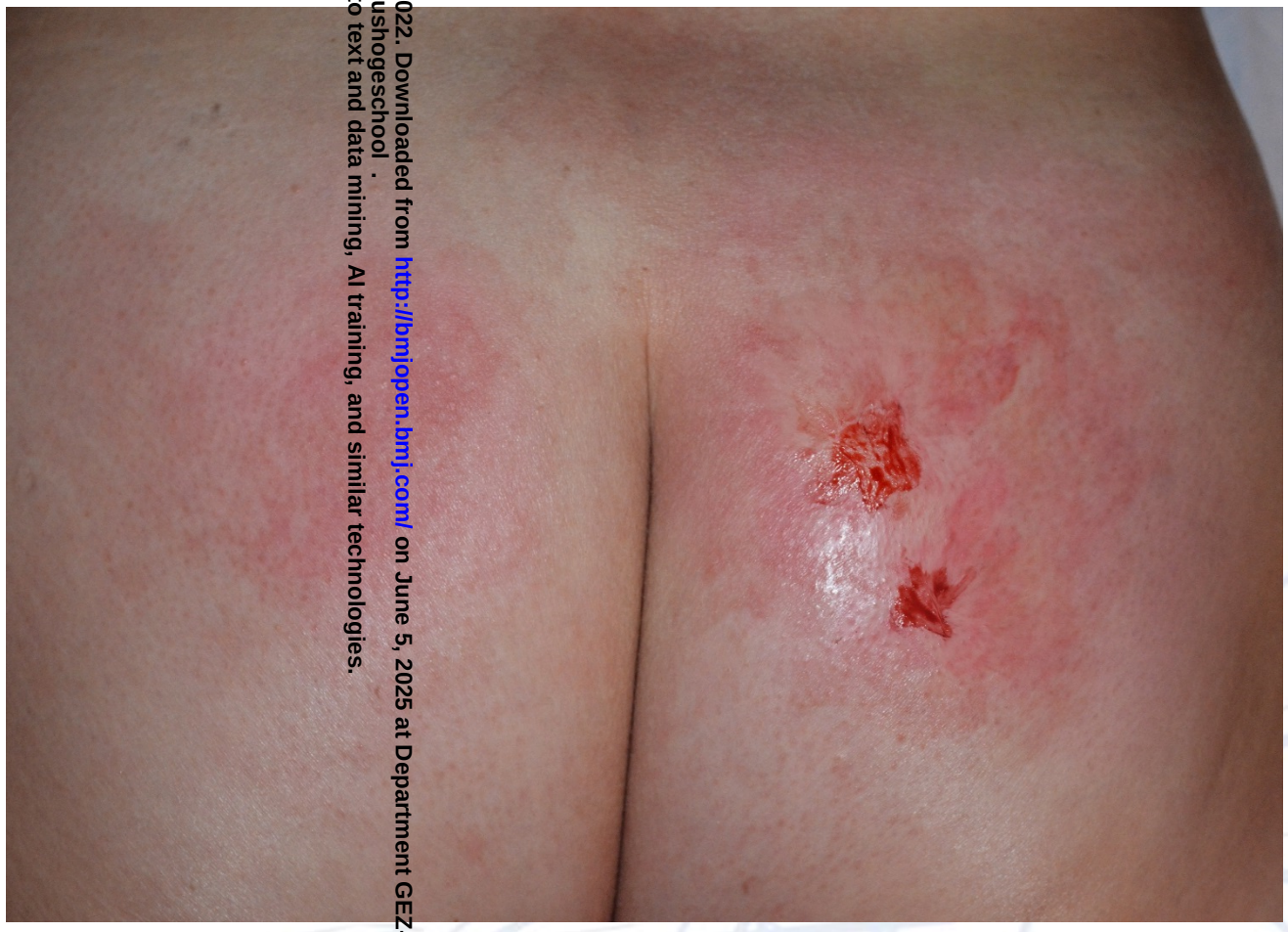
Although we tried to use representative photographs for this test, we are well aware that it is not obvious to evaluate stages of pressure injuries without relevant clinical information.

Good luck!

Question 1

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

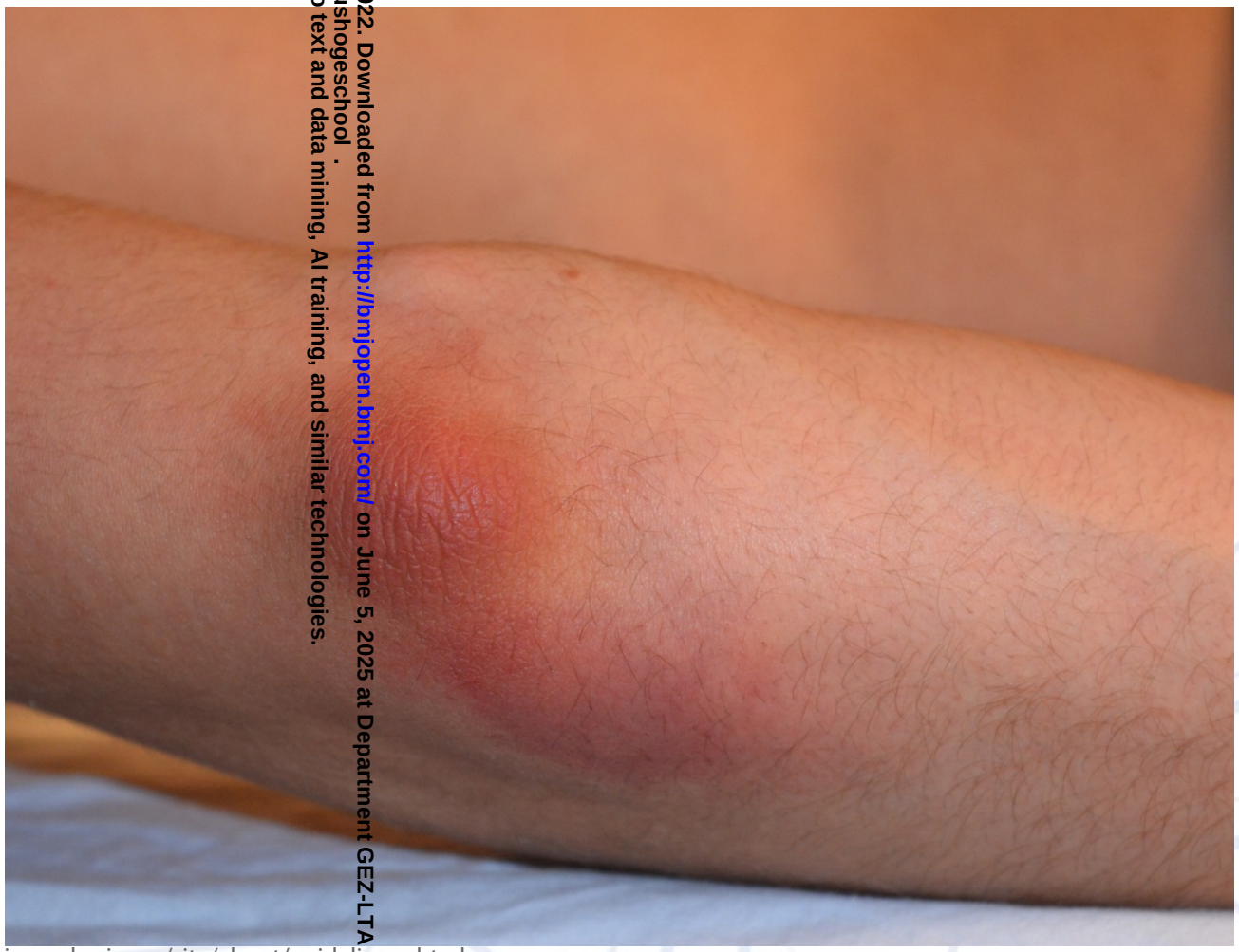
Correct answer: moisture-associated skin damage (MASD), possibly incontinence-related.

Explanation: there is a noticeable erythema of the skin. Skin damage is superficial and the edges are irregular. There is also some degree of maceration present, probably due to friction. The effects of friction on a wet skin are more damaging that on the dry skin.

Question 2

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

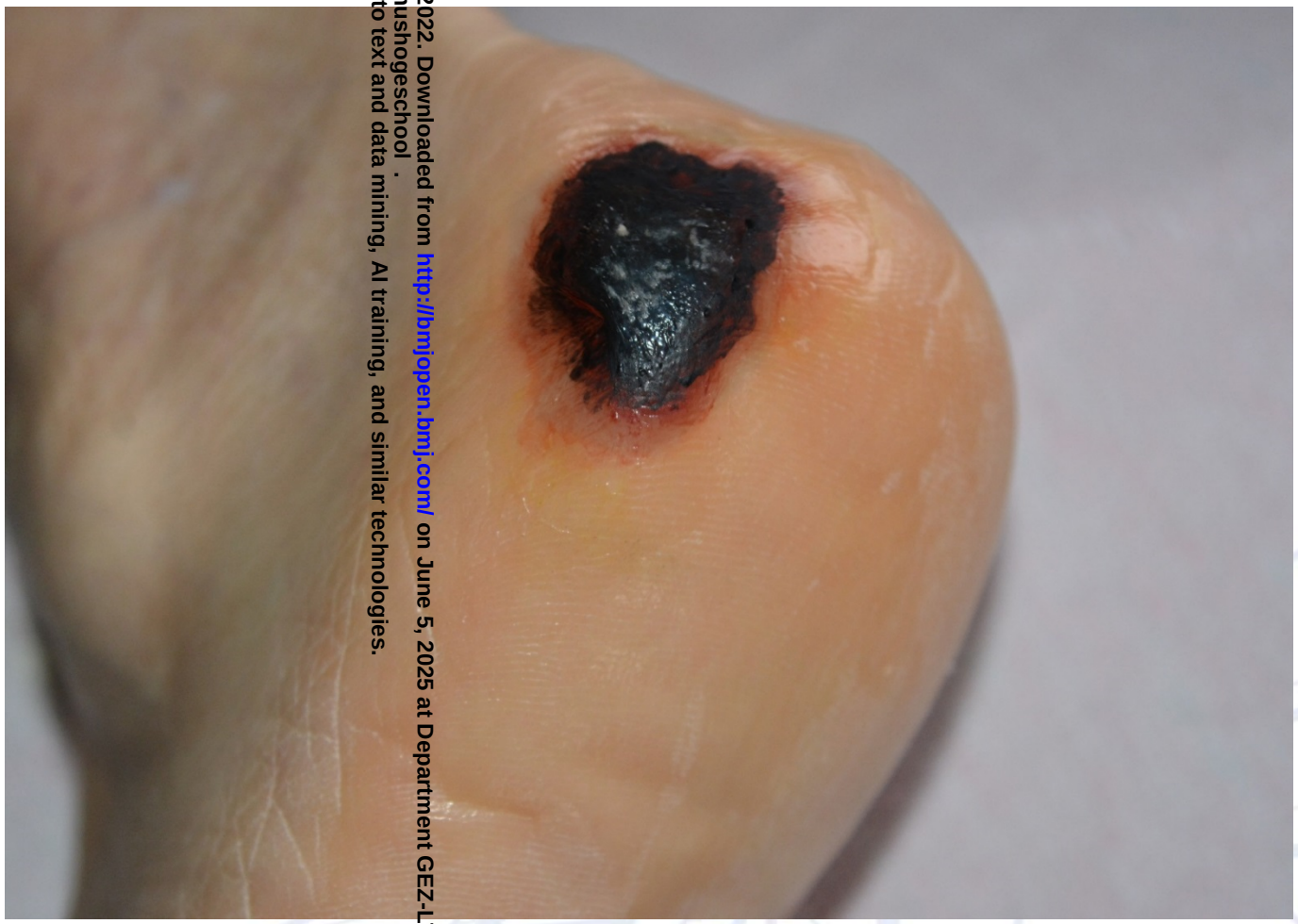
Correct answer: Stage I pressure injury

Explanation: the skin is intact and the erythema is nonblanchable.

Question 3

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

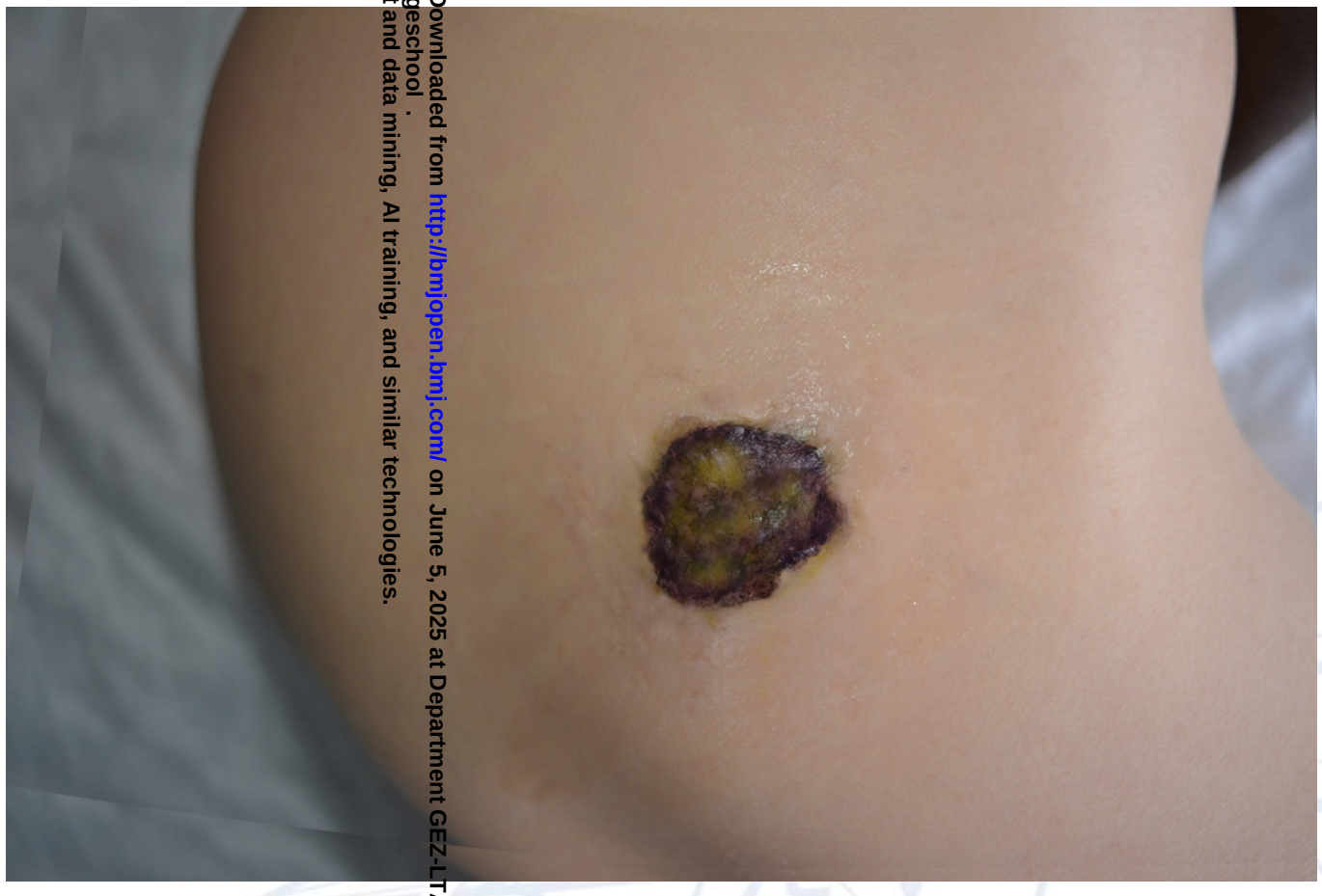
Correct answer: suspected deep tissue injury

Explanation: a dark eschar covers the localized wound area. The skin surrounding the eschar is coloured maroon. The visible skin is intact. We can assume that the underlaying soft tissue has been damaged.

Question 4

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

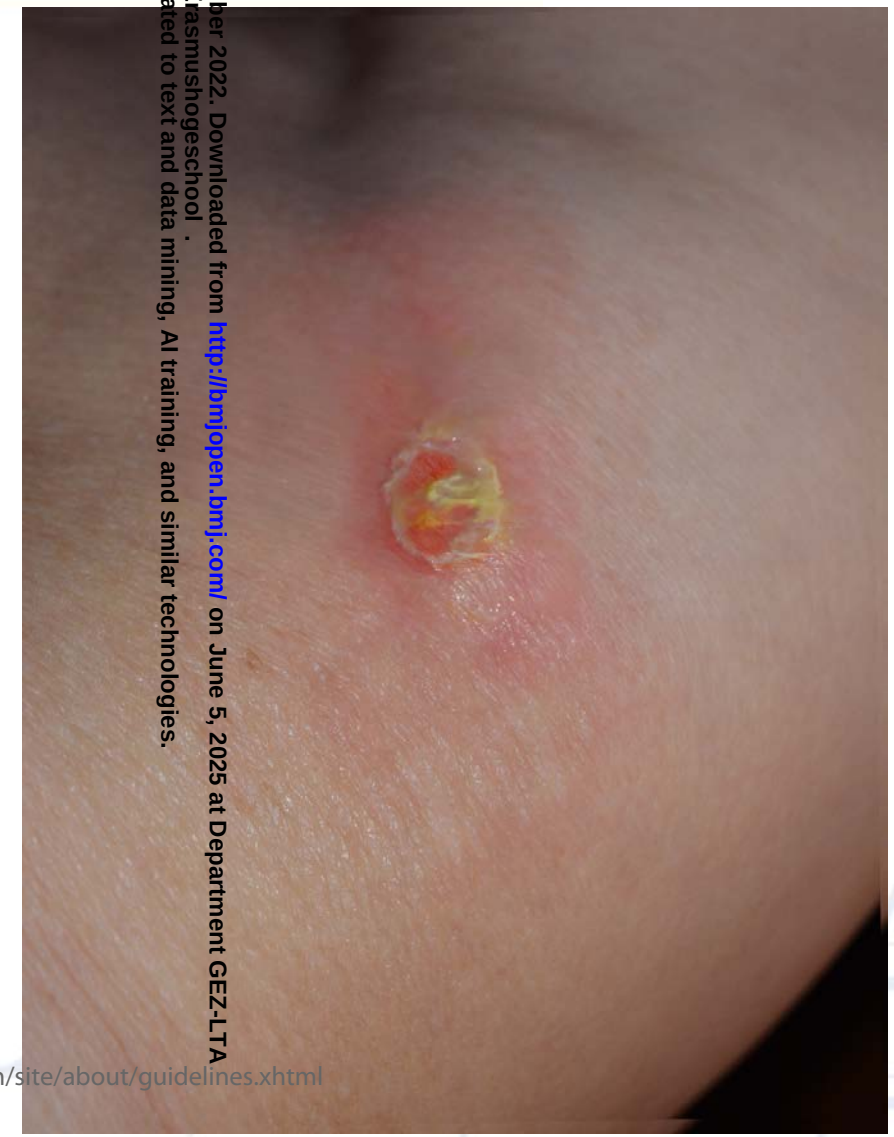
Correct answer: suspected deep tissue injury

Explanation: a necrotic eschar covers the injury. The visible skin is intact. We can assume that the underlaying soft tissue has been damaged. To determine the status of underlaying tissue, the eschar has to be removed first.

Question 5

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

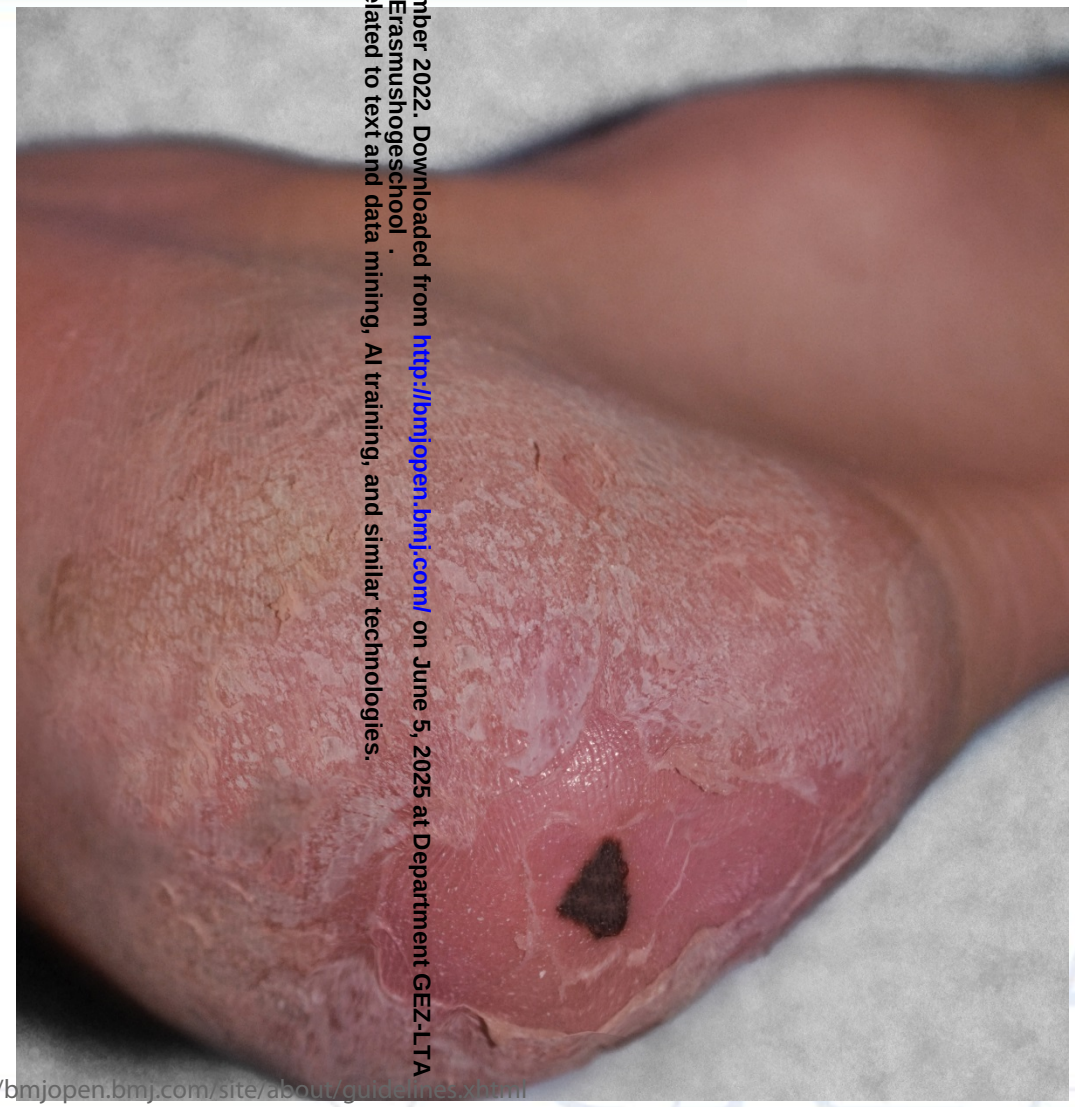
Correct answer: Stage III pressure injury

Explanation: there is a full thickness tissue loss with no exposition of the bone. Slough is present without interfering with the examination of the tissue loss. This is a shallow stage III injury because the tissue damage is on the iliac crest where there is little/no subcutaneous tissue.

Question 6

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

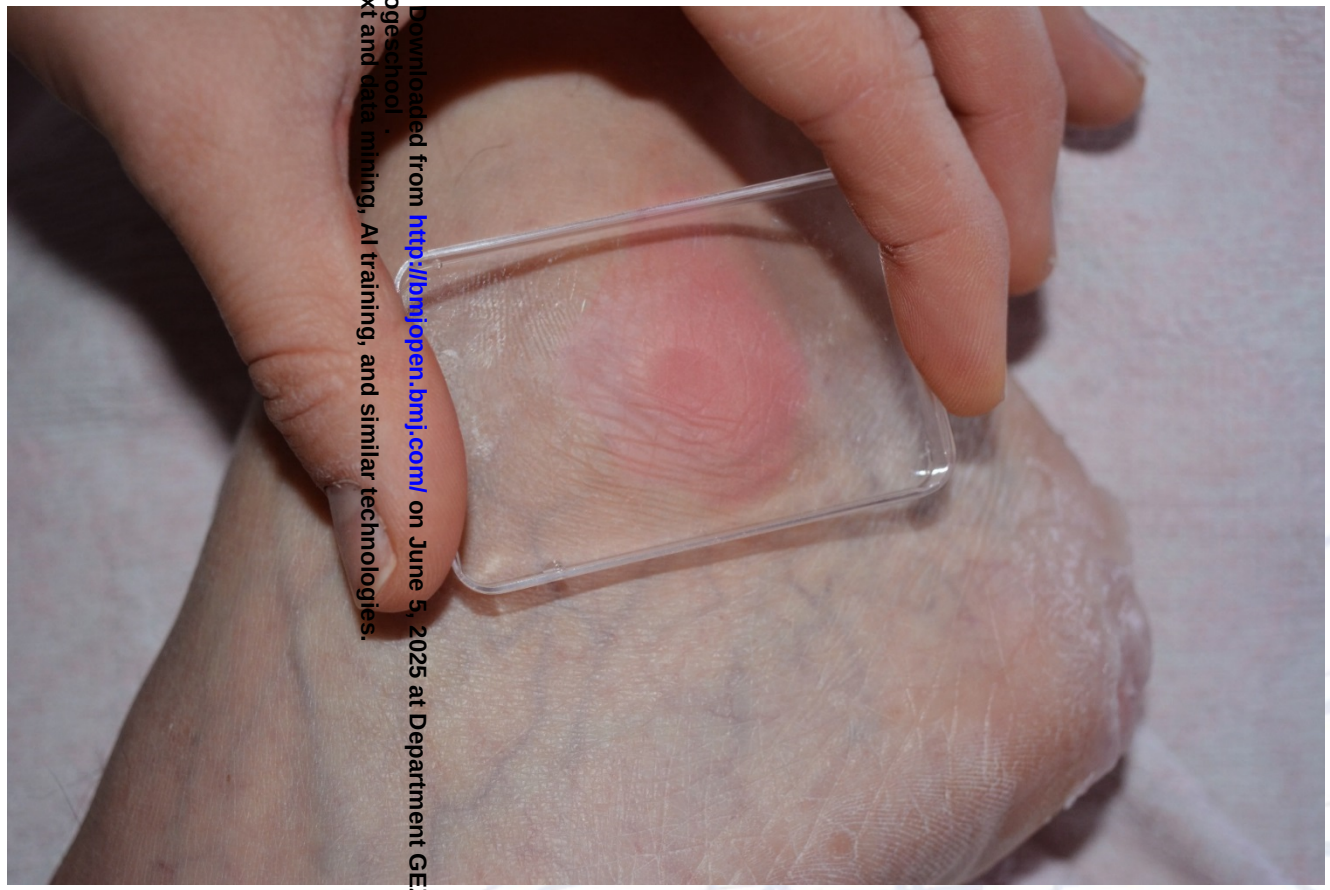
Correct answer: unstageable pressure injury

Explanation: a stable black eschar is covering the wound. It is impossible to determine how deep the wound is but probably there is a full thickness tissue loss.

Question 7

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

Correct answer: Stage I pressure injury

Explanation: the skin is intact and the erythema is nonblanchable as determined by the transparent disk method. The ankle is a typical area for developing Stage I pressure injury because of its bony prominence.

Question 8

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage

Answer

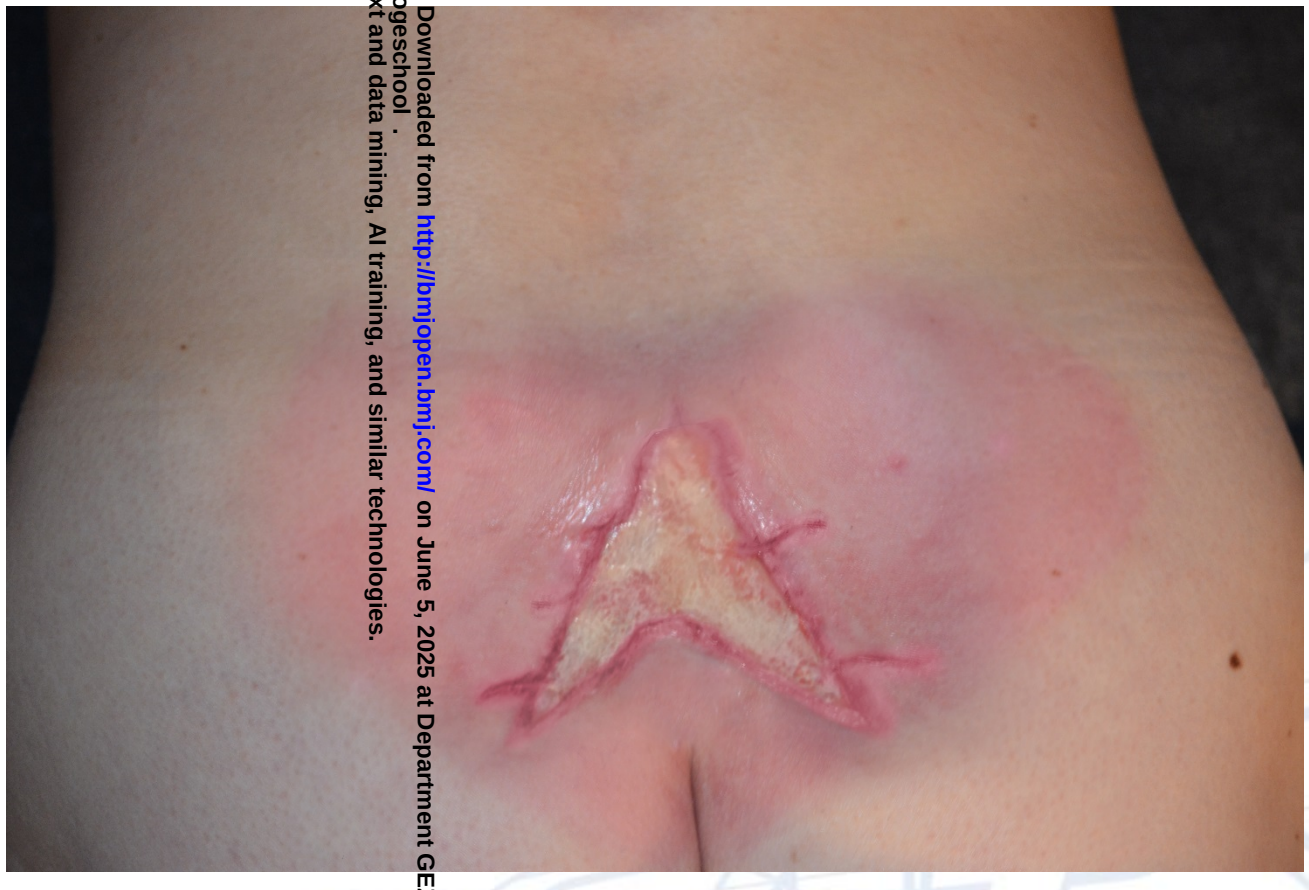
Correct answer: suspected deep tissue injury

Explanation: the entire wound area is coloured purple/maroon and the skin is intact. It can be assumed that the underlying soft tissue is damaged.

Question 9

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

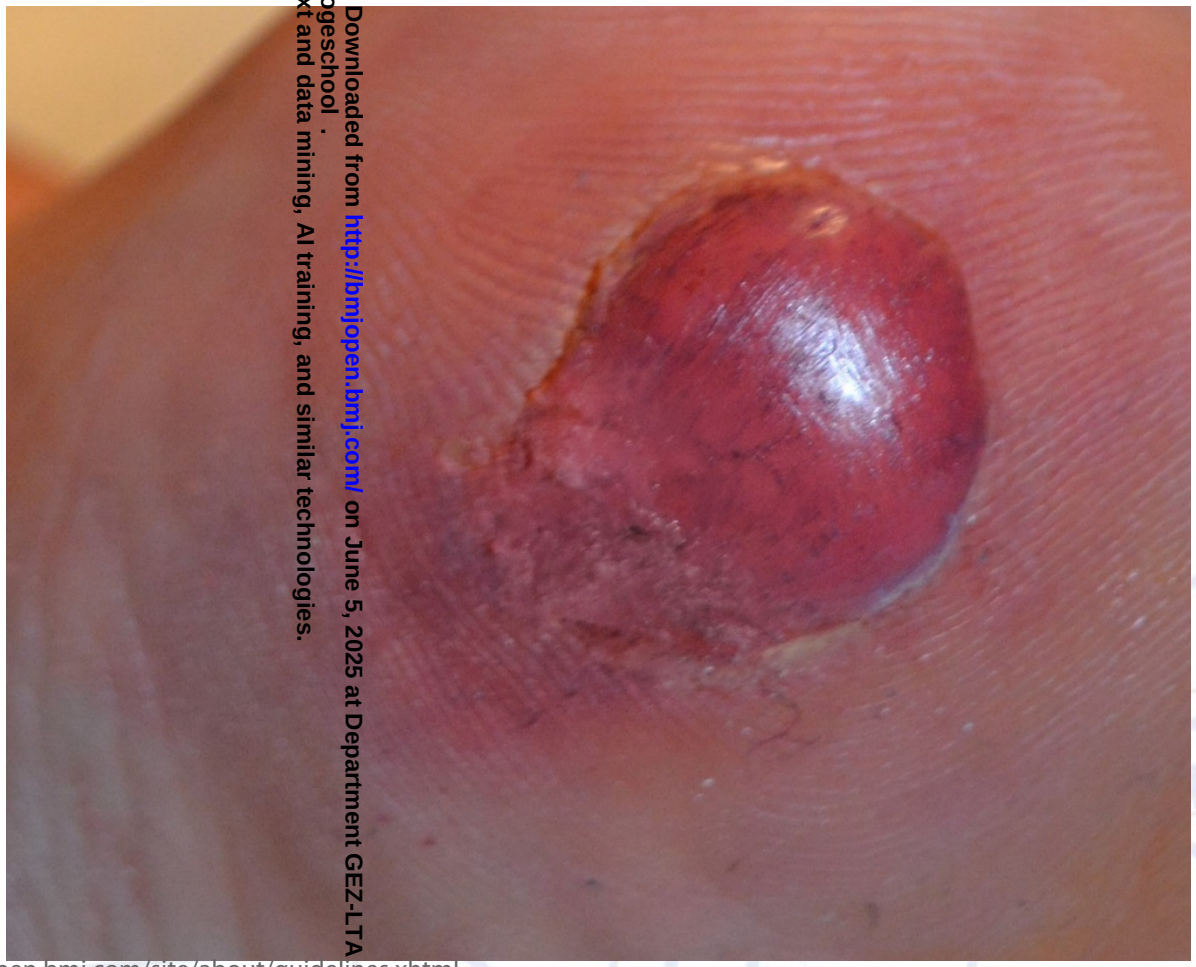
Correct answer: Stage III pressure injury

Explanation: there is a full thickness tissue loss without exposition of the bone. The slough does not interfere with the examination of the tissue loss.

Question 10

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

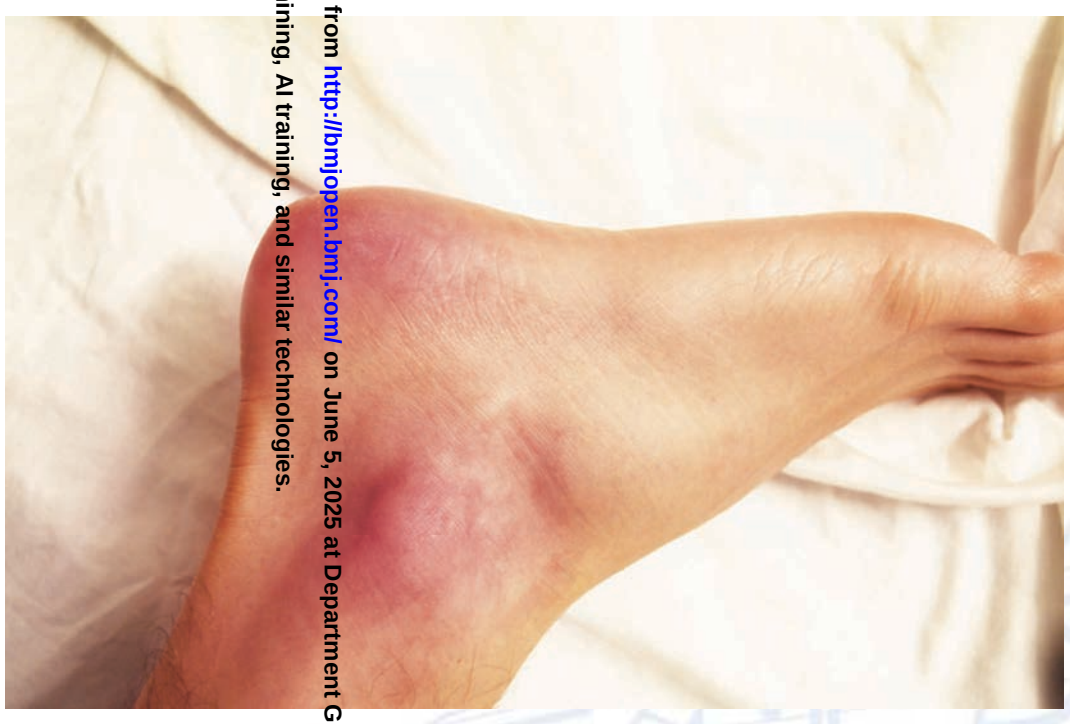
Correct answer: Stage II pressure injury

Explanation: there is a partial thickness skin loss without slough or necrosis. This intact blister indicates a Stage II pressure injury.

Question 11

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

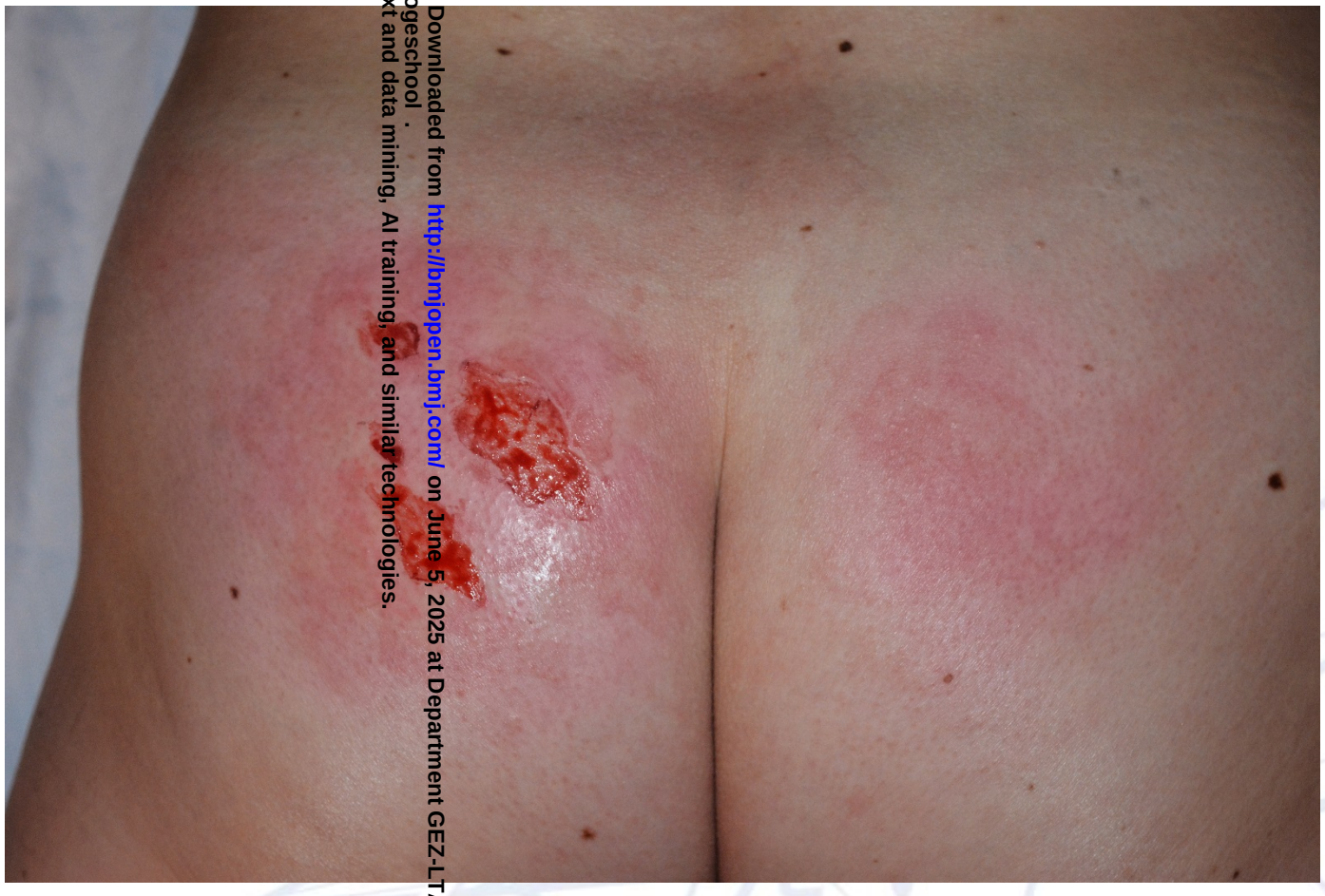
Correct answer: Stage I pressure injury

Explanation: the erythema is nonblanchable. The skin of the ankle is intact. The ankle is a typical area for Stage I pressure injury development because of its bony prominence.

Question 12

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

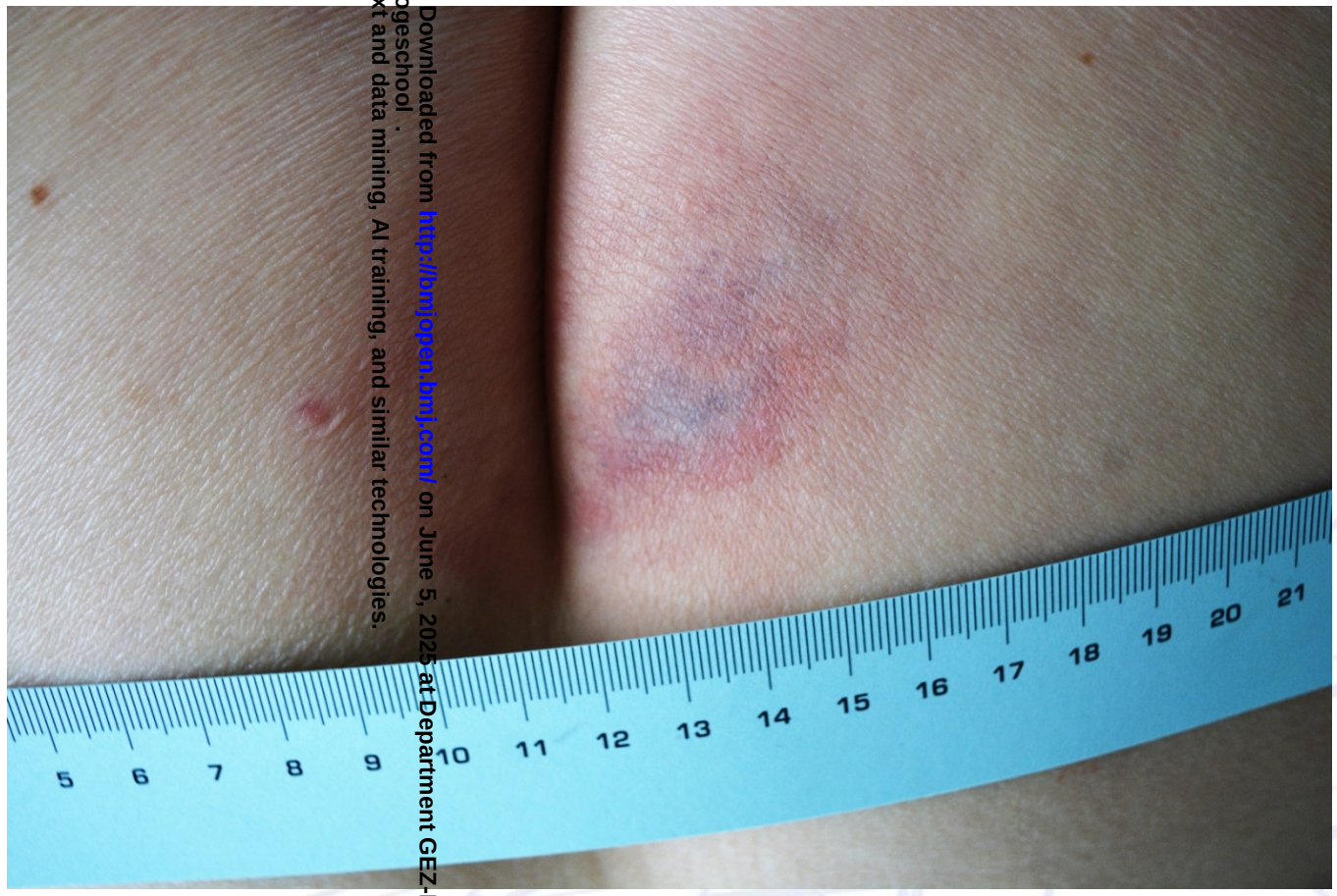
Correct answer: moisture-associated skin damage (MASD), possibly incontinence-related.

Explanation: there is a noticeable erythema of the skin. Skin damage is superficial and the edges are irregular. There is also some degree of maceration present, probably due to friction. The effects of friction on a wet skin are more damaging that on the dry skin.

Question 13

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

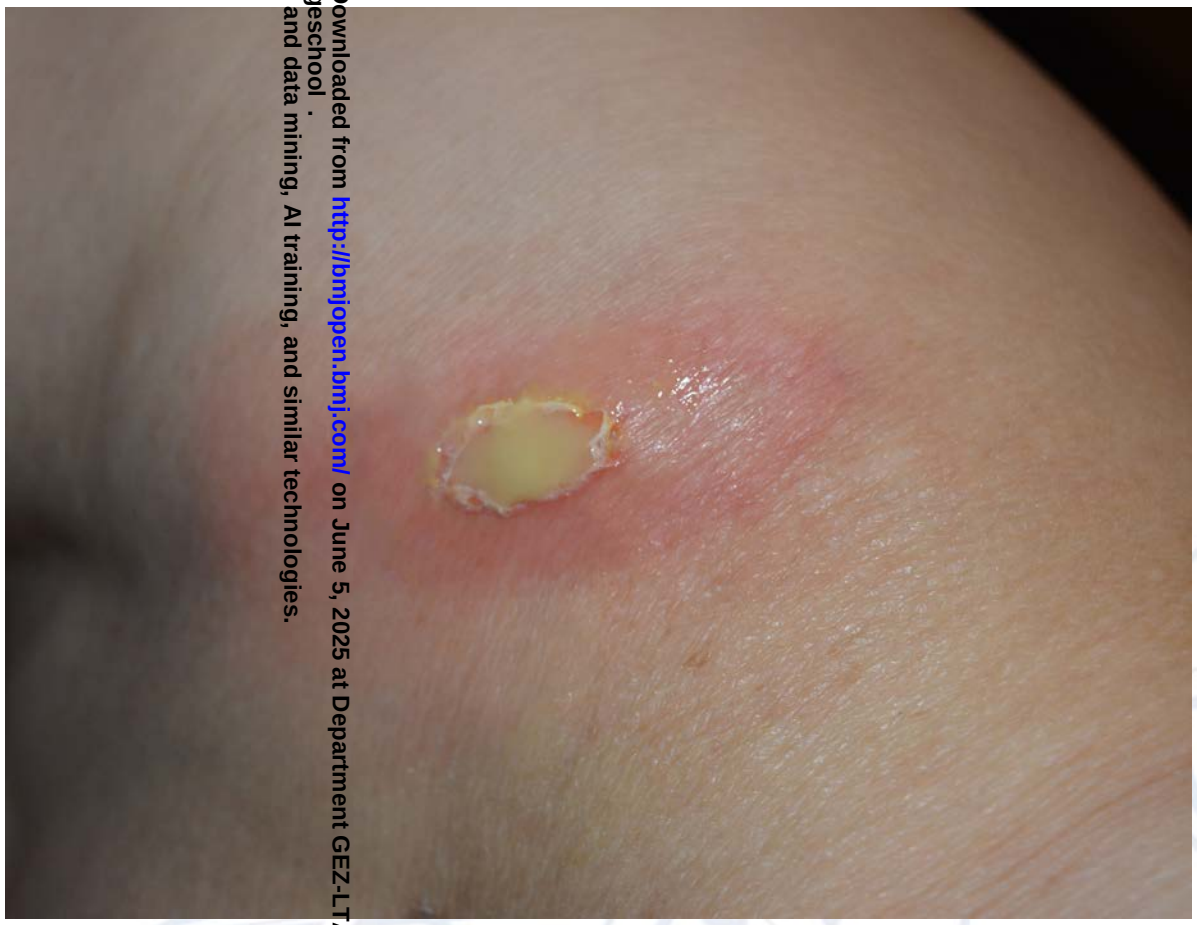
Correct answer: suspected deep tissue injury

Explanation: the area of the wound is purple/maroon and the skin is intact. We can assume that the underlying soft tissue has been damaged.

Question 14

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

Correct answer: Stage III pressure injury

Explanation: there is a full thickness tissue loss on the iliac crest with no exposition of the bone. Slough is excessively present.

Question 15

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage

Answer

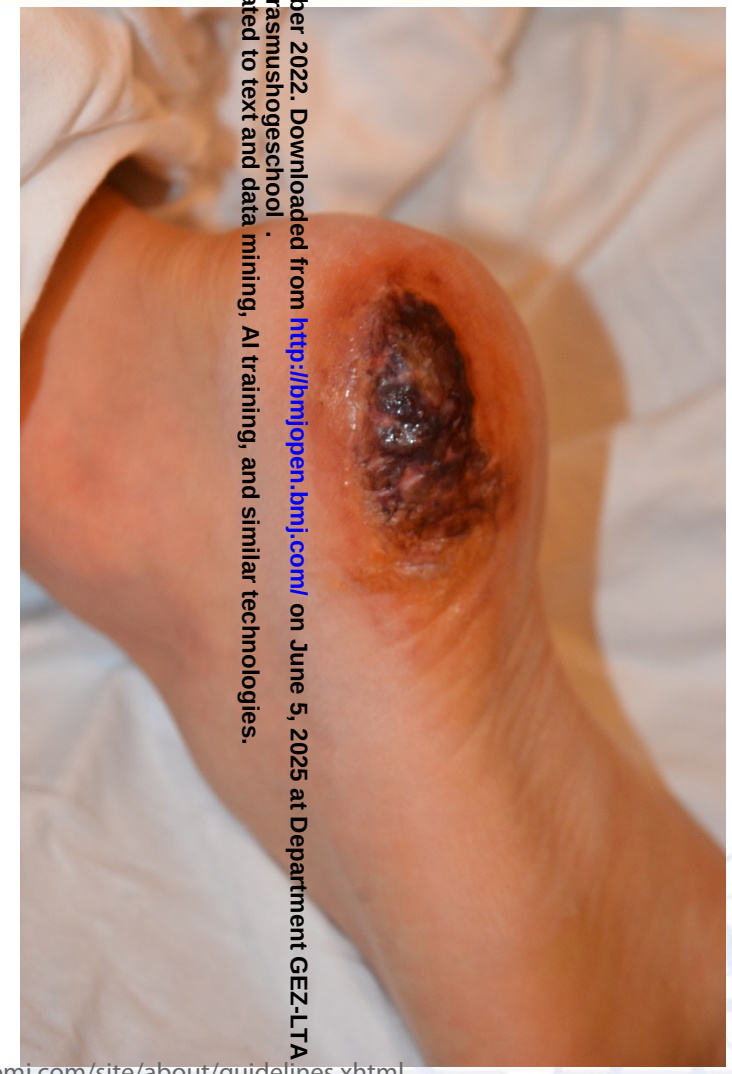
Correct answer: Stage IV pressure injury

Explanation: the tissue damage indicates a stage IV pressure injury. The tissue loss is extensive and the cartilage of the ear is directly exposed.

Question 16

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

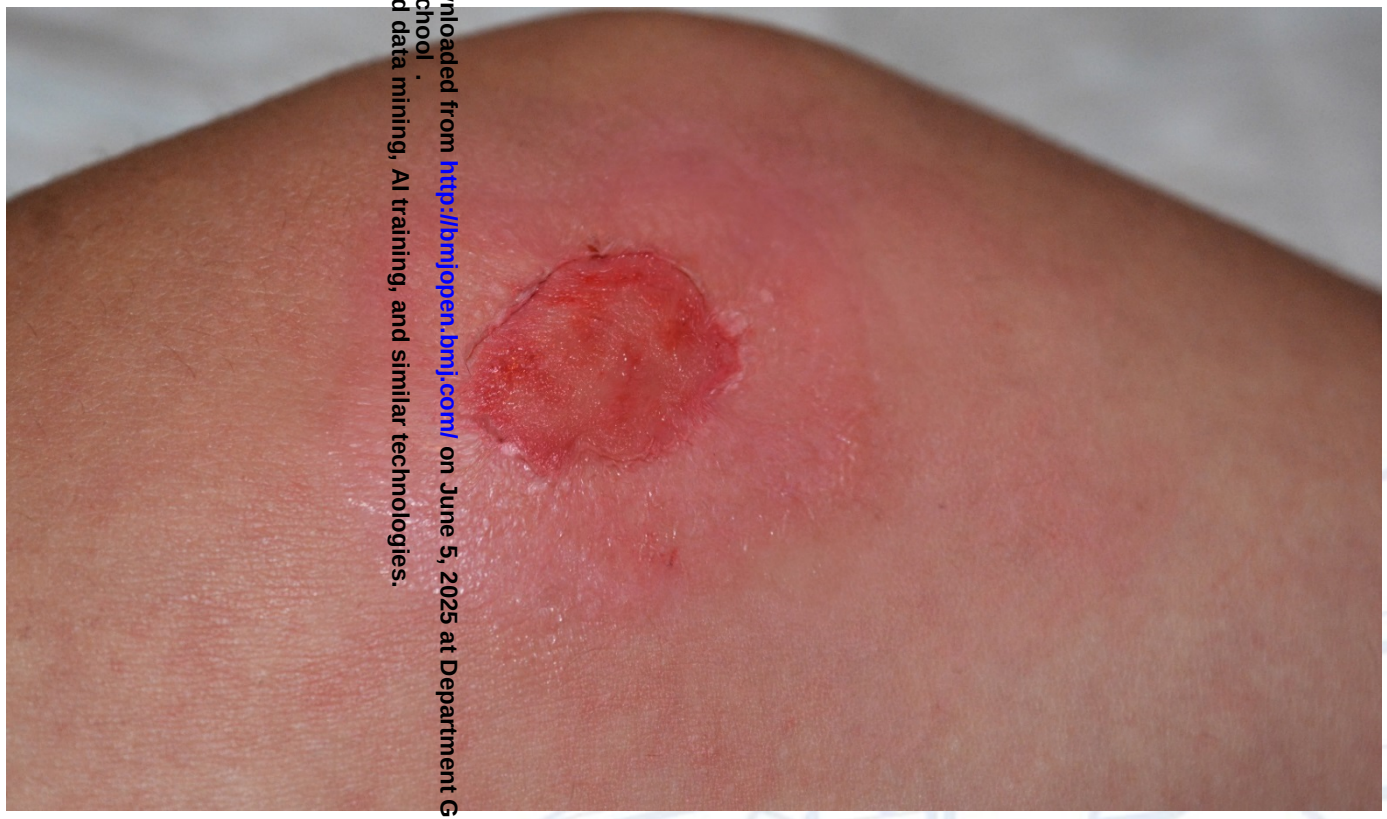
Correct answer: unstageable pressure injury

Explanation: a dark eschar covers the localized wound area. The skin around the eschar is dark (maroon/brown). Until the eschar has been removed, the depth of the injury and the extent of the damage is not to be determined.

Question 17

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

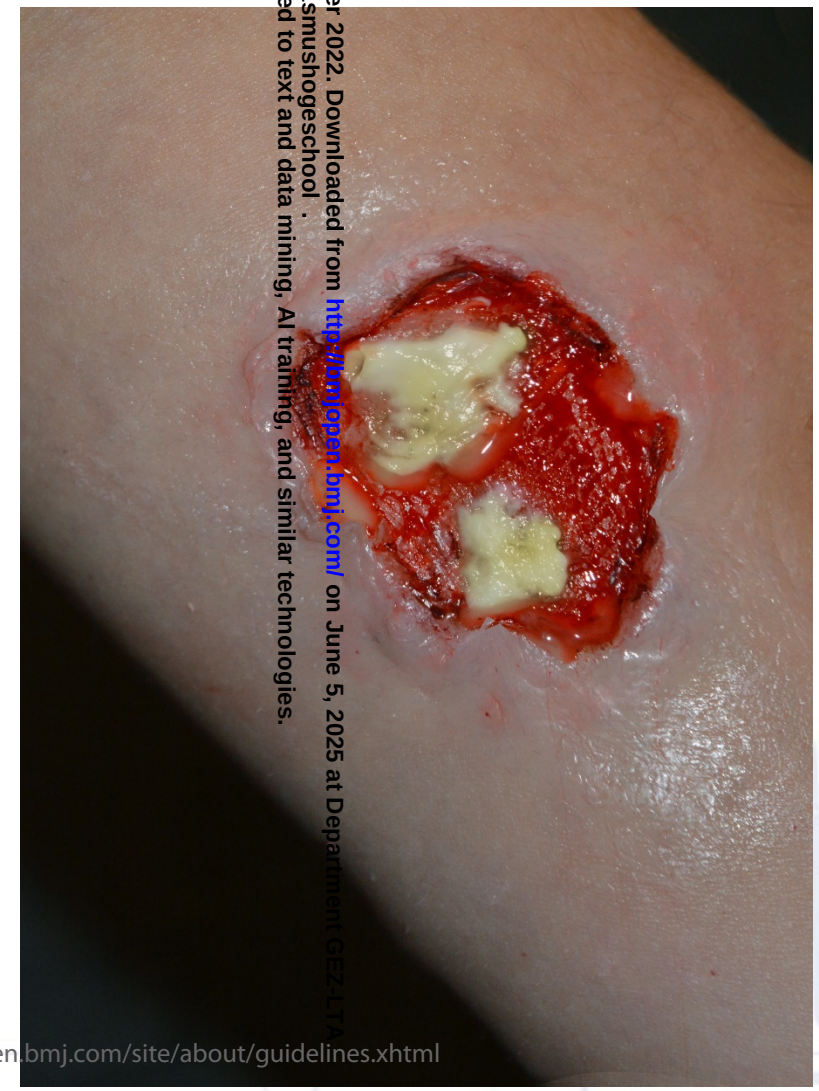
Correct answer: Stage II pressure injury

Explanation: there is a clear partial thickness loss of dermis. The wound is presented as a dry, shallow open ulcer with a red/pink wound bed. There is no slough visible.

Question 18

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

Correct answer: Stage III pressure injury

Explanation: extensive full tissue loss with slough and eschar on some parts of the wound. The tissue might be undermined. The supporting tissues are probably invaded

Question 19

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage

Answer

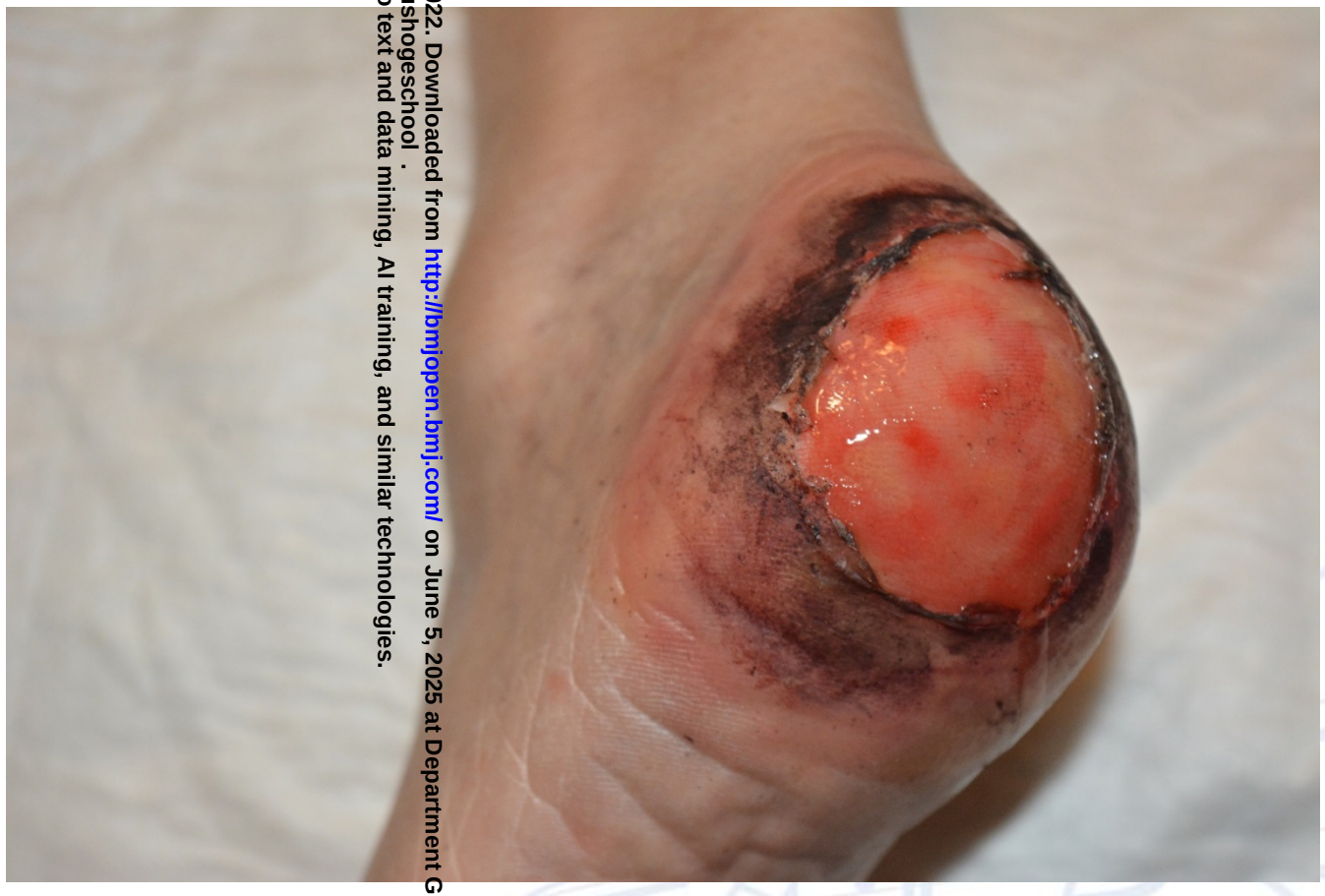
Correct answer: Stage IV pressure injury

Explanation: there is a full thickness tissue loss with exposed bone.

Question 20

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

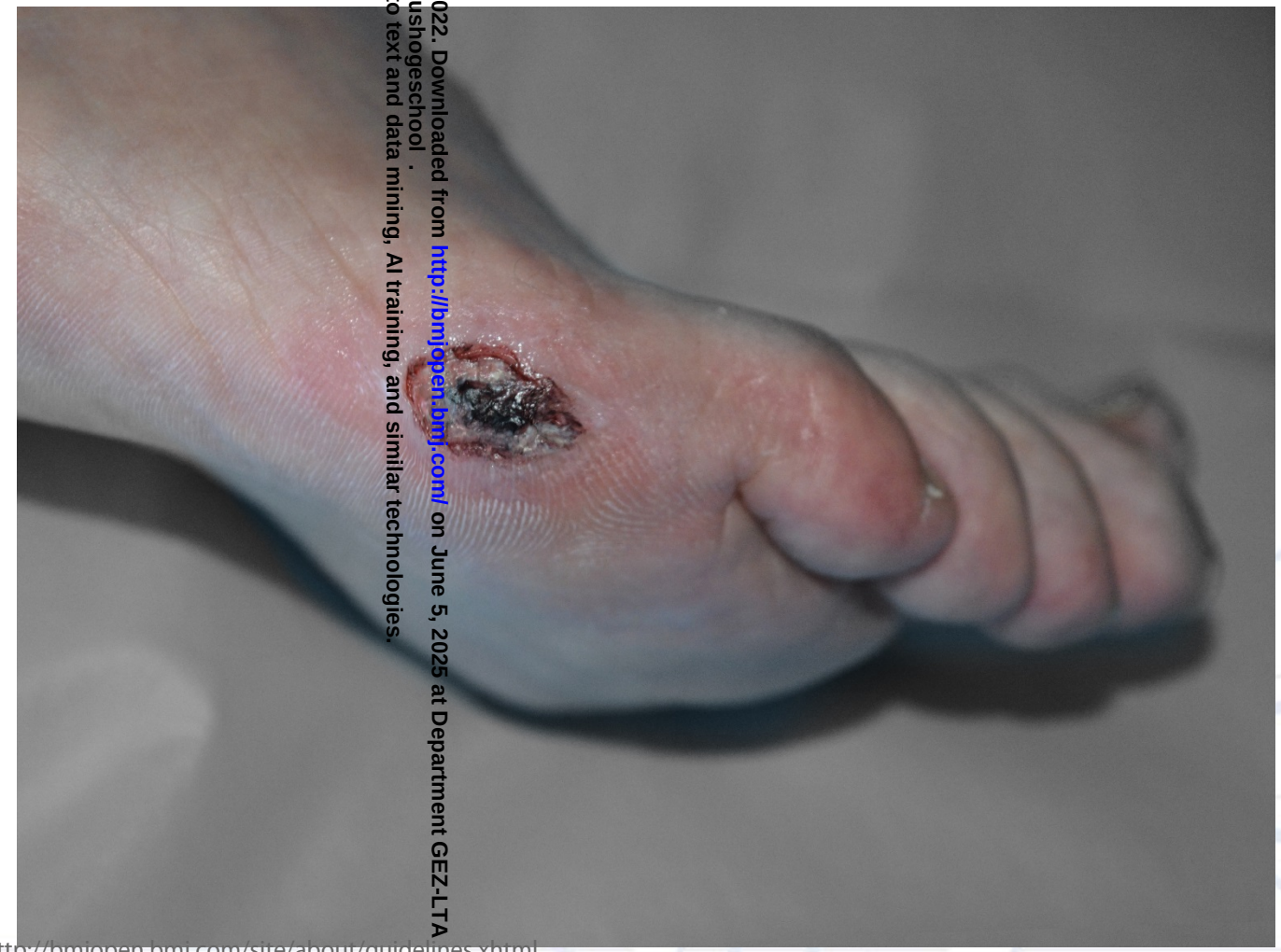
Correct answer: Stage II pressure injury

Explanation: there is an explicit partial thickness skin loss on the heel. The injury is presented as an open blister with a red/pink wound bed. There is no slough detectable.

Question 21

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

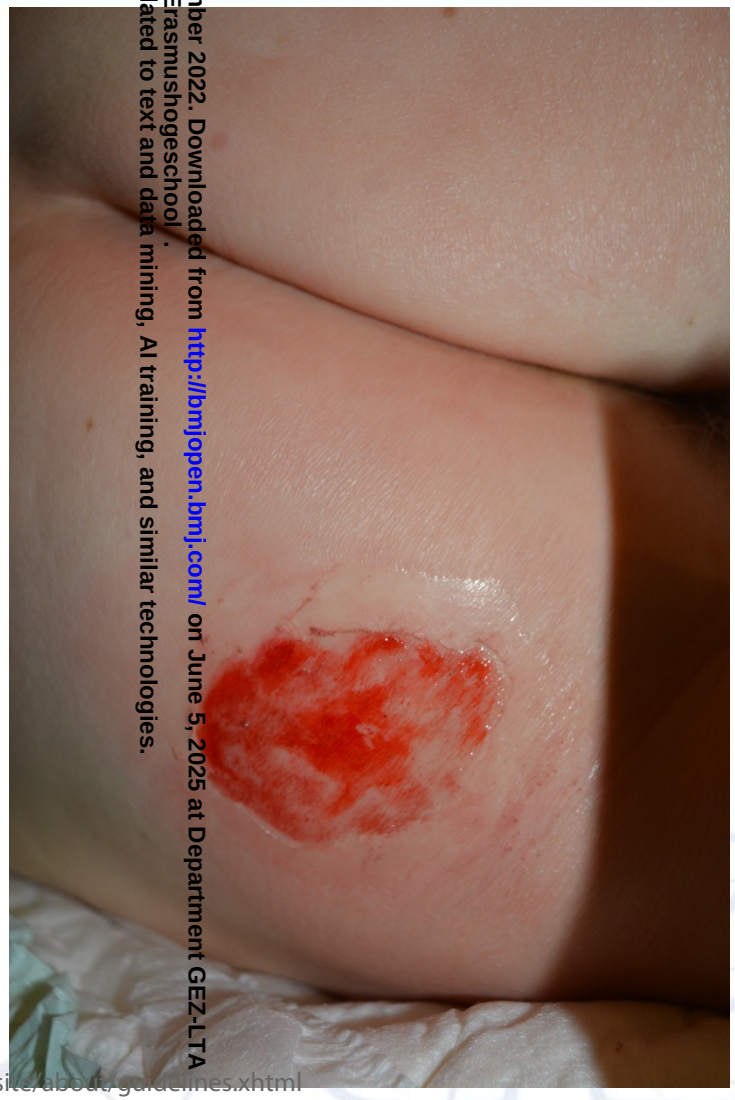
Correct answer: Stage IV pressure injury

Explanation: Stage IV pressure injury is characterised by full thickness tissue loss. The tissue loss is extensive. Removing the necrotic eschar would expose the underlying bone. There is a risk of osteomyelitis.

Question 22

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

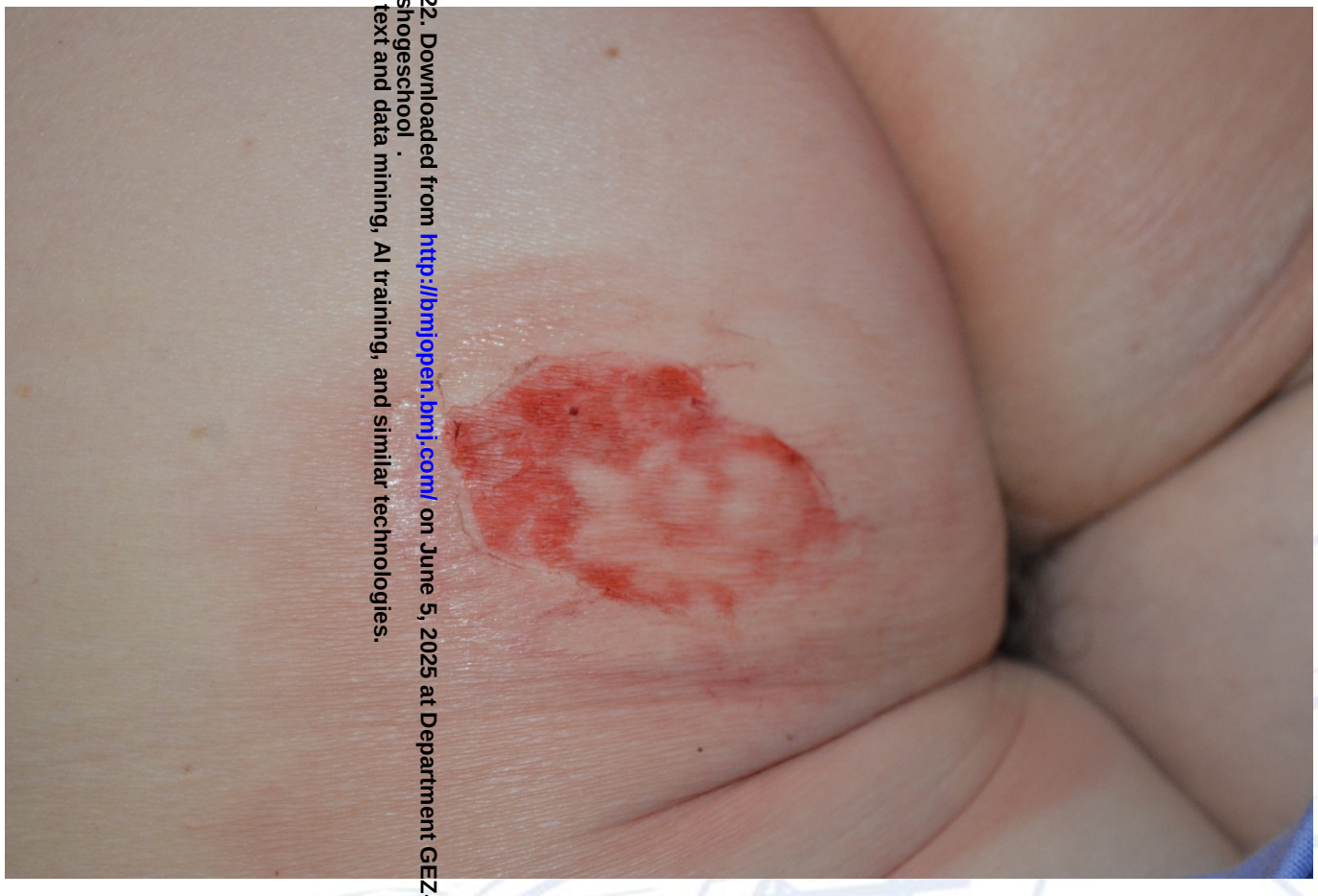
Correct answer: Stage II pressure injury

Explanation: the wound is presented as a partial thickness skin loss of the gluteal region. The injury is superficial. The blister is open and the wound bed red. There is no slough detectable.

Question 23

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

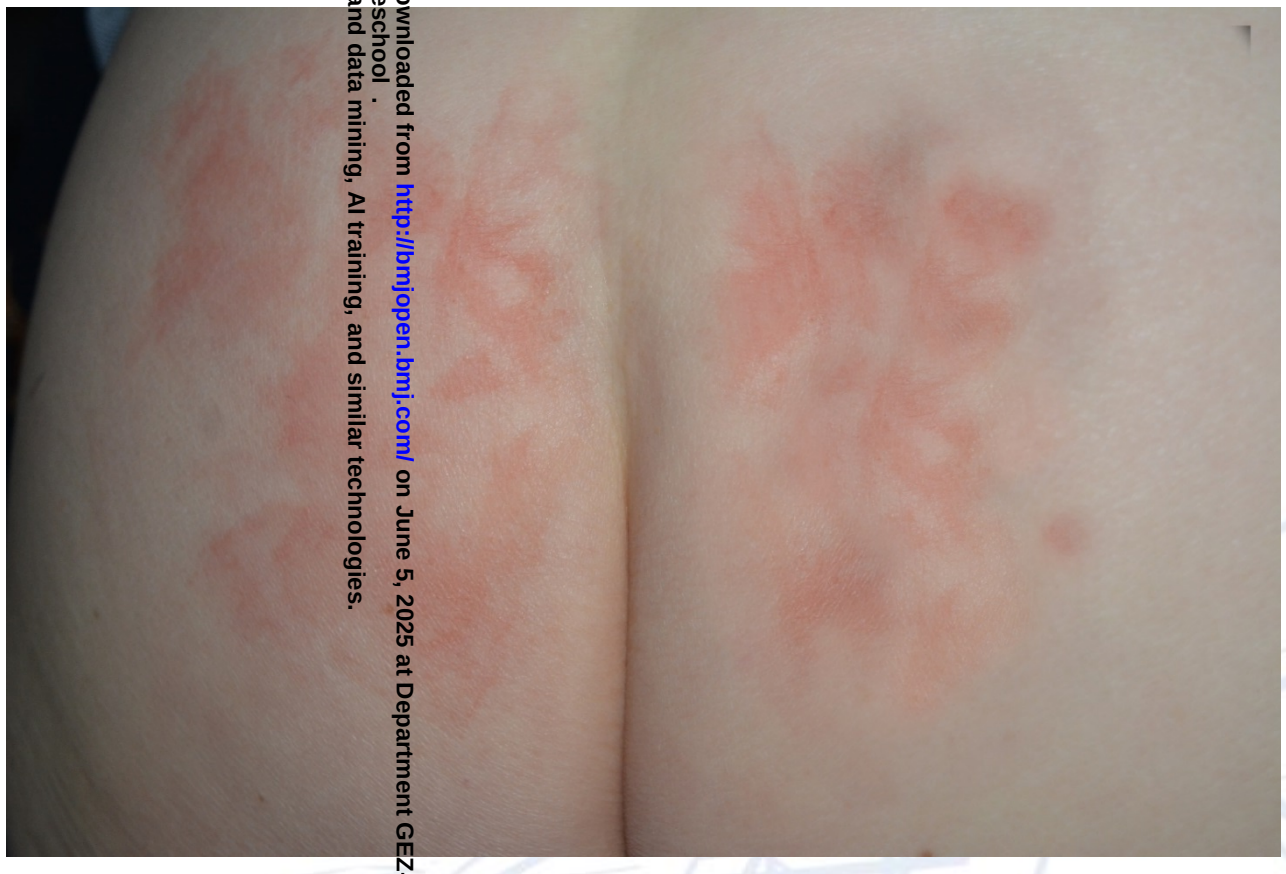
Correct answer: Stage II pressure injury

Explanation: there is a clear partial thickness loss of dermis. The wound is presented as a shallow open ulcer with a red/pink wound bed. There is no slough visible.

Question 24

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

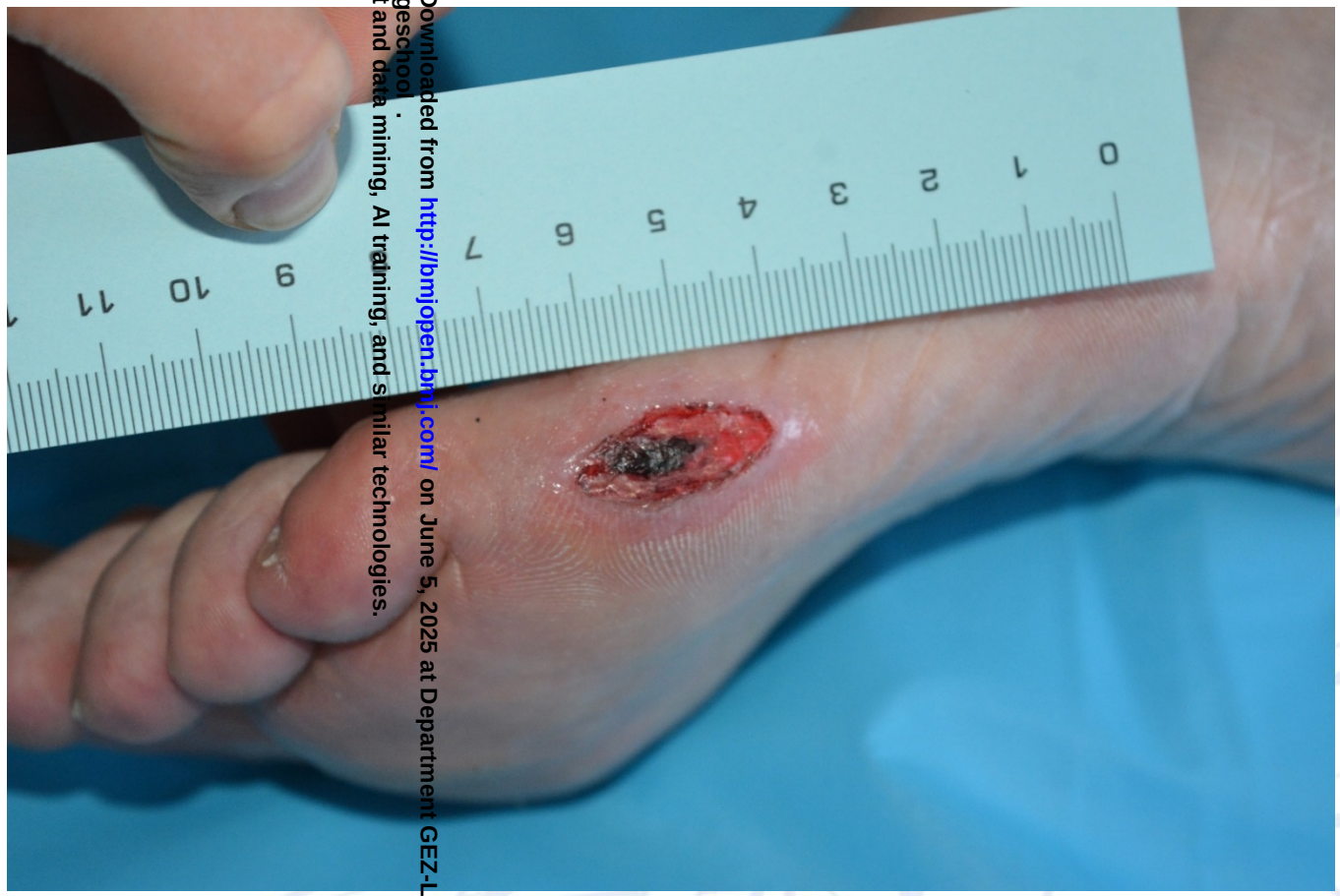
Correct answer: moisture-associated skin damage (MASD), possibly incontinence-related.

Explanation: there is a noticeable erythema of the skin. The skin redness is diffuse. The inflammation of the skin is caused by exposure to moisture.

Question 25

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

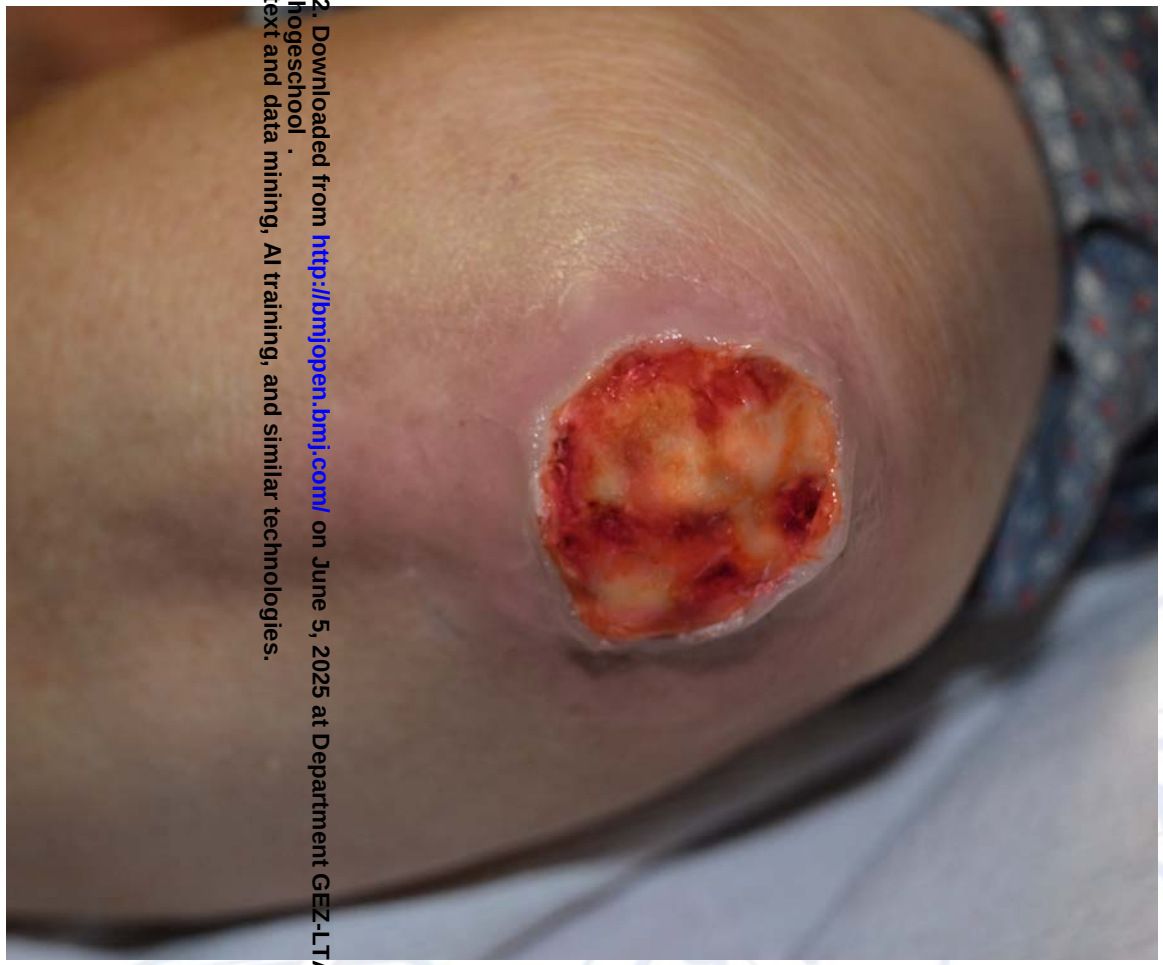
Correct answer: Stage IV pressure injury

Explanation: Stage IV pressure injury is characterised by full thickness tissue loss. The tissue loss is extensive. Removing the necrotic eschar would expose the underlying bone. There is a risk of osteomyelitis.

Question 26

What is this?

- Stage I pressure injury
- Stage II pressure injury
- Stage III pressure injury
- Stage IV pressure injury
- Unstageable pressure injury
- Suspected Deep Tissue Injury
- Moisture-associated skin damage



Answer

Correct answer: Stage IV pressure injury

Explanation: The tissue loss is extensive, and the underlying bone is exposed. There is a risk of osteomyelitis.

Congratulations, you have finished the e-learning module.

Thank you for your time.

We hope that we have fulfilled your expectations and that this module will help you to correctly classify pressure injuries.

Authorship

This module was developed by Marta BORKOWSKA[1], Vinciane PLEITINCKX[2], Liesbet DEMARRE[3], Mireia LLAURADO-SERRA[4], Stijn BLOT[5] and Sonia LABEAU[6] .

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Disclaimer and acknowledgements

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The wounds presented in this e-learning module are simulations, based on representations of true skin lesions. They are shown on healthy adults, who voluntarily participate in this project after written informed consent.

We gratefully acknowledge Ms. Ellen Devos, (Bodypaint by Ellen), for the skillful simulations, and the volunteers represented on the photographs for their appreciated collaboration. We are also grateful to The Life Dignity Fund of the European Society for Intensive Care Medicine and the Flemish Society for Critical Care Nurses for funding this project.

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SUPPLEMENTARY APPENDIX C: Tables

Supplementary Table 1- Preventative measures

Preventive measures	***Not used***	***Available***	*Used in all patients*	*Data not available*
Standard foam mattresses	47.9% (n. 45)	43.6% (n. 41)	4.3% (n. 4)	4.3% (n. 4)
Alternative foam mattresses or overlays	77.7% (n. 73)	17% (n. 16)	1.1% (n. 1)	4.3% (n. 4)
Gel filled mattresses	92.6% (n.87)	3.2 % (n. 3)		4.3% (n. 4)
Fibre filled mattresses	94.7% (n. 89)	1.1% (n. 1)		4.3% (n. 4)
Air filled mattresses	47.9% (n. 45)	27.7% (n. 26)	20.2% (n. 19)	4.3% (n. 4)
Water filled mattresses	95.7% (n.90)			4.3% (n. 4)
Bead filled mattresses	93.6% (n. 88)	2.1% (n. 2.2)		4.3% (n. 4)
Foam cushions	45.7% (n.43)	47.9% (n.45)	2.1% (n.2)	4.3% (n. 4)
Non-foam cushions	77.7% (n.73)	17% (n.16)	1.1% (n.1)	4.3% (n. 4)
Ring cushions	91.5% (n.86)	1.1% (n.1)	3.2% (n.3)	4.3% (n. 4)
Sheepskins	89.4% (n.84)	4.3% (n.4)	2.1% (n.2)	4.3% (n. 4)
Alternating pressure mattresses	16 % (n.15)	43.6% (n.41)	36.2% (n.34)	4.3% (n. 4)
Air fluidised beds	88.3% (n. 83)	6.4% (n. 6)	1.1% (n. 1)	4.3% (n. 4)
Low air loss beds	84% (n.79)	10.8% (n.10)	1.1% (n.1)	4.3% (n. 4)
Continuous bedside pressure mapping	91.5% (n.86)	4.3 % (n.4)		4.3% (n. 4)
Turning beds	47.9% (n.45)	42.8% (n.40)	5.3% (n.5)	4.3% (n. 4)
Patient repositioning	3.2% (3)	23.4% (22)	69.1% (65)	4.3% (n. 4)
Ice friction	95.7 % (n.90)			4.3% (n. 4)
Blow drying	94.7% (n.89)	1.1% (n.1)		4.3% (n. 4)
Bolstering of the heels	47.9% (n. 45)	43.6% (n. 41)	4.3% (n. 4)	4.3% (n. 4)
Floating heels	38.3% (n.36)	52.1% (n.49)	5.3% (n.5)	4.3% (n. 4)
Hydrating body moisturizers	24.5% (n.23)	60.6% (n. 57.4)	1.1% (n. 1)	4.3% (n. 4)
Soft silicone multi layered foam dressing	37.2% (n.35)	57.4% (n.54)	1.1% (n.1)	4.3% (n. 4)
Other preventive measures	63.8% (n.60)	31.9% (n.30)		4.3% (n. 4)

Supplementary Table 2 - Primary diagnosis

Primary diagnosis	n	frequency (%)
Gastro-intestinal perforation/obstruction/rupture	97	7.39
Community-acquired bacterial pneumonia	84	6.4
Cardiac arrest	66	5.03
Other respiratory diseases	45	3.43
Other digestive tract diseases	43	3.28
Other diseases	38	2.9
Other neurological diseases	35	2.67
Other trauma- and skin-related diseases	35	2.67
Pancreatitis	32	2.44
Healthcare-associated bacterial pneumonia	31	2.36
Valvular heart surgery	31	2.36
CABG	31	2.36
Drug overdose, intoxication	31	2.36
Polytrauma, without brain trauma	31	2.36
Seizures	30	2.29
Subarachnoid haemorrhage	29	2.21
Intercerebral haemorrhage	27	2.06
Other (cardio)vascular diseases	27	2.06
Acute kidney injury	26	1.98
Hepatic failure	23	1.75
Urosepsis	22	1.68
Neoplasm of the upper digestive tract	21	1.6
Stroke by ischemic or haemorrhagic mechanism	19	1.45
Exacerbation of chronic pulmonary disease	19	1.45
Neoplasm of the lower digestive tract	19	1.45
Gastro-intestinal bleeding due to varices, ulcer or diverticulitis	18	1.37
Neurologic infection	17	1.3
Acute myocardial infarction	17	1.3

Head trauma (isolated)	17	1.3
Polytrauma, with brain trauma	17	1.3
Spinal cord injury	17	1.3
Aortic aneurysm	16	1.22
Diabetic ketoacidosis	16	1.22
Burn injury	14	1.07
Inhalation pneumonia	12	0.91
Other metabolic diseases	12	0.91
Mechanical airway obstruction	11	0.84
Malignant gynaecological diseases	11	0.84
Spinal cord surgery	10	0.76
Pulmonary embolism	10	0.76
Cardiopathy	10	0.76
Polyneuritus and polyradiculoneuritis	9	0.69
Respiratory neoplasm	9	0.69
Malignant haematological disease	9	0.69
Inflammatory disease of the digestive tract	9	0.69
Skin lesions requiring intensive care, non-traumatic	9	0.69
Respiratory arrest	8	0.61
Rhythm disturbance	8	0.61
Dissecting/ruptured aorta	8	0.61
Other renal/genito-urinary tract diseases	8	0.61
Pulmonary edema	7	0.53
Viral pneumonia	7	0.53
Elective abdominal aneurysma repair	7	0.53
Chronic renal failure	7	0.53
Neuromuscular disease	6	0.46
Pleural effusion	6	0.46
Cardiogenic shock	6	0.46
Neutropenic sepsis	6	0.46
Peripheral vascular surgery	5	0.38
Endocrinopathy	5	0.38
Asthma attack	4	0.3
Congestive heart failure	4	0.3

Peripheral artery bypass graft	4	0.3
Renal neoplasia	4	0.3
Neurologic neoplasm	3	0.23
Unstable angina	3	0.23
Hypertension	3	0.23
Endocarditis	3	0.23
Non-malignant gynaecological diseases	3	0.23
Thrombocytopenia, coagulopathy	3	0.23
Non-malignant haematological disease	3	0.23
Other haematological diseases	3	0.23
Metabolic coma	3	0.23
Other pregnancy-related diseases	2	0.15
Pressure injury requiring surgical debridement or extensive wound care	2	0.15
Severe surgical wound infection	2	0.15
Fungal pulmonary infection	1	0.08
Near-drowning	1	0.08
Perivascular disease	1	0.08
Carotid endarterectomy	1	0.08
Transfusion reaction	1	0.08
Eclampsia, preeclampsia	1	0.08
Delivery haemorrhage	1	0.08

Supplementary Table 3: Primary trigger for extra preventative measures (90 units responded)

Trigger	Frequency	% of sites reporting
High risk profile as indicated by a risk assessment scale	69	76.6
Mechanical ventilation	4	4.4
Anticipated ICU stay>3days	1	1.1
Coma/sedation	2	2.2
Malnutrition	1	1.1
Obesity	1	1.1
Presence of pressure injury	7	7.7
Other	5	5.5
Total	90	

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	5-6
Methods			
Study design	4	Present key elements of study design early in the paper	7-9
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7-10
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	7-10
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-10
Bias	9	Describe any efforts to address potential sources of bias	*N/A*
Study size	10	Explain how the study size was arrived at	N/A
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	N/A
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	8-9
		(*c*) Explain how missing data were addressed	8-9
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9 et seq.
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1, 26 et seq Supplementary Table 2
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	9-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-10 Mixed model is in Table 3, page 31
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	See above
Discussion			
Key results	18	Summarise key results with reference to study objectives	10-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	12-14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	21

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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THE PREVALENCE OF SKIN PRESSURE INJURY IN CRITICAL CARE PATIENTS IN THE UNITED KINGDOM; RESULTS OF A SINGLE DAY POINT PREVALENCE EVALUATION IN ADULT CRITICALLY ILL PATIENTS

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THE PREVALENCE OF SKIN PRESSURE INJURY IN CRITICAL CARE PATIENTS IN THE UNITED KINGDOM; RESULTS OF A SINGLE DAY POINT PREVALENCE EVALUATION IN ADULT CRITICALLY ILL PATIENTS

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ABSTRACT:

Objectives: Hospital acquired pressure injuries (PIs) are a source of morbidity and mortality, many are potentially preventable.

Design: This study prospectively evaluated the prevalence and associated factors of PIs in adult critical care patients admitted to Intensive Care Units (ICU) in the United Kingdom (UK).

Setting: This service evaluation was part of a larger, international single day point-prevalence study of PIs in adult ICU patients. Training was provided to health care givers using an electronic platform to ensure standardised recognition and staging of PIs across all sites. Participants: Characteristics of the ICUs were recorded before the survey; deidentified patients' data were collected using a case report form and uploaded onto a secure online platform. Primary and secondary outcomes:

Factors associated with ICU-acquired PIs in the UK were analysed descriptively and using mixed multiple logistic regression analysis

Results**:** Data from 1312 adult patients admitted to 94 UK ICUs were collected. The proportion of individuals with at least one PI was 16% (211/1312 patients) of whom 8.8% (n=115/1312) acquired one or more PIs in the ICU and 7.3% (96/1312) prior to the ICU admission. The total number of PIs was 311, of which 148 (47.6%) were acquired in the ICU. The location of the majority of these PIs was the sacral area followed by the heels,. Braden score and prior length of ICU stay were associated with PI development.

Conclusions**:** The-prevalence and the stage of severity of PIs were generally low in adult critically ill patients admitted to participating UK ICUs during the study period. However, PIs are a problem in an important minority of patients. Lower Braden score and longer lengths of ICU-stay were associated with the development of injuries; most ICUs assess risk using tools which do not account for this.

aTrial registration: ClinicalTrials.gov (NCT03270345).

KEY WORDS:

Pressure sores, pressure injury, critical care, intensive care, risk factors, oucome

Strengths and limitations of this study

Strengths:

- This is the first study ever completed to evaluate the impact of PIs in the adult population.
- It is a robustly planned and executed study.

Limitations:

- Limitations are mainly due to the low incidence and severity of PIs.
- The inability of linking preventative measures used in patients to the prevalence of PIs.
- The study was conducted in the pre-COVID-19 era and majority of patients were nursed in the supine position.

Original protocol supplementary file appendix A and B

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INTRODUCTION:

In 2014, the UK National Institute for Health and Care Excellence (NICE) published a document for the prevention and management of pressure injuries (PIs) in primary and secondary care in the United Kingdom (UK).[1,2] This document was revised in 2019 and states that "pressure ulcers are serious and distressing adverse events that can represent a failure of care".[3] PIs are generated when an area of skin and / or the underlying tissues are damaged due to being placed under sufficient pressure for a period long enough to impair blood supply or when shearing forces generate friction on the skin during manual handling.[1,2] An international classification categorises the injuries into Stages I to IV, Unstageable, and Suspected Deep Tissue Injury according to the extent of the tissue damage. [3,4]

Pressure ulcers caused by both moisture and shear stress, are directly associated with the quality of care provided as well as patient outcomes.[1-4] NICE guidelines[2] state that PIs consume significant resources, and that these should be preventable in the National Health Service (NHS), which has therefore employed tissue viability nurses (TVN) in the majority of hospitals. TVNs provide expert advice in the prevention and the treatment of wounds including PIs.

Unfortunately, critically ill patients in intensive care units (ICUs) are extremely vulnerable due to the severity of their illness, immobility, sedation, poor tissue perfusion, hypoxia and frequently haemodynamic instability. The current prevalence of PIs in the UK ranges widely with estimates from 4.7% to 32.1% in ward areas, while in the ICUs it is not known. [2,5,6] The aim of this service evaluation was to provide up to date information on PIs within UK adult ICUs. The specific objectives were to offer a picture of (a) the prevalence of pressure injury in adult critically ill patients, specifically in relation to presence of PIs on admission and PIs acquired within ICU; (b) the characteristics of the

PIs in terms of severity and anatomical distribution; and (c) to contribute data to the international DecubICUs study, of which this project formed a part.[1]

METHODS:

Study design and participants

This service evaluation was conducted using a single day (midnight to midnight) point prevalence survey in all adult ICU patients. The study protocol was reviewed by the Joint Research Compliance Office at Imperial College Healthcare NHS Trust London and by the Health Research Authority. These bodies deemed the survey a Service Evaluation. All participating Trusts/Hospitals confirmed registration as a Service Evaluation according to their local protocols and non-objection from the relevant local Caldicott Guardian. A full description of the methods can also be found in the DecubICUs global study report.[1] The study was registered at ClinicalTrials.gov (NCT03270345).

There was no" Patient and public involvement" in this study.

Data collection

The study website provided the protocol and an electronic Case Report Form [CRF; Supplementary Electronic Appendix A and https://www.esicm.org/trials-group-2/decubicus/]. Data were collected from all participating centres before the study day. Anonymous data were collected in the CRF on all adult patients present in participating ICUs on the 15th May 2018 [Supplement A]. Admission data included patients' demographic, type of ICU admission (i.e. medical, elective or emergency surgical, or trauma/burns), principal diagnosis leading to ICU admission, mechanical ventilation on admission, and whether the patient already had pressure injuries at the time of ICU admission. Data included PI assessment which included site and stage (generally referred to as "grade" in the UK),[3-6] and whether injuries were present at ICU admission (specifically these were areas exhibiting pressure injuries, rather than discrete injuries; referred to as PIs for simplicity). The injury risk was evaluated using the Braden scale.[7]

This scale combines six subscales (mobility, activity, sensory perception, skin moisture, nutritional state, and friction/shear) and ranges 6 to 23, with lower scores reflecting higher risk. Follow-up data gathered were survival status and length of ICU and hospital stay until hospital discharge, maximally at 12 weeks following the study day (7 August 2018). An online training module was developed for all clinical data collectors and published on the study website [protocol supplement A or available on line URL: https://www.esicm.org/trials-group-2/decubicus/; training module available on line on the European Society of Intensive care web https://www.esicm.org/wp-content/uploads/2018/04/Module-DecubICUs-LR.pdf] prior to initiation in order to assist with consistency of data collection. Hospital and follow up data were collected by clinical and research nurses and the site study coordinator. Individual patient data were collected by the bedside nurse by direct skin observation according to the international staging definitions.[3-6]

Statistics

Data were summarised as mean (standard deviation; SD) or median (interquartile range; IQR) as appropriate, categorical data were summarised as proportions (%). Overall PI prevalence was calculated as the proportion of the sample who had at least one pressure injury on the study day. ICU-acquired prevalence was calculated as the proportion of the sample who had at least one PI determined to be acquired in the ICU present on the study day. Prevalence is reported as percentage with 95% confidence interval (CI).

Associations with ICU-acquired PI were explored using a mixed multiple logistic regression analysis with the logit link function and including a random intercept for site.

This method was chosen to balance potential effects resulting from variability in care processes across the participating sites. All demographic variables as well as those related to acute illness and chronic conditions were included. The variable 'length of ICU stay before study day' was included based on both clinical judgement and the literature on pressure injury risk factors.[8,9,10] As such, all variables were included following an exploratory approach, irrespective of their relationship with pressure injury in univariate analysis [11]. Results are reported as odds ratios (OR) with 95% confidence intervals (CI). Statistical analysis was performed using IBM SPSS for Windows 26.0 (IBM Corp., NY, US) and R statistical software 3.6.1.[12]

RESULTS:

Ninety-four adult ICUs distributed across the whole of the UK participated to this study. In 2018, the Scottish Intensive Care Society audit group (SICS) collected data from 72 adult ICUs,[13] while ICNARC report was based on data from 263 NHS adult ICUs in the rest of the United Kingdom.[14] The definition of an ICU can be broad, however for the purpose of this study the authors assumed that 28% (94/335) of ICUs participated to this study in the UK; 51% declared themselves to be university affiliated. The majority of ICUs were mixed medical and surgical (75; 80%), the remainder were surgical of one type or another with one specialist burns unit. Four participating units did not submit descriptive data. The ICUs had a median of 14 beds (IQR 10-20) and 68% declared themselves to be "closed". There were six very large units with more than 40 beds.

Local investigators collected data from 1312 critically ill patients, the majority of whom were cared for in University-affiliated centres (67.3% of patients). The median nurse to patient ratio for the night shift on the survey day was 1:1 (IQR 0.8-1), reflecting the UK national standard of 1:1 nursing for level 3 patients (these are individuals requiring

ventilatory and multiple organ support) and 1:2 for level 2 “high dependency” patients. Only one hospital reported that neither physiotherapy nor dietic support was available on the study day. Four units did not report on this specification. A list of preventive measures used is listed in the Supplementary Appendix. B, [Supplementary Table 1, 2] Four units reported that they did not have a section in the patient record for describing pressure injury, and four units entered no data; 59 (63%) units employed the Waterlow Scale, 11 (12%) used the Braden Scale and 19 (20%) reported using a different PI risk assessment scale and one unit reported not using a scale (four units entered no data).

The characteristics of the patients included are in Table 1; the majority were men (59.7%) and the median age was 62 years (IQR 50-72). The median number of days in the ICU before the study day was 4 (IQR 1-10) and 51% of these patients were requiring invasive mechanical ventilation on ICU admission. The source of admission to the ICU was in 34.2% of cases the operating theatre followed by the emergency room (30.5%) and the general ward (23.3%). Nine hundred and ninety-two patients (76%) were known to be alive at 84 days, with 271 (20.7%) known to have died (missing data on 49 patients).

The total number of PIs was 311, of which 148 (47.6%) were acquired in the ICU and 154 (52.4%) prior to ICU admission. Thus 54.5% of patients with PIs acquired those following their ICU admission. The majority of PIs were classified as Grade 1 or 2 [figure 1a]. 115 patients had ICU acquired pressure injuries, and 96 had injuries that were pre-existing at the time of admission), and the number of PIs per patient varied from 1 to 9 sites. Anatomical site of 311 injuries of which 148 (47.6%) were acquired in the ICU and 163 (52.4%) were prior to ICU admission. The sacral area, along with the heels, mouth and nose appeared most vulnerable with the sacral and heels accounting for most of the higher-

grade injuries; of 97 areas with injuries classified as Grade 3 or above, 33 (34%) were sacral areas and 28 (29%) were heels [figure 1b].

The mixed multiple logistic regression analysis identified the following factors as independently associated with ICU-acquired PIs. decreasing Braden scores (OR=0.77 [95%CI, 0.69 – 0.85], p<0.001) and increasing prior duration of ICU stay (0-3 days, reference; 4–6 days in ICU before study day, OR=2.29 [95%CI1.06 – 4.95], p=0.03; 7–9 days in ICU before study day, OR=2.30 [95%CI, 0.91 – 5.84], p=0.08; 10–12 days in ICU before study day, OR=7.77 [95%CI, 3.42 - 17.69], p<0.001; >12 days in ICU before study day, OR=7.73 [95%CI, 3.94-15.15], p<0.001; [table 2].

DISCUSSION:

This service evaluation identified that 16% of 1312 patients in a large sample of UK intensive care units had an area exhibiting pressure damage on the study day. Although 96 patients already had injuries on admission, 115 had acquired them during their ICU stay. Generally, these injuries were not severe, however there were some that were, and these injuries come with a human and institutional cost. The impact of PIs is not easy to measure in terms of patients' outcome and totals costs. In 2004, the estimated annual cost paid by the NHS for the treatment of PIs was between £1.4 billion and £2.1 billion a year. A more recent estimate suggests that the cost of treating a PI varies from £1214 (stage 1) to £14,108 (stage 4 more severe).[2]

Recently, Labeau et al. conducted a worldwide prospective, point-prevalence study comprising 1,117 ICUs in 90 countries and found 6,747 pressure injuries in 3,526 patients[1]. The proportion of ICU-acquired PIs was 59.2%. They identified several factors associated with ICU-acquired pressure injuries including older age, presence of organ support and high severity of illness scores. This analysis of the UK data identified a low prevalence of generally low severity of PIs.. However, having a lower Braden score and a longer length of prior ICU stay were associated with a greater likelihood of acquiring a pressure injury in ICU. The global study (including data from many significantly lower resource settings) identified numerous risk-factor associations, but the overall prevalence was greater (26.6%), as was the total sample (n=13,254)[1]. Importantly, the global cohort was able to identify that local factors, case-mix, and especially type of ICU admission (i.e., medical, elective or emergency surgery), were associated with ICU-acquired PI risk.[15]

The locations of PIs were mainly the sacral area and the heels and the more severe injuries tended to be in these areas. This clearly needs continuous focus in equipment and practice development and education, along with communication amongst the multidisciplinary team. It is a reasonable assumption that the overwhelming majority of the patients were nursed in the supine position on the study day, nevertheless there were injuries reported to nose, mouth and ears. The results might have been different had the study been conducted during the COVID-19 pandemic, during which there was a widespread need for nursing patients in the prone position. [16-24] The prevalence and location of PIs likely would reflect staff experience and training, positioning of patients and workload.[21] The mouth and the nose may be damaged when using NIV with limited options for interface or suctioning. [23] The nurse to patient ratio was 1:1 for level 3 patients and this is a reflection of UK standards of good care. Due to limitations of data collected we cannot comment on the detailed acuity which contributing units experienced in the period running up to the study day, similarly we cannot infer that staffing has an impact on the prevalence of PIs; the impact of a period of inadequate staffing will be reflected in pressure injuries sometime later.

The study sought information on preventative measures used. [2,4] The NICE guidance does not cover the specific issues relating to the critically ill patient, [2-4] however a list of preventive measures used in the ICUs is in Supplementary Appendix B [Supplementary Table 1]. Data in this table are reflective of current NICE guidelines, but the lack of longitudinal data and low prevalence of PI precluded exploration of the relative effectiveness of such measures.

In the UK the presence of ICU PIs generates a mandatory investigation generally initiated via adverse event reporting systems, such as "Datix" [https://rldatix.com]. This triggers investigation and challenge but may not account the specific issues relevant to the critically ill. The ability to differentiate which PIs were preventable with appropriate measures and those which were not, due to acuity, nutrition, vasopressors, hydration status etc. would ensure appropriate attention but cannot be evaluated with this study methodology. It has been acknowledged that some pressure injuries, particularly in a critical care setting, are unavoidable.[23]

The mixed multiple logistic regression analysis identified decreasing Braden scores as associated with ICU-acquired pressure injuries. The Braden scale includes largely static factors and a dynamic system which adjust risk as time goes on may be worth evaluating. This is even more relevant given that prior LOS has a significant association with the incidence of PIs demonstrated in both this and other studies.[24] The development of such a scale including elapsed-time as a variable would require an extensive longitudinal study; it is not currently clear whether the effort would be justified. Of note, the majority of sites reported using the Braden or Waterlow scales; such scales would be the primary trigger for additional measures [Supplement B, Supplementary Table 3]; neither Braden or Waterlow has notion of prior length of stay. The importance of length of stay has been highlighted previously but this seems not to have translated into current risk assessment.[25] Although better risk prediction can be valuable for comparative audit as part of quality improvement, we do not know if an improved risk prediction score would translate into fewer pressure injuries.

One potential limitations of the study include the sample of intensive care units contributing; we estimate 28% of UK services contribute and we cannot assume this to be

a representative sample. However, the site data submitted, and the patient diagnostic data are in line with broader UK critical care [Supplement B, Supplementary Table 2].[26] Conceivably participating sites may have had greater interest in pressure injury or evaluative practice, which may be different from non-contributing sites, and be reflected in quality of care. Finally, bedside nurses may perhaps have been inhibited from reporting injuries over anxieties that this would be regarded badly by managers. An important mitigation of this is that pressure injury reporting is mandatory in the UK and has arguably become routine.

CONCLUSION:

The prevalence and the stage of severity of PIs, both ICU-acquired and non-ICU-acquired, were low in adult critically ill patients admitted to UK ICUs. Nevertheless, 16% of patients had evidence of pressure injury on the study day, and this clearly represents an opportunity for improvement. Decreasing Braden scores and increasing ICU stay were identified as risk factors associated with the prevalence of ICU-acquired PIs. The sacral area and the heels are clearly very vulnerable areas with greater numbers and the site of more severe injuries.

Contributors

FR, SJB, CB, BB were responsible for coordinating the study in the UK

FR and SJB drafted the manuscript

MD, SOL, SIL produced a UK extract of data from the global study database

FR, SJB, BB, MD and SOL conducted the analysis

SOL and SIB were the lead investigators for the global study

All authors revised the manuscript for important intellectual content

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Competing interests

The authors declare they have no conflicts of interest.

Data availability statement

The complete DecubICUs database is under the guardianship of the global senior investigators SOL and SIB. The database cannot be shared as it is governed by a variety of Data Use Agreements. It may be possible to respond to reasonable information requests and these are to be addressed to sonia.labeau@hogent.be and stijn.blot@ugent.be.

Ethics:

"The study protocol was reviewed by the Joint Research Compliance Office at Imperial College Healthcare NHS Trust London and by the Health Research Authority. These bodies deemed the survey a Service Evaluation. All participating Trusts/Hospitals confirmed registration as a Service Evaluation according to their local protocols and non-objection from the relevant local Caldicott Guardian. A full description of the methods can also be found in the DecubICUs global study report.1 The study was registered at ClinicalTrials.gov (NCT03270345)."

REFERENCES:

1. Labeau S O, Afonso E, Benbenishty J, et al. Prevalence, associated factors and outcomes of pressure injuries in adult intensive care unit patients: the DecubICUs study. *Intensive Care Medicine* 2021;47:160-9.. https://doi.org/10.1007/s00134-020-06234-9.
2. NICE. Pressure ulcer prevention. The prevention and management of pressure ulcers in primary and secondary care. Clinical Guidelines 179. Methods, evidence and recommendations April 2014 https://www.nice.org.uk/guidance/cg179/evidence/full-guideline-prevention-pdf-547610509 . (Accessed August 2021)
3. National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel, and Pan Pacific Pressure Injury Alliance. Prevention and treatment of pressure ulcers: Clinical practice guideline. Emily Haesler ed. Osborne Park, Australia: Cambridge Media; 2014.
4. National Pressure Injury Advisory Panel, European Pressure Ulcer Advisory Panel, and Pan Pacific Pressure Injury Alliance. Prevention and treatment of pressure ulcers: Clinical practice guideline. Emily Haesler ed. Osborne Park, Australia: Cambridge Media; 2019.
5. Edsberg LE, Black JM, Goldberg M, et al. National Pressure Ulcer Advisory Panel pressure injury staging system: Revised pressure injury staging system. *J Wound Ostomy Continence Nur*s 2016;43:585-97.
6. National Pressure Injury Advisory Panel. Position statement on staging – 2017 clarifications. https://npuap.org/page/PositionStatements. (Accessed August 2021)
7. Bergstrom N, Braden B, Laquzza A, Holman V. The Braden scale for predicting pressure sore risk - reliability studies. *Nurs Res* 1985;36:205–10. http://www.ncbi.nlm.nih.gov/pubmed/3299278.
8. El-Marsi J, Zein-El-Dine S, Zein B, et al. Predictors of Pressure Injuries in a Critical Care Unit in Lebanon: Prevalence, Characteristics, and Associated Factors. *J Wound Ostomy Continence Nurs*. 2018; 45:131-136.

9. Cox J, Predictors of pressure ulcers in adult critical care patients. *Am J Crit Care*. 2011;20: 364-75.
10. Society of Critical Care Medicine. Critical Care Statistics. https://www.sccm.org/Communications/Critical-Care-Statistics. (Accessed August 2021)
11. R Core Team (2018) R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Available at https://www.R-project.org/.
12. The Scottish Intensive Care Society audit group. Audit of Critical Care in Scotland 2018, reporting on 2017. https://www.sicsag.scot.nhs.uk/publications/_docs/2018/SICSAG-report-2018-2609-final.pdf?55 . (Accessed August 2021)
13. Intensive Care national audit & research centre. Annual Quality Report 2018/19 for adult critical care. https://onlinereports.icnarc.org/Reports/2019/12/annual-quality-report-201819-for-adult-critical-care . (Accessed August 2021)
14. Deschepper M, Labeau SO, Waegeman W, et al. Heterogeneity hampers the identification of general pressure injury risk factors in intensive care populations: A predictive modelling analysis. *Intensive Crit Care Nurs* 2021 12:103117 (on line ahead of print)
15. Shearer S C, Parsa K M, Newark A, et al. Facial Pressure Injuries from Prone Positioning in the COVID-19 Era. *Laryngoscope* 2021;131:E2139-2142 PMID: 33389768 DOI: 10.1002/lary.29374
16. Perrillat A, Foletti JM, Lacagne AS, et al. Facial pressure ulcers in COVID-19 patients undergoing prone positioning: How to prevent an underestimated epidemic? *J Stomatol Oral Maxillofac Surg*. 2020;121:442–444. doi: 10.1016/j.jormas.2020.06.008.
17. Kim RS, Mullins K. Preventing facial pressure ulcers in Acute Respiratory Distress Syndrome (ARDS) *J Wound Ostomy Continence Nurs*. 2016;43:427–429. doi: 10.1097/WON.0000000000000247.

18. Lucchini A, Bambi S, Mattiussi E.et al. Prone position in acute respiratory distress syndrome patients: a retrospective analysis of complications. *Dimens Crit Care Nurs*. 2020;39:39–46. doi: 10.1097/DCC.0000000000000393.

19. Nazerali RS, Song KR, Wong MS. Facial pressure ulcer following prone positioning. *J Plast Reconstr Aesthetic Surg*. 2010;63:e413–e414. doi: 10.1016/j.bjps.2009.11.001.

20. Azoulay E, Timsit JF, Sprung CL, et al. Prevalence and Factors of Intensive Care Unit Conflicts: The Conflicus Study. *Am J Respir Crit Care Med*. 2009;180:853-60.

21. Alqahtani JS, AlAhmari MD. Evidence based synthesis for prevention of noninvasive ventilation related facial pressure ulcers. *Saudi Med J*. 2018;39:443-452. doi: 10.15537/smj.2018.5.22058.PMID: 29738002 .

22. Edsberg LE, Langemo D, Baharestani MM, et al. Unavoidable pressure injury: state of the science and consensus outcomes. *J Wound Ostomy Continence Nurs* 2014; 41:313-334

23. Zhang Y, Zhuang Y, Shen J, et al. Value of pressure injury assessment scales for patients in the intensive care unit: Systematic review and diagnostic test accuracy meta-analysis. *Intensive & Critical Care Nursing*. 2021;64;103009. doi: 10.1016/j.iccn.2020.103009

24. Cox J. Risk factors for pressure injury development among critical care patients. *Crit Care Nurs Clin N Am* 2020;32;473-488

25. Coyer F, Cook J L, Doubrovsky A, et al. Exploring medical device-related pressure injuries in a single intensive care setting: a longitudinal point prevalence study. ICCN 2022; 103155.

26. Coyer F, Labeau S, Blot S. Preventing pressure injuries among patients in the intensive care unit: insights gained. Intensive Care Med. 2022 Aug 22:1–3. doi: 10.1007/s00134-022-06838-3. Epub ahead of print. PMID: 35995873; PMCID: PMC9395895.

TABLE 1: Characteristics of patients
TABLE 2: Mixed multiple logistic regression model.

Figure 1a: grade of injury
Figure 1b: anatomical site of injury

TABLE 1:

Characteristic	All patients (n = 1312; 100%)[a]	Patients without pressure injuries (n = 1101; 83.9%)[a]	Patients with ICU-acquired pressure injuries and / or pressure injuries acquired prior to ICU admission (n = 211; 16%)[a]	Patients with ICU-acquired pressure injuries only (n = 115; 8.8%)[a]
Age, years (M, IQR)	62 (50–72)	62 (49–72)	65 (54–74)	62 (52–73)
Sex (male) n (%)	783 (59.7)	656 (59.6)	127 (60.2)	68 (59.1)
Body Mass Index class n (%)				
Underweight <18.5 kg/m^2	57 (4.3)	42 (3.8)	15 (7.1)	10 (8.7)
Normal weigh 18.5–24.9 kg/m^2	464 (35.4)	381 (34.6)	83 (39.3)	49 (42.6)
Pre-obesity 25–29.9 kg/m^2	391 (29.8)	341 (31.0)	50 (23.7)	27 (23.5)
Obesity class I 30–34.9 kg/m^2	227 (17.3)	195 (17.7)	32 (15.2)	12 (10.4)
Obesity class II 35–39.9 kg/m^2	90 (6.9)	75 (6.8)	15 (7.1)	11 (9.6)
Obesity class III ≥40 kg/m^2	83 (6.3)	67 (6.1)	16 (7.6)	6 (5.2)
Mechanical ventilation on ICU admission n (%)	669 (51.0)	555 (50.4)	114 (54.0)	77 (67.0)
Type of admission n (%)				
Medical	617 (47.0)	495 (45.0)	122 (57.8)	63 (54.8)
Elective surgery	279 (21.3)	260 (23.6)	19 (9.0)	11 (9.6)
Emergency surgery	309 (23.6)	255 (23.2)	54 (25.6)	31 (27.0)
Trauma and burns	107 (8.2)	91 (8.3)	16 (7.6)	10 (8.7)
Comorbidities n (%)				
Acquired Immune Deficiency Syndrome	6 (0.5)	5 (0.5)	1 (0.5)	1 (0.9)
Chronic Obstructive Pulmonary Disease	173 (13.2)	143 (13.0)	30 (14.2)	17 (14.8)
Malignancy	164 (12.5)	137 (12.4)	27 (12.8)	14 (12.2)
Cancer, solid tumour	118 (9.0)	102 (9.3)	16 (7.6)	8 (7.0)
Metastatic cancer	32 (2.4)	27 (2.5)	5 (2.4)	1 (0.9)
Haematologic cancer	27 (2.1)	19 (1.7)	8 (3.8)	5 (4.3)
Immunocompromised	104 (7.9)	79 (7.2)	25 (11.8)	15 (13.0)

Corticosteroid therapy	57 (4.3)	39 (3.5)	18 (8.5)	10 (8.7)
Immunosuppression	33 (2.5)	24 (2.2)	9 (4.3)	5 (4.3)
Chemotherapy	37 (2.8)	34 (3.1)	3 (1.4)	2 (1.7)
Cirrhosis	39 (3.0)	27 (2.5)	12 (5.7)	7 (6.1)
Diabetes	239 (18.2)	193 (17.5)	46 (21.8)	25 (21.7)
Heart failure	130 (9.9)	102 (9.3)	28 (13.3)	15 (13.0)
Impaired mobility	120 (9.1)	95 (8.6)	25 (11.8)	10 (8.7)
Malnutrition	45 (3.4)	27 (2.5)	18 (8.5)	12 (10.4)
Peripheral vascular disease	41 (3.1)	27 (2.5)	14 (6.6)	5 (4.3)
Renal failure	106 (8.1)	93 (8.4)	13 (6.2)	5 (4.3)
Simplified Acute Physiology Score II category n (%)[b]				
≤23	385 (29.3)	353 (32.1)	32 (15.2)	16 (13.9)
24–33	327 (24.9)	283 (25.7)	44 (20.94)	26 (22.6)
34–44	290 (22.1)	220 (20.0)	70 (33.2)	37 (32.2)
≥45	310 (23.6)	245 (22.3)	65 (30.8)	36 (31.3)
Braden score category[c] n (%)				
Very High Risk (≤ 9)	110 (8.4)	79 (7.2)	31 (14.7)	18 (15.7)
High Risk (10–12)	370 (28.2)	284 (25.8)	86 (40.8)	51 (44.3)
Moderate Risk (13–14)	236 (18.0)	194 (17.6)	42 (19.9)	27 (23.5)
Mild Risk (15–18)	396 (30.2)	349 (31.7)	47 (22.3)	19 (16.5)
No Risk (19–23)	193 (14.7)	189 (17.2)	4 (1.9)	0 (0.0)
Length of stay in ICU prior to study day (days) (Median, IQR)	4 (1–10)	3 (1–9)	8 (3–20)	12 (6–26)
Length of stay in ICU (days) (Median, IQR)	9 (4–24)	8 (3–20)	19.5 (8–45.75)	26.5 (12–53)
Length of stay from ICU admission to hospital discharge (days) (Median, IQR)	18 (8–40)	16 (8–35)	33 (14.25–61.75)	42 (18–63.75)
Length of stay in hospital after study day (days) (Median, IQR)	11 (6–28)	10 (5–24)	21 (9–41)	22 (10–42)
Patients still in ICU 3 months after study day	2 (0.2)	1 (0.1)	1 (0.5)	0 (0.0)
Patients still in non-ICU ward 3 months after study day	93 (7.1)	59 (5.4)	34 (16.1)	22 (19.1)
Deceased during hospital stay	271 (20.7)	210 (19.1)	61 (28.9)	29 (25.2)
28-days mortality	196 (14.9)	157 (14.3)	39 (18.5)	15 (13.0)

Abbreviations: ICU, intensive care unit; M, median; IQR, interquartile range

[a] Totals may not sum to 1312, 1101, 211 and 115, respectively, owing to missing values.

[b] Range of possible scores is 0–163; a higher SAPS II score indicates a higher severity of disease and acute illness; scores are categorized according to the sample's quartiles

[c] Range of possible scores is 6–23

TABLE 2.

Variable		OR [95%CI]	p-value
Days in ICU before study day			
	0–3 days	Reference	
	4–6 days in ICU before study day	2.29 [1.06 – 4.95]	0.03
	7–9 days in ICU before study day	2.30 [0.91 – 5.84]	0.08
	10–12 days in ICU before study day	7.77 [3.42 – 17.69]	<0.001
	>12 days in ICU before study day	7.73 [3.94 – 15.15]	<0.001
Age, years		1.01 [0.99 – 1.03]	0.27
Male sex		0.98 [0.61 – 1.56]	0.92
Body Mass Index, kg/m²			
	[18.5–25[: normal weight	Reference	
	<18–5: underweight	1.97 [0.80 – 4.85]	0.14
	[25–30[: pre-obesity	0.56 [0.32 – 1.08]	0.053
	≥30: obesity	0.60 [0.34 – 1.07]	0.08
Braden Score		0.77 [0.69 – 0.85]	<0.001
Admission type: medical		1.11 [0.47 – 2.60]	0.82
Admission type: elective surgery		0.83 [0.28 – 2.47]	0.74
Admission type: emergency surgery		1.03 [0.41 – 2.54]	0.96
Chronic Obstructive Pulmonary Disease		0.96 [0.50 – 1.88]	0.92
Acquired Immune Deficiency Syndrome		3.67 [0.27 – 50.17]	0.33
Heart failure		1.07 [0.51 – 2.22]	0.86
Peripheral vascular disease		0.97 [0.30 – 3.06]	0.95
Diabetes		1.22 [0.69 – 2.15]	0.49
Cirrhosis		2.25 [0.83 – 6.17]	0.11
Malignancy		0.90 [0.42 – 1.93]	0.80
Immunocompromised		1.96 [0.91 – 4.20]	0.09
Vasopressor use		0.64 [0.34 – 1.21]	0.17
Sedation		0.77 [0.40 – 1.47]	0.43
Muscle relaxant use		1.13 [0.31 – 4.12]	0.86

Mechanical ventilation on admission	1.34 [0.79 – 2.27]	0.28
Renal replacement	1.63 [0.83 – 3.22]	0.16
Simplified Acute Physiology Score II score	0.99 [0.97 – 1.01]	0.46

Abbreviations: OR, odds ratio CI, confidence interval,

Figure 1a

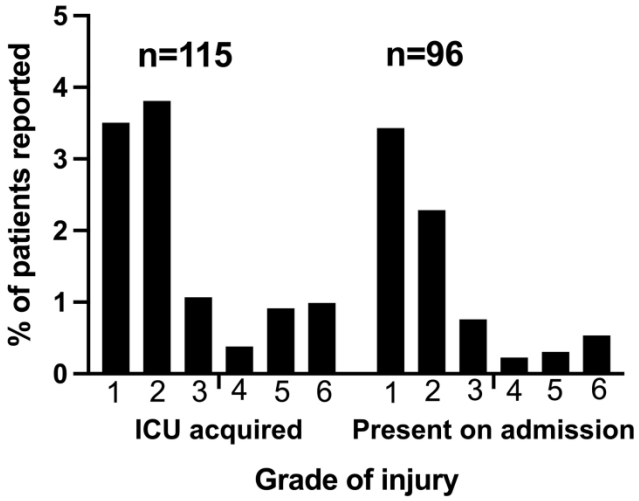

Figure 1b

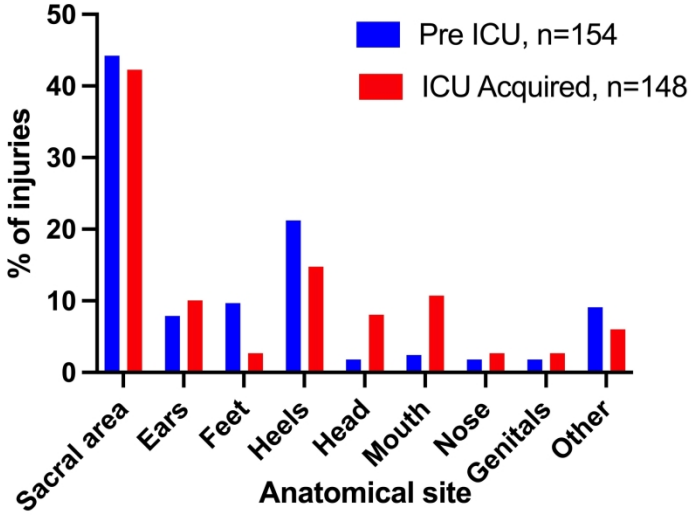

Fig 1a: Grade of injury. Fig 1b: anatomical site

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Online Resource 4. Study protocol

Decub*ICU*s

Decubitus in Intensive Care Units

A Multicenter International One-Day Prevalence Study

1 Organisational information

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Coordinating center: Ghent University, Belgium (Prof. Dr. S. Blot)

National representatives:

The role of the national representatives can be summarized as follows:

(1) Advertise the study in the individual countries and identify participating hospitals and local investigators in their country.
(2) Apply for regulatory approval in a national level where applicable and ensure that ethical committee (EC) approvals or waivers for all the participating hospitals in the country are in place prior to the initiation of the study.
(3) Assist with the translation of the study protocol/CRF where required.
(4) Ensure good communication with the participating sites in the respective country and to animate local investigators to achieve optimal recruitment and follow up during the period of the study. During the period of database quality control (data 'cleaning') the national representative should animate the individual to reply in possible queries.

Local co-ordinators:

Local co-ordinators in individual institutions will have the following responsibilities:

(1) Provide leadership for the project in their institution
(2) Ensure all relevant regulatory approvals are in place and communicated with the coordinating center
(3) Ensure adequate data collection and act as guarantor for the integrity and quality of the data
(4) Ensure timely completion of the e-CRFs
(5) Ensure collaboration to solve possible queries that may arise during the database quality control process.

2 Protocol summary

Study title:	Decubitus in Intensive Care Units
Acronym:	Decub*ICU*s
Design:	multicentre, international one-day prevalence study
Target population:	all patients present on **15 May 2018**

Interventions: no interventions – observational study

Outcomes:

- major risk factors for pressure injury development;
- preventive measures used in distinct ICU populations and countries;
- identifying shortages in the availability of evidence-based measures to prevent pressure injuries;
- occurrence rates of pressure injuries with/without accurate adjustment for risk profile and preventive measures taken;
- benchmarking between regions/countries;
- clinical outcomes associated with pressure injuries (major organ derangements and 12 week mortality);
- economic outcomes associated with pressure injuries (length of ICU stay) and linking these outcomes with local practice regarding prevention measures applied/available.

Subanalyses:

- country and regional differences in prevalence of pressure injuries and outcome;
- age, sex and morphology-related differences in prevalence of pressure injuries and outcome;
- comorbidities, prevalence and outcome of pressure ulcers;
- relationship of ICU organisational issues with prevalence of pressure ulcers and outcome;
- prevalence and outcome in specific subgroups (trauma, surgical, medical, etc…).

Study duration: one-day prevalence [**15 May 2018**]

Follow-up period: until hospital discharge or at 12 weeks to evaluate ICU and hospital outcomes [**7 August 2018**]

3 Description of the study

3.1 Introduction

Pressure injuries remain among the most important complications of hospitalisation. They are associated with an increased infection risk, pain and disability, high level of dependence, longer hospitalisation, and as such higher hospital costs. The total annual cost for pressure injuries in the UK has been estimated to range 1.4 to 2.1 billion pounds [1].

Because severe pressure injuries are generally considered preventable, the occurrence rate of pressure injuries has increasingly been used as a quality indicator in hospital care. In addition, and in accordance with the ruling on Inpatient Prospective Payment System by the Centers for Medicare and Medicaid, hospitals in the US are no longer reimbursed for hospital costs related to severe pressure injuries (stage III or higher). These evolutions have put substantial emphasis on the prevention of pressure injuries.

In the past decades increasing efforts to prevent pressure injuries have been made, but –contrariwise– the challenge of pressure injury prevention seems to become harder as medicine progresses. Indeed, favourable evolutions in emergency medicine and organ support have led to an increasing pool of long-term intensive care (ICU) patients. Patients admitted to ICUs are at particular high risk for pressure injuries because of their debilitated physical condition and exposure to numerous risk factors. Risk factors for ICU patients are generally the same as those in a general hospital population. Yet, in ICU patients they are exaggerated in terms of both a stronger effect and the presence of more factors at the same time [2]. Also, the proportion of elderly admitted to ICU is on the rise. In a university hospital the number of patients aged >75 years increased by one third over a 15-year period [3].

Although many studies reporting on pressure injuries in ICU settings are outdated single-center or regional initiatives [4-7], a recent randomized trial conducted in the United Kingdom found a prevalence of new or substantially worsened pressure injuries of 15% in intensive care (ICU) patients with an anticipated stay of at least 36 hrs [8]. A 58% prevalence was identified in a Brazilian single center study among adult ICU patients of which 55.5% were estimated to be at high risk of developing a pressure injury according to the Braden scale, while 40% actually developed one [9].

The changing ICU patient profile, the high prevalence and the substantial economic impact make large-scaled international studies necessary to keep up with present epidemiology of pressure injuries in ICUs.

3.2 Objectives

Our objective is to provide an up-to-date, international “global” picture of the extent and patterns of pressure injuries in ICUs. Thereto we plan to perform a 1-day, prospective, multicenter point-prevalence study. The large scale of the project should allow thorough epidemiological analyses. More precisely the study will enable to identify:

- major risk factors for pressure injury development;

- preventive measures used in distinct ICU populations and countries;
- shortages in the availability of evidence-based measures to prevent pressure injuries;
- malpractice in pressure injury prevention in particular regions or countries;
- occurrence rates of pressure injuries with/without accurate adjustment for risk profile and preventive measures taken;
- benchmarking between regions/countries; clinical outcomes associated with pressure injuries (major organ derangements and mortality);
- economic outcomes associated with pressure injuries (length of ICU stay) and linking these outcomes with local practice regarding prevention measures applied/available.
- country and regional differences in prevalence of pressure injuries and outcome.

3.3 Methods

3.3.1. Network development

Steering committee

Point prevalence studies are only of value when performed on a vast scale. To sample a representative cohort, we intend to recruit about 1200 ICUs with all continents covered and as many countries as possible within each continent. Thereto an international steering committee will be established. Following our extensive experience in international research projects (see profile of the principal investigators) we currently have research contacts in all continents. Clinicians/researchers with a high ability to recruit centres will be invited in the steering committee.

Recruitment strategy

To maximize the recruitment of centers, different approaches to invite ICUs for participation will be used:

- development of a dedicated informative website including an extensive Frequently Asked Questions (FAQs) section. In all recruitment initiatives the website will be mentioned;
- our current network of researchers and participants in other studies will be contacted (e.g., all 3587 participants in the EVIDENCE-project, representing 79 countries);
- members of the steering committee will contact their personal network;
- endorsement of the European Society of Intensive Care Medicine (ESICM), will be pursued. The ESICM facilitates spread of their projects through blast mails to all their members. In the past, we succeeded in gaining endorsement from the ESICM for three of our research projects;
- for countries currently lacking from our network, embassies will be contacted to obtain a list of hospitals with intensive care activity (this strategy has been successfully used for the development of the EVIDENCE project). Especially for African and Eastern European countries this can be an important approach;
- advertisement on websites of critical care societies such as the ESICM, the Society of Critical Care Medicine (SCCM), and the American Association for Critical Care Nurses (AACCN);
- flyers will be distributed at national and international critical care symposia and congresses.

3.3.2. Organizing the point-prevalence study

For the point prevalence study a date will be picked (**15 May 2018**). Centers prepared to participate must obtain approval of the local ethics committee or review board. A local investigator with email contact is a prerequisite. Centers will be alerted by repeated email in the weeks before the study date. At that time, they will be asked to provide minimal data regarding the organisation of the unit (e.g. staffing and number of ICU beds).

3.3.3. Data recording

Pressures injury stages will be graded following the classification system jointly developed by the National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel, and Pan Pacific Pressure Injury Alliance [10]. A concise educational web-base training package will be available to optimally prepare participating ICUs for data recording.

Data will be recorded using electronic or pre-printed case report forms. Electronic forms (e-CRFs) can be consulted and submitted online. For countries with restricted digital resources, pre-printed forms will be available. These will be downloadable via the dedicated website or sent via fax, postal mail or email two weeks preceding the point prevalence measurement. After data input, pre-printed forms can be submitted through the channel best suiting the participating centers' commodities. Besides the FAQs section on the study website, a dedicated telephone hotline will be available for any queries during the study follow-up period.

Data to be recorded include patient demographics, data on severity of underlying disease and acute illness, organ failure, pressure ulcers, major risk factors for pressure ulcers, and measures taken to prevent pressure uinjuries. For more detail, see the case report form.
Participating ICUs will be asked to provide patient follow up until hospital discharge or for 84 days. At that time point survival status and length of ICU and hospital stay will be recorded.

3.3.4. Analyses & reporting of the study results
The principal investigators will perform data analyses. Data will be analysed as a whole and per continent, the latter to allow defining benchmark thresholds per continent. Initial data will be presented at international congresses as abstract and published in an international peer reviewed medical journal.

4 Study population

4.1 Inclusion criteria
All adult patients (>18 years of age) present on **15 May 2018**

4.2 Exclusion criteria
There are no exclusion criteria. All patients should be included. Patients with severe clinical conditions not allowing safe pressure injury identification should not be evaluated for the respective risk zones. If it is known that the patient has a pressure injury at the body sites that cannot be safely evaluated, the stage of the pressure injury should be recorded as previously known. If it is unknown whether the patient has a pressure injury at these body sites, this should be indicated with a '?' (See also case report form).

5 Study course

5.1 Patients' enrolment
Patients' enrolment will be limited to **15 May 2018** (from 00:00 until 24:00).

5.2 Ethics committee approval
Even though this is an epidemiological study with entirely anonymous data collection, it is advised to submit the protocol to the local ethics committee for approval.

5.3 Therapeutic intervention
The study is purely observational in nature; no interventions are planned.

5.4 Daily documentation
Data collection includes three stages:
a. on admission: see center report form;
b. on the study day: see case report form;
c. during follow up period: outcome at ICU and hospital discharge.

6 Organisation

6.1 Documentation
Data will be recorded using electronic or pre-printed case report forms by the attending intensivist, a trained research nurse, or an appropriately instructed nurse.

6.2 Collecting data
Data should be submitted digitally, faxed or (e-)mailed periodically to the coordinating center (See contact information).

6.3 Data management and archiving

6.3.1 Data property
The individual data provided by a participating ICU are primarily the property of the ICU who generated the data. All investigators have the right to access their data at any time.

6.3.2 Data control
Data control will involve the following levels:

- all participants are provided with detailed information (See instructions form). The coordinating center will provide a rapid response for any query throughout the study period (See contact information);
- data plausibility check will start at the entry level, setting validity limits for each variable. Investigators will be queried in case of outliers, excessive numbers of missing values.

6.3.3 Subsequent use of data

The steering committee, on behalf of the investigators, has the right to use all data that are pooled in the databank for scientific purposes. Investigators will be regularly informed about ongoing study activities. All participants have the right to access the data, pooled in the databank, for research purposes after the research project has been terminated, and with the approval of the steering committee. A copy of the databases generated by the project can only be provided to third-part entities after specific approval by the participating ICUs.

6.3.4 Archiving

A copy of the electronic databank will be kept in the coordinating centers and preserved for 15 years for subsequent use by the steering committee and investigators. It is recommended that a copy of all case report forms be kept at each center for future reference.

6.3.5 Publication rules

The executive committee will appoint a writing committee to draft the scientific report(s). Authorship will take the following elements into account: study design, study organisation, data collection, patient enrolment, data analysis, and contribution to the manuscript. All national representatives and local coordinators will have their efforts recognized by being mentioned as 'collaborator' in the authorship of the paper and as such listed in PUBMED. Members of the executive committee, national representatives and local coordinators may suggest research questions for secondary manuscripts and take initiative in drafting the paper after approval by the head investigators. In this regard, the head investigators control the risk of potential overlap between manuscripts.

6.4 Sponsorship

The DecubICUs project is in part supported by the LIFE Priority Fund of the European Society of Intensive Care Medicine, and the Flemish Society of Critical Care Nurses.

6.5 Statistical analysis

A single final analysis is planned at the end of the study; no interim analyses are planned. Study cohort characteristics will be described as proportions for categorical variables and for continuous variables as mean and standard deviation if normally distributed or median and inter-quartile range if not normally distributed (according to the Kolmogorov-Smirnov test for normality). Relationships with binary outcome variables (e.g. pressure ulcers, mortality) will be assessed by means of unadjusted and adjusted logistic mixed (multi-level) effects modelling in order to consider a centre effect. Likewise, linear mixed-effect modelling will be used to assess unadjusted and adjusted relationships with continuous outcome variables (e.g. length of ICU stay, organ failure score). Covariates that will be evaluated on their relationship with the presence of pressure ulcers encompass various organizational aspects of the ICU (e.g. nurse-to-patient ratio), pressure ulcer prevention measures (e.g. type of matrasses used), and severity of underlying disease and acute illness (co-morbidities, SAPS2 score, organ failure,…).

Covariates with an association with the outcome variable at a statistical level <0.25 in unadjusted logistic/linear mixed-effects analysis will be considered for adjusted analysis. A stepwise approach will be used to eliminate terms into the regression model where $p<0.15$ or $p<0.10$ (depending on the more favorable Hosmer-Lemeshow goodness-of-fit test) was set as the limit to keep covariates in the model. Results of logistic regression will be reported as adjusted odds ratios with 95% confidence intervals. If of value, pressure ulcer rates will be provided for large geographic regions (e.g. continent). Eventual differences in pressure ulcer rates might offer the opportunity to evaluate variances in prevention measures on a large scale.

Statistical analysis will be performed using SPSS for windows version 23.0 (Chicago, US). The head investigator (SB) is in charge of all statistical analysis and he is backed by the team of the Dept. of Biostatistics at the Faculty of Medicine & Health Sciences, Ghent University. In case unusual statistical challenges are faced, Dr. Ellen Deschepper of the Dept. of Biostatistics will be consulted.

Initial data will be presented at international congresses as abstract and published in an international peer reviewed medical journal.

7 References

1. Bennett G, Dealey C, Posnett J, (2004) The cost of pressure ulcers in the UK. Age Ageing 33: 230-235
2. Keller BP, Wille J, van Ramshorst B, van der Werken C, (2002) Pressure ulcers in intensive care patients: a review of risks and prevention. Intensive Care Med 28: 1379-1388
3. Blot S, Cankurtaran M, Petrovic M, Vandijck D, Lizy C, Decruyenaere J, Danneels C, Vandewoude K, Piette A, Verschraegen G, Van Den Noortgate N, Peleman R, Vogelaers D, (2009) Epidemiology and outcome of nosocomial bloodstream infection in elderly critically ill patients: a comparison between middle-aged, old, and very old patients. Critical care medicine 37: 1634-1641
4. Iranmanesh S, Rafiei H, Sabzevari S, (2012) Relationship between Braden scale score and pressure ulcer development in patients admitted in trauma intensive care unit. Int Wound J 9: 248-252
5. Manzano F, Navarro MJ, Roldan D, Moral MA, Leyva I, Guerrero C, Sanchez MA, Colmenero M, Fernandez-Mondejar E, (2010) Pressure ulcer incidence and risk factors in ventilated intensive care patients. J Crit Care 25: 469-476
6. Nijs N, Toppets A, Defloor T, Bernaerts K, Milisen K, Van Den Berghe G, (2009) Incidence and risk factors for pressure ulcers in the intensive care unit. J Clin Nurs 18: 1258-1266
7. Terekeci H, Kucukardali Y, Top C, Onem Y, Celik S, Oktenli C, (2009) Risk assessment study of the pressure ulcers in intensive care unit patients. Eur J Intern Med 20: 394-397
8. Harvey SE, Parrott F, Harrison DA, Bear DE, Segaran E, Beale R, Bellingan G, Leonard R, Mythen MG, Rowan KM, Investigators CT, (2014) Trial of the route of early nutritional support in critically ill adults. N Engl J Med 371: 1673-1684
9. Matos LS, Duarte NLV, Minetto RdCs, (2010) Incidence and prevalence of ulcer for pressure in CTI of a Public Hospital of DF. Revista Eletronica de Enfermagem 12: 719-726
10. National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and Treatment of Pressure Ulcers: Quick Reference Guide. Emily Haesler (Ed.). Cambridge Media: Osborne Park, Australia; 2014.

8 Contact details

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Appendix 1: Center Report Form

CENTER REPORT FORM Center: __ __ __

Did the data collectors consult an educative module on the correct staging of pressure injuries prior to data collection?
□ No □ Yes, the module provided by the ESICM □ Yes, another module

Section 1: general data

Institution: ……………………………………………………………………………………….

Type of hospital: ☐ University/academic ☐ Non-university

Hospital capacity: __ __ __ __ beds
ICU capacity: __ __ __ __ beds

Type of ICU: ☐ Closed ☐ Open (non-ICU doctors may write orders)

ICU speciality:
Surgical ☐ cardiac ☐ non-cardiac ☐ transplantation ☐ mixed ☐ burns ☐ trauma

Medical ☐ coronary ☐ neurologic ☐ respiratory ☐ mixed
Mixed medical/surgical ☐ Other ☐ Please, specify ……………………………………..……….

How many patients were (approximately) treated in your ICU in 2017? _ __ __ patients

Section 2: data pertaining to the study day

How many ICU beds are occupied at the day of the study? __ __ __ __ ICU beds

Number of nurses on the day of the study Between 2 - 3 am: __ __ __
Between 8 - 9 am: __ __ __
Between 4 - 5 pm: __ __ __

Physiotherapist available on the day of the study? ☐ Yes ☐ No

Is your unit currently participating in an (inter)national study on pressure injuries? ☐ Yes ☐ No

Do patient files contain a specific section for reporting pressure injuries? ☐ Yes ☐ No

Dietician/nutrition specialist available on the day of the study? ☐ Yes ☐ No

Which preventive measures are used in your ICU? (see codes list)
__ __
__ __

Which of the **above** measures are used in **all** patients (irrespective of risk profile)? (see codes list)
__ __
__ __

Which risk assessment scale is used to estimate the risk of pressure injuries?
☐ No scale ☐ Norton scale ☐ Braden scale ☐ Waterlow scale ☐ Other scale (specify):

What is the primary trigger to use extra preventive measures?
☐ high risk profile as indicated by a risk assessment scale
Ulcer: ☐ stage I ☐ stage II ☐ stage III ☐ stage IV ☐ U (unstageable) ☐ S (depth unknown)
☐ mechanical ventilation ☐ anticipated ICU stay >3 days ☐ coma/sedation ☐ vasopressor use
☐ malnutrition ☐ incontinence ☐ obesity
☐ Other (specify): ……………………………………………………………………

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Appendix 2: Case Report Form

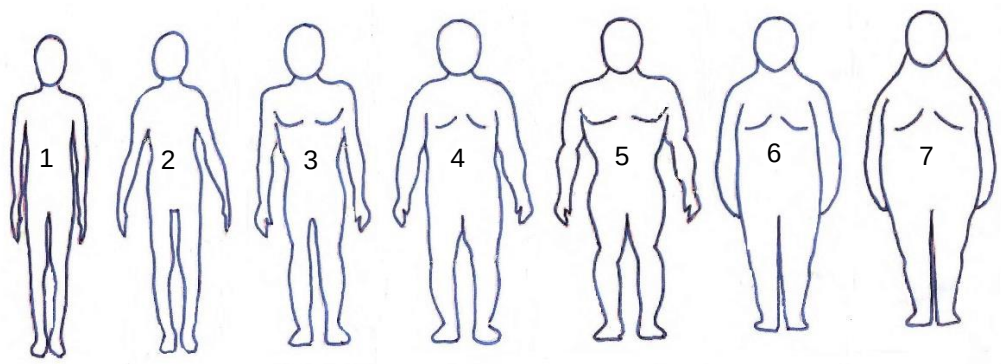
CASE REPORT FORM Center: __ __ __ __ __ Patient: __ __

Patient demographics & admission data

Date of ICU admission: __ __ / __ __ / __ __ __ __ (dd/mm/yyyy) **Sex:** ☐ male ☐ female

Age: __ __ __ years **Weight:** __ __ __ kg **Length:** __ __ __ cm

Morphological type: __



Type of admission: ☐ medical ☐ surgical ☐ elective ☐ emergency ☐ trauma ☐ burns

Mechanical ventilation on admission: ☐ yes ☐ no

Admission source: ☐ other hospital ☐ emergency room ☐ operating room ☐ general ward ☐ other

Primary diagnosis (only 1, see Codes list): __ __ __

Secondary diagnosis (max. 3, see Codes list): __ __ __ / __ __ __ / __ __ __

Comorbidities:

☐ COPD	☐ AIDS	☐ cancer (solid tumour)
☐ cirrhosis	☐ renal failure	☐ metastatic cancer
☐ heart failure	☐ diabetes	☐ hematologic cancer
☐ steroid therapy	☐ chemotherapy	☐ immunosuppression
☐ malnutrition	☐ impaired mobility	☐ peripheral vascular disease

Site(s) of surgery (max. 3, see Codes list): __ __ __ / __ __ __ / __ __ __

Study day parameters

Heart rate	(min.) __ __ __	(max.) __ __ __	bpm
Body temperature	(min.) __ __ __	(max.) __ __ __	°C
Therapeutic hypothermia	☐ yes	☐ no	
Systolic blood pressure	(min.) __ __ __	(max.) __ __ __	mmHg
Mean arterial pressure	(min.) __ __ __	(max.) __ __ __	mmHg
Lactate	(max.) __ __ __	mmol/L	
Vasopressor use	☐ yes	☐ no	
Sedation	☐ yes	☐ no	
Muscle relaxants	☐ yes	☐ no	
Respiratory rate	(min.) __ __ __	(max.) __ __ __	/minute
PaO_2/FiO_2	(min.) __ __ __	(max.) __ __ __	
Mechanical ventilation	☐ yes	☐ no	
Blood urea	(max.) __ __ __	☐ mg/dL or ☐ mmol/L or ☐ BUN (max.) __ __ __ mg/dL	
Blood creatinine	(max.) __ __ __	☐ mg/dL or ☐ mmol/L	
Leucocytes	(min.) __ __ __	(max.) __ __ __	$10^3/mm^3$
Platelets	(min.) __ __ __	$10^3/mm^3$	
Urine output	__ __ __	mL/24hours	
Renal replacement therapy	☐ yes	☐ no	
Serum potassium	(min.) __ __	(max.) __ __	mmol/L
Serum sodium	(min.) __ __ __	(max.) __ __	mmol/L
Total bilirubin	(max.) __ __ __	☐ mg/dL or ☐ mmol/L	
Serum bicarbonate	(min.) __ __	mmol/L	
Glasgow Coma Score	__ __		

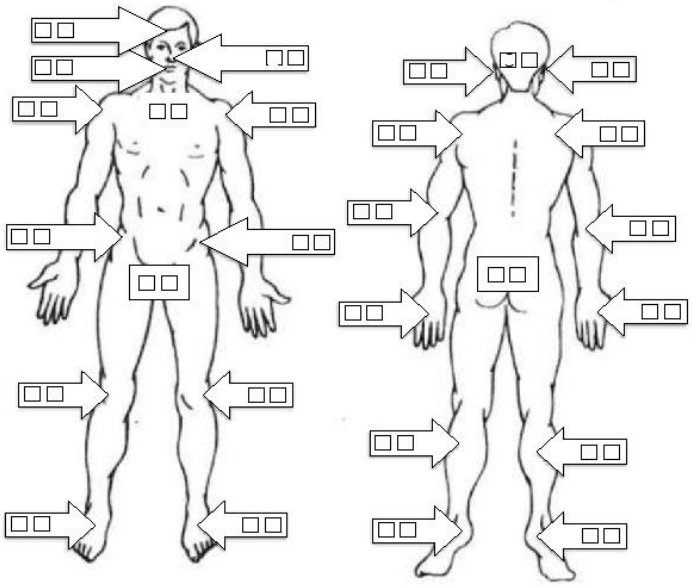
Device use on day of study (see Codes list)

__ __

Pressure injury prevention measures used (see figure and Codes list)

__ __ __ __ __ __ __ __ __ __ __ __

Pressure injuries (see Codes list)



Lesions following fixation of the patient: ☐ wrist(s) ☐ ankle(s) ☐ trunk

Pressure injury risk assessment

Sensory perception: ☐ completely limited ☐ very limited ☐ slightly limited ☐ no impairment

Moisture: ☐ constantly moist ☐ very moist ☐ occasionally moist ☐ rarely moist

Activity: ☐ bedfast ☐ chair-fast ☐ walks occasionally ☐ walks frequently

Mobility: ☐ completely immobile ☐ very limited ☐ slightly limited ☐ no limitation

Nutrition status: ☐ very poor ☐ probably inadequate ☐ adequate ☐ excellent

Friction and shear: ☐ problem ☐ potential problem ☐ no problem

Outcomes

Date of ICU discharge: __ __ / __ __ / __ __ __ __ (dd/mm/yyyy) ☐ alive
☐ dead

Date of hospital discharge:__ __ / __ __ / __ __ __ __ (dd/mm/yyyy) ☐ alive
☐ dead

Patient still in hospital on **7 August 2018** (= 15 May 2018 + 84 days) ☐

Appendix 3: Instructions to complete the center report form and case report form

Participants should register online on our webpage (www.esicm.org/research/decubICUs). Registration deadline is set to two weeks before the data collection date (1 May 2018). Enter the mailing address clearly. Providing a valid email is mandatory to facilitate correspondence during the study. Please inform us timely of any changes in your mailing address/email.
Upon completion of the online registration form, participating centers can chose to use either electronic either paper copy CRFs. To obtain paper copy CRFs, please contact the coordinating center (see contact information) by e-mail, postal mail or fax, specifying by which channel you wish to receive the CRFs (postal mail, fax, …). Please provide a valid postal address or fax number. To access the e-CRFs, each investigator will receive personalised login information to enter our secured website, where all data should be electronically entered. Each ICU will be assigned a code number. Please use this center number in all correspondence with the coordinating center. We invite the investigators to take some time in exploring the data entry area before the start of the study. Please feel free to contact the coordinating centre in case of any questions.

- -

Upon registration, the following data must be provided:

- ☐ Institution: name of the hospital
- ☐ Type of hospital: university/academic or non-university hospital
- ☐ Hospital capacity: the number of beds must be indicated
- ☐ ICU capacity: the number of beds must be indicated
- ☐ Type of ICU: the ICU is classified according to the majority (> 60 %) of regular admissions. Please indicate whether your ICU is open or closed.
- ☐ ICU specialty: the most appropriate choice must be marked. This should be based on the majority of admissions (> 60%). A free text can be added to report other specialties if applicable.
- ☐ Number of patients treated in 2015: if exact figures are lacking, provide a realistic estimate.

On the study day, two CRFs must be completed, i.e., (1) a CRF providing center-related data and (2) a CRF providing patient-related data.

1. CENTER REPORT FORM

This CRF consists of two sections

Section 1: the same data as upon registration must be provided. These are general data related to the identification of the hospital and participating ICU

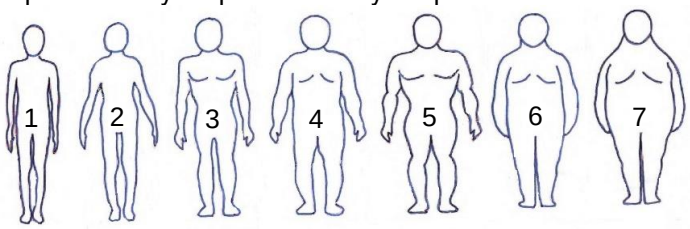
- ☐ Center nr.: center number provided by the coordinating center.
- ☐ Institution: name of the hospital
- ☐ Type of hospital: university/academic or non-university hospital
- ☐ Hospital capacity: the number of beds must be indicated
- ☐ ICU capacity: the number of beds must be indicated
- ☐ Type of ICU: the ICU is classified according to the majority (> 60 %) of regular admissions. Please indicate whether your ICU is open or closed.
- ☐ ICU specialty: the most appropriate choice must be marked. This should be based on the majority of admissions (> 60%). A free text can be filled in for other specialties if applicable.
- ☐ Number of patients treated in 2015: if exact figures are lacking, please provide a realistic estimate.

Section 2: pertains to center-related data on the study day

- ☐ Number of ICU beds occupied at the day of the study: provide number of beds.
- ☐ Number of nurses on the day of the study: provide the number of nurses per shift.
- ☐ Availability physiotherapist: take any time of availability during the study day into account.
- ☐ Participation in other study on pressure ulcers: all studies, even local or institutional, must be taken into account.
- ☐ Specific section in patient files: relates to any section dedicated to reporting pressure ulcers.
- ☐ Preventive measures that are used in the unit: use code list provided to indicate all measures used (if necessary) to prevent pressure ulcers in the unit.
- ☐ Measures used in all patients: from the measures reported in the above question, indicate which are always used in all patients (standard preventive measures).
- ☐ Risk assessment scales: check the scale(s) used in your unit. For other scales than Norton and Braden scale, please provide the scale's name.
- ☐ Primary trigger: check what is most appropriate (question not only pertaining to the day of study).

2. CASE REPORT FORM

- ☐ Center nr.: center number provided by the coordinating center.
- ☐ Patient nr.: provide sequential numbers from 1 to n for your center.
- ☐ Date of admission: the format day/month/year should be used.
- ☐ Sex: check the appropriate box.
- ☐ Age: patient's age (in years) at their last birthday.
- ☐ Weight: patient's weight in kilograms must be provided.
- ☐ Length: patient's length in centimetres should be provided.
- ☐ Morphological type: please refer to the figure below to choose the morphological type your patient matches best. Report the digit 1/2/3/4/5/6/7 on the case report form to indicate which of the types on the figure best corresponds with your patient's body shape.



- ☐ Type of admission: surgical is defined as surgery in the 4 weeks preceding admission. Elective surgery is defined as surgery scheduled >24 hours in advance; emergency surgery as scheduled within 24 hours of operation. Trauma is defined as ICU admissions directed related to, or as a complication of, a traumatic event in the 30 days preceding admission. Both trauma and surgical admissions could be chosen simultaneously if a trauma patient was operated on. All other admissions are considered medical. Codes for site of surgery are listed separately (up to 3 sites).
- ☐ Mechanical ventilation on admission: indicate whether the patient was on mechanical ventilation on ICU admission.
- ☐ Admission source: only one choice is possible.
- ☐ Primary diagnosis: the main reason for admission to the ICU. Only one primary diagnosis should be entered (see Codes list).
- ☐ Secondary diagnoses: defined as associated acute conditions on admission. Up to 3 secondary diagnoses are possible (see Codes list). If no relevant secondary diagnoses, please leave blank.
- ☐ Comorbidities: chronic diseases present prior to admission. More than one can be chosen according to the following definitions:
  - COPD: GOLD stage ≥ I.
  - Cirrhosis: defined as the histological development of regenerative nodules surrounded by fibrous bands in response to chronic liver injury, leading to portal hypertension and end stage liver disease.
  - Heart failure: New York Heart Association III-IV.
  - Steroid therapy: defined as immunosuppressive therapy where steroids are used to downregulate uncontrolled immune responses such as in autoimmunity or chronic inflammatory conditions
  - Malnutrition: defined as a state of nutrition in which a deficiency or excess (or imbalance) of energy, protein, and other nutrients causes measurable adverse effects on tissue/body form (body shape, size and composition) and function, and clinical outcome.
  - Cancer: solid tumour.
  - Metastatic cancer: metastases proven by surgery, computed tomography or magnetic resonance scan, or any other method.
  - Hematologic cancer: lymphoma, acute leukaemia, or multiple myeloma.
  - AIDS: HIV positive patients with clinical complications such as Pneumocystis pneumonia, Kaposi's sarcoma, lymphoma, tuberculosis, or toxoplasma infection.
  - Renal failure: defined as the need for chronic renal support or history of chronic renal insufficiency with a serum creatinine over 3.6 gm/dL (300 µmol/L).
  - Immunosuppression: administration in the 6 months prior to ICU admission of steroid treatment (at least 0.3 mg/kg/day prednisolone for at least one month), severe malnutrition, congenital immune-humoral or cellular immune deficiency state.
  - Chemotherapy: in the 6 months prior to ICU admission.
  - Insulin dependent diabetes mellitus: the need, prior to ICU admission, for insulin injections to control blood sugar levels.
  - Impaired mobility: underlying neurological or neuromuscular condition leading to impaired mobility, such as hemi-, para-, or quadriplegia or –paresis, or spasticity.
  - Peripheral vascular disease: defined as lower extremity arterial atherosclerosis.

- ☐ Study day parameters:
  - PaO2/FiO2 should be recorded simultaneously and the lowest value during the day is reported. In absence of respiratory support, use the conversion tables below to estimate the FiO2 and/or PaO2. Artefacts should be avoided (transient decrease during pneumothorax etc.).
  - Mechanical ventilation: indicate whether the patient was on mechanical ventilation on the study day.
  - Urine output: if the patient dies within the first 24 hours, the urine output should be estimated for the 24 hour period (e.g., if the patient dies after 8 hours and had 500 ml of urine during his ICU stay, the urine output would be 1.5 L).
  - Renal replacement therapy: any form of renal therapy (CVVH, CVVHD, etc.).
  - Glasgow Coma Score: report only the "assumed" Glasgow coma score. In other words, a patient who is in deep coma only because he is being treated with high doses of sedative agents should be considered to have a Glasgow coma score of 15.

Conversion tables for PaO_2 and FiO_2 estimation

Estimating PaO_2 from a given SO_2

SO_2 (%)	PaO_2 (mmHg)
80	44
81	45
82	46
83	47
84	49
85	50
86	52
87	53
88	55
89	57
90	60
91	62
92	65
93	69
94	73
95	79
96	86
97	96
98	112
99	145

FiO_2 estimation

Method	O_2 flow (l/min)	Estimated FiO2 (%)
Nasal cannula	1	24
	2	28
	3	32
	4	36
	5	40
	6	44
Nasopharyngeal catheter	4	40
	5	50
	6	60
Face mask	5	40
	6-7	50
	7-8	60
Face mask with reservoir	6	60
	7	70
	8	80
	9	90
	10	95

- ☐ Devices used: indicate all devices used on the day of the study (see Codes list).
- ☐ Pressure injury prevention measures used: indicate all prevention measures used in the patient on the day of the study (see Codes list).
- ☐ Pressure injuries: indicate any pressure injuries on the identification chart. Report pressure stage in one box and indicate whether the lesion is ICU-acquired by checking the second box (see Codes list for more information). If necessary, indicate any pressure injuries outside the arrows indicating high-risk zones. Patients with severe clinical conditions hampering safe pressure injury identification should not be evaluated for the respective risk zones. If it is known that the patient has a pressure injury at the body sites that cannot be safely evaluated, the stage of the pressure injury should be recorded as previously known. If it is unknown whether the patient has a pressure injury at these body sites, this should be indicated with a '?'.

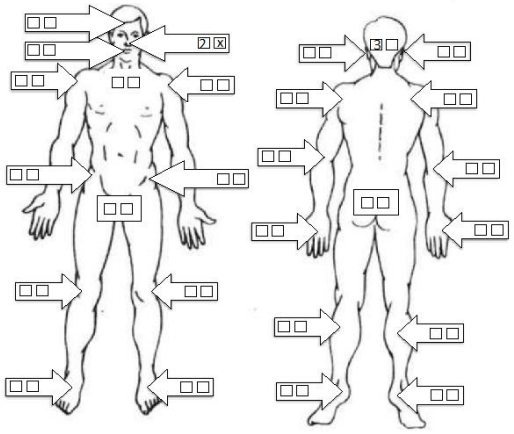


Figure – Exemplary pressure injury identification chart.
Stage 2 pressure injury at the nose; ICU-acquired as second box is checked.
Stage 3 pressure injury at the back of the head; not ICU-acquired as second box is not checked.

Pressure injury risk assessment: the risk for developing pressure ulcers is assessed by means of the six elements included in the Braden score (Bergstrom N, et al., Nurs Res 1987): sensory perception, skin moisture, activity, mobility, friction and shear. For each of the six elements, check the box that corresponds the best with the patients' condition. Find hereby a more detailed description of the boxes to check.

Sensory perception. Ability to respond meaningfully to pressure-related discomfort.

1. Completely limited. Unresponsive (does not moan, flinch, or grasp) to painful stimuli, owing to diminished level of consciousness or sedation. OR Limited ability to feel pain over most of the body.
2. Very limited. Responds only to painful stimuli. Cannot communicate discomfort except by moaning or restlessness. OR Has sensory impairment that limits the ability to feel pain or discomfort over half of the body.
3. Slightly limited. Responds to verbal commands but cannot always communicate discomfort or the need to be turned. OR Has some sensory impairment which limits ability to feel pain or discomfort in 1 or 2 extremities.
4. No impairment. Responds to verbal commands. Has no sensory deficit that would limit ability to feel or voice pain or discomfort.

Moisture. Degree to which skin is exposed to moisture.

1. Constantly moist. Skin is kept moist almost constantly by perspiration, urine, etc. Dampness is detected every time patient is turned.
2. Very moist. Skin is often, but not always, moist. Linen must be changed at least once per shift.
3. Occasionally moist. Skin is occasionally moist requiring an extra linen approximately once daily.
4. Rarely moist. Skin is usually dry. Linen requires changing only at routine intervals.

Activity. Degree of physical activity.

1. Bedfast. Confined to bed.
2. Chairfast. Ability to walk severely limited or non-existent. Cannot bear own weight and/or

must be assisted into chair or wheelchair.

3. Walks occasionally. Walks occasionally during day, but only for very short distances, with or without assistance. Spends majority of each shift in bed or chair.
4. Walks frequently. Walks outside room at least twice daily and inside room at least every 2 hours during walking hours.

Mobility. Ability to change and control body position.

1. Completely immobile. Does not make even slight changes in body or extremity position without assistance.
2. Very limited. Makes occasional slight changes in body or extremity position but unable to make frequent or significant changes independently.
3. Slightly limited. Makes frequent though slight changes in body or extremity position independently.
4. No limitation. Makes major and frequent changes in position without assistance.

Nutrition. Usual food intake pattern.

1. Very poor. Never eats a complete meal. Rarely eats more than half of any food offered. Eats 2 servings or lessof protein (meat or diary products) per day. Takes fluids poorly. Does not take a liquid dietary supplement. OR Has no oral intake and/or has been maintained on clear liquids or IV nutrition for more than 5 days.
2. Probably inadequate. Rarely eats a complete meal and generally eats only about half of any food offered. Protein intake includes only 3 servings per day. Occasionally will take a dietary supplement. OR Receives less than optimum amount of liquid diet or tube feeding.
3. Adequate. Eats more than half of most meals. Eats 4 servings of protein (meat or dietary products) per day. Occasionally will refuse a meal but will usually take a supplement when offered. OR Is receiving tube feeding or total parenteral nutrition that probably meets most of nutritional needs.
4. Excellent. Eats most of every meal. Never refuses a meal. Usually eats 4 or more servings of meat and dietary products. Occasionally eats between meals. Does not require supplementation.

Friction & shear.

1. Problem. Requires moderate to maximum assistance in moving. Complete lifting without sliding against sheets is impossible. Frequently slides down in bed or chair, requiring frequent repositioning with maximum assistance. Spasticity, contractures, or agitation leads to almost constant friction.
2. Potential problem. Moves feebly or requires minimum assistance. During a move, skin probably slides to some extent against the sheets, chair, restraints, or other devices. Maintains relatively good position in chair or bed most of the time, but occasionally slides down.
3. No apparent problem. Moves in bed and in chair independently and has sufficient muscle strength to lift up completely during move. Maintains good position in bed or chair.

Outcomes: Report date of ICU discharge and hospital discharge and survival status of the patient. If the patient is still in the hospital 84 days after the study date, check the box.
After completing both CRFs on the day of study, all completed forms should be kept in a safe place in the unit in order to be available for outcome registration 84 days after the day of study [7 August 2018].

All forms should be submitted before 18 September 2018.

Appendix 4: List of codes

PRIMARY and SECONDARY DIAGNOSES

Description: The primary and maximally 3 secondary diagnoses (acute or acute on chronic disease) should be recorded for all patients as they best reflect the reason(s) for ICU admission.

100 Neurological:

- 101 Stroke by ischemic or haemorrhagic mechanism (non-traumatic)
- 102 Intracerebral hemorrhage
- 103 Subarachnoid hemorrhage
- 104 Neurologic infection
- 105 Neurologic neoplasm
- 106 Neuromuscular disease
- 107 Dementia
- 108 Seizures
- 109 Polyneuritis and polyradiculoneuritis: includes polyneuritis due to infection, inflammation, toxic, Guillain-Barré syndrome
- 110 Post-anoxic coma
- 111 Delirium tremens
- 112 Spinal cord surgery
- 113 Other

200 Respiratory:

- 201 Exacerbation of chronic pulmonary disease (either obstructive or non obstructive)
- 202 Asthma attack
- 203 Pulmonary embolism
- 204 Pleural effusion
- 205 Mechanical airway obstruction
- 206 Inhalation pneumonitis: induced by gastrointestinal contents, blood, smoke, and/or gases
- 207 Respiratory neoplasm (include larynx and trachea)
- 208 Respiratory arrest
- 209 Pulmonary edema (non-cardiogenic)
- 210 Community-acquired bacterial pneumonia
- 211 Healthcare-associated bacterial pneumonia
- 212 Viral pneumonia
- 213 Fungal pulmonary infection
- 214 Near-drowning
- 215 Other

300 Cardiovascular / vascular:

- 301 Acute myocardial infarction
- 302 Unstable angina
- 303 Cardiac arrest
- 304 Cardiopathy: includes ischemic, valvular, hypertensive, alcoholic and other, non-infectious forms
- 305 Cardiogenic shock
- 306 Congestive heart failure
- 307 Rhythm disturbance
- 308 Perivascular disease
- 309 Hypertension
- 310 Aortic aneurysm
- 311 Dissecting/ruptured aorta
- 312 Elective abdominal aneurysm repair
- 313 Peripheral vascular surgery
- 314 Valvular heart surgery
- 315 CABG
- 316 Peripheral artery bypass graft
- 317 Carotid endarterectomy
- 318 Endocarditis
- 319 Other

400 Renal/genito-urinary tract:
- 401 Acute kidney injury
- 402 Chronic renal failure
- 405 Renal neoplasia
- 406 Non-malignant gynaecological diseases, non-malignant: lesions of ovary, uterus, cervix, vulvae, vagina not due to neoplasia
- 407 Malignant gynaecological diseases
- 408 Urosepsis
- 409 Other

500 Hematological:
- 501 Transfusion reaction
- 502 Neutropenia
- 503 Neutropenic sepsis
- 504 Thrombocytopenia, coagulopathy
- 503 Non-malignant disease (e.g. anaemia, aplastic anaemia, methemoglobinemia, congenital disorders of blood coagulation factors)
- 504 Malignant disease: lymphoma, acute leukaemia and multiple myeloma
- 505 Other

600 Digestive:
- 601 Hepatic failure
- 602 Gastro-intestinal perforation/obstruction/rupture
- 603 Gastro-intestinal bleeding due to varices, ulcer or diverticulitis
- 604 Inflammatory disease (ulcerative colitis, crohn's disease)
- 605 Neoplasia of the upper digestive tract (oesophageal, gastric or duodenal)
- 606 Neoplasia of the lower digestive tract (colon and rectum)
- 607 Pancreatitis
- 608 Other

700 Metabolic:
- 701 Drug overdose, intoxication
- 702 Diabetic ketoacidosis
- 703 Metabolic coma
- 704 Endocrinopathy
- 705 Other

800 Pregnancy-related:
- 801 Eclampsia, preeclampsia
- 802 HELLP syndrome
- 803 Delivery haemorrhage
- 804 Other

900 Trauma & skin:
- 901 Head trauma (isolated)
- 903 Polytrauma, without brain trauma
- 904 Polytrauma, with brain trauma
- 905 Spinal cord injury
- 905 Burn injury
- 907 Skin lesions requiring intensive care, non-traumatic (e.g. toxic epidermal necrolysis)
- 908 Pressure ulcer requiring surgical debridement or extensive wound care
- 909 Severe surgical wound infection
- 910 Other

000 Other diseases

SITE(S) OF SURGERY

Description: For patients undergoing surgery the anatomical site of surgery should be indicated. Up to three surgery sites can be reported on the case report form. Invasive radiological procedures or definitive pacemaker insertions should not be considered as surgical procedures.

000 No surgery in the current hospital stay

100 Neurosurgery:
- 101 Cerebrovascular accident: neurosurgery of intracranial hematoma or other non-traumatic accident (haemorrhage, aneurysm)
- 102 Intracranial tumour: neurosurgery for any type of tumour primary or secondary
- 103 Spinal surgery
- 104 Ear, nose and throat surgery
- 105 Maxillo-facial surgery
- 106 Other

200 Thoracic surgery:
- 201 Pneumonectomy
- 202 Lobectomy
- 203 Pleural surgery: includes all surgery on pleura either for tumour or talcage/abrasion for pneumothorax
- 204 Lung transplantation
- 205 Other

300 Cardiac surgery:
- 301 Valvular, without coronary artery by-pass graft (CABG): surgical treatment of valvulopathies without coronary surgery
- 302 Valvular with CABG: valvular repair with coronary surgery
- 303 CABG without valvular repair
- 304 Other: pericardial effusion, congenital anomaly, ventricular aneurysm, neoplastic disease, vena cava clipping/filter
- 305 Heart transplantation
- 306 Heart & lung transplantation
- 307 Major aortic surgery: includes all surgery on aorta for dissection, atheroma, aneurysm
- 308 Carotid endarterectomy: includes all surgery on the carotid artery
- 309 Other major vascular surgery: includes all surgery on intrathoracic or intraabdominal vessels
- 310 Peripheral vascular surgery: includes all surgery on non-intracranial, non-intrathoracic, non-intraabdominal vessels, either arteries or veins with or without by-pass graft
- 311 Other

400 Renal-urinary tract:
- 401 Renal surgery
- 402 Urologic surgery

600 Digestive:
- 601 Upper gastro-intestinal surgery (up to and including the jejunum)
- 602 Lower gastro-intestinal surgery
- 603 Biliary tract: surgery of gallbladder and/or biliary tract
- 604 Liver: partial hepatectomy, portal-systemic shunt surgery
- 605 Liver transplantation
- 606 Pancreas

700 Metabolic:
- 701 Endocrine surgery (thyroid, adrenal, pancreas etc.)

800 Obstetric/gynaecologic:
- 801 Obstetric surgery: Caesarean section, surgery for ectopic pregnancy, peri- or post-partum haemorrhage, intra-uterine death
- 802 Gynaecological surgery: surgery of uterus, ovaries, cervix, genitalia

900 Trauma:
- 901 Brain: surgery for subdural, epidural, intracerebral haematoma or skull fracture
- 902 Thorax: surgery of intra-thoracic organs (cardiac, respiratory or digestive tract) and vessels
- 903 Abdomen
- 904 Limb
- 905 Multiple
- 906 Other

DEVICES

Description: For patients in which devices are used the type of device should be indicated. Report all devices used.

100 Respiratory tract:
- 101 Oral endotracheal tube
- 102 Nasal endotracheal tube
- 103 Tracheostomy with cannula
- 104 Nasal oxygen cannula
- 105 Mask for non-invasive ventilation
- 106 Oxygen mask
- 107 Other

200 Peripheral intravascular catheters:
- 201 Right hand
- 202 Left hand
- 203 Right arm
- 204 Left arm
- 205 Right foot
- 206 Left foot
- 207 Other location

300 Central venous catheters:
- 301 Internal jugular vein right
- 302 Internal jugular vein left
- 303 Subclavian vein right
- 304 Subclavian vein left
- 305 Femoral vein right
- 306 Femoral vein left
- 307 Other location

400 Arterial line:
- 401 Radial artery, right
- 402 Radial artery, left
- 403 Femoral artery, right
- 404 Femoral artery, left
- 405 Other location

500 Urinary tract catheter:
- 501 Urethral
- 502 Suprapubic
- 503 Other

600 Feeding tubes:
- 601 Orogastric
- 602 Nasogastric
- 603 Percutane Endoscopic Gastrostomy (PEG)
- 604 Duodenal / jejunal

000 Other devices

PRESSURE INJURY STAGES

Description: Pressure injury stages definitions used are published as National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and Treatment of Pressure Ulcers: Quick Reference Guide. Emily Haesler (Ed.). Cambridge Media: Osborne Park, Western Australia; 2014.
The case report form includes a figure to report pressure injury development at different body sites. Each site is marked by two selection boxes. Use these boxes next to each corresponding body site to indicate :

- the category/stage of pressure injuries (first box, codes 1/2/3/4/U/S)
- whether the injury was present upon ICU admission (check second box if ICU acquired)

Box 1: category/stage of pressure injuries (codes 1/2/3/4/U/S)

1 - Category/Stage I: Non-blanchable erythema
Intact skin with non-blanchable redness of a localized area usually over a bony prominence. Darkly pigmented skin may not have visible blanching; its color may differ from the surrounding area. The area may be painful, firm, soft, warmer or cooler as compared to adjacent tissue. Category I/Stage I may be difficult to detect in individuals with dark skin tones. May indicate “at risk” individuals (a heralding sign of risk).

2 - Category/Stage II: Partial thickness skin loss
Partial thickness loss of dermis presenting as a shallow open ulcer with a red pink wound bed, without slough. May also present as an intact or open/ruptured serum-filled filled blister. Presents as a shiny or dry shallow ulcer without slough or bruising*. This Category/Stage should not be used to describe skin tears, tape burns, perineal dermatitis, maceration or excoriation. *Bruising indicates deep tissue injury.

3 – Category/Stage III: Full thickness skin loss
Full thickness tissue loss. Subcutaneous fat may be visible but bone, tendon or muscle are *not* exposed. Slough may be present but does not obscure the depth of tissue loss. *May* include undermining and tunneling. The depth of a Category/Stage III pressure ulcer varies by anatomical location. The bridge of the nose, ear, occiput and malleolus do not have subcutaneous tissue and Category/Stage III ulcers can be shallow. In contrast, areas of significant adiposity can develop extremely deep Category/Stage III pressure ulcers.
Bone/tendon is not visible or directly palpable.

4 - Category/Stage IV: Full thickness tissue loss
Full thickness tissue loss with exposed bone, tendon or muscle. Slough or eschar may be present on some parts of the wound bed. Often include undermining and tunneling. The depth of a Category/Stage IV pressure ulcer varies by anatomical location. The bridge of the nose, ear, occiput and malleolus do not have (adipose) subcutaneous tissue and these ulcers can be shallow. Category/Stage IV ulcers can extend into muscle and/or supporting structures (e.g., fascia, tendon or joint capsule) making osteomyelitis possible. Exposed bone/muscle is visible or directly palpable.

U - Unstageable/ Unclassified: Full thickness skin or tissue loss –: depth unknown
Full thickness tissue loss in which the base of the ulcer is covered by slough (yellow, tan, gray, green or brown) and/or eschar (tan, brown or black) in the wound bed. Until enough slough and/or eschar are removed to expose the base of the wound, and therefore Category/Stage cannot be determined. Stable (dry, adherent, intact without erythema or fluctuance) eschar on the heels serves as “the body’s natural (biological) cover” and should not be removed.

S - Suspected Deep Tissue Injury: depth unknown
Purple or maroon localized area of discolored intact skin or blood-filled blister due to damage of underlying soft tissue from pressure and/or shear. The area may be preceded by tissue that is painful, firm, mushy, boggy, warmer or cooler as compared to adjacent tissue. Deep tissue injury may be difficult to detect in individuals with dark skin tones. Evolution may include a thin blister over a dark wound bed. The wound may further evolve and become covered by thin eschar. Evolution may be rapid exposing additional layers of tissue even with optimal treatment.

Box 2: ulcer present upon ICU admission
Check the second box if ICU acquired.
Please refer to the instructions form for an exemplary pressure ulcer identification chart.

PREVENTIVE MEASURES
Description: All measures **used specifically in order to prevent pressure ulcers** on the study day should be reported. Measures listed which are commonly used on the ward but not specifically in order to prevent pressure ulcers should NOT be scored (e.g. use of body moisturizing products, massage).

100 Low-tech (non-powered) support surfaces
- 101 Standard foam mattresses
- 102 Alternative foam mattresses/overlays (e.g. convoluted foam, cubed foam)
- 103 Gel-filled mattresses/overlays
- 104 Fibre-filled mattresses/overlays
- 105 Air-filled mattresses/overlays
- 106 Water-filled mattresses/overlays
- 107 Bead-filled mattresses/overlays
- 108 Foam cushions
- 109 Non-foam cushions (except ring cushions)
- 110 Ring cushions
- 111 Sheepskins

200 High-tech support surfaces
- 201 Alternating-pressure mattresses/overlays: patient lies on air-filled sacs which sequentially inflate and deflate and relieve pressure at different anatomical sites for short periods; may incorporate a pressure sensor.
- 202 Air-fluidised beds: warmed air circulated through fine ceramic beads covered by a permeable sheet; allows support over a larger contact area.
- 203 Low-air-loss beds: patients are supported on a series of air sacs through which warmed air passes.
- 204 Continuous bedside pressure mapping devices indicating excessive pressures.

300 Various
- 301 Turning beds/frames: these devices work by either aiding manual repositioning of the patient, or by automatic motor-driven turning and tilting. They may have a static or an alternating support surface in conjunction with the frame.
- 302 Patient repositioning: patient is repositioned in the bed and / or chair within predefined fixed timeframes.
- 303 Ice friction
- 304 Blow-drying
- 305 Bolstering of the heels
- 306 Floating heels
- 307 Hydrating body moisturizers
- 308 Soft silicone multi-layered foam dressing

000 Other preventive measures

SUPPLEMENTARY APPENDIX B: Tables

Supplementary Table 1- Preventative measures

Supplementary Table 2 - Primary diagnosis

Supplementary Table 3: Primary trigger for extra preventative measures (90 units responded)

Supplementary Table 1- Preventative measures

Preventive measures	***Not used***	***Available***	*Used in all patients*	*Data not available*
Standard foam mattresses	47.9% (n. 45)	43.6% (n. 41)	4.3% (n. 4)	4.3% (n. 4)
Alternative foam mattresses or overlays	77.7% (n. 73)	17% (n. 16)	1.1% (n. 1)	4.3% (n. 4)
Gel filled mattresses	92.6% (n.87)	3.2 % (n. 3)		4.3% (n. 4)
Fibre filled mattresses	94.7% (n. 89)	1.1% (n. 1)		4.3% (n. 4)
Air filled mattresses	47.9% (n. 45)	27.7% (n. 26)	20.2% (n. 19)	4.3% (n. 4)
Water filled mattresses	95.7% (n.90)			4.3% (n. 4)
Bead filled mattresses	93.6% (n. 88)	2.1% (n. 2.2)		4.3% (n. 4)
Foam cushions	45.7% (n.43)	47.9% (n.45)	2.1% (n.2)	4.3% (n. 4)
Non-foam cushions	77.7% (n.73)	17% (n.16)	1.1% (n.1)	4.3% (n. 4)
Ring cushions	91.5% (n.86)	1.1% (n.1)	3.2% (n.3)	4.3% (n. 4)
Sheepskins	89.4% (n.84)	4.3% (n.4)	2.1% (n.2)	4.3% (n. 4)
Alternating pressure mattresses	16 % (n.15)	43.6% (n.41)	36.2% (n.34)	4.3% (n. 4)
Air fluidised beds	88.3% (n. 83)	6.4% (n. 6)	1.1% (n. 1)	4.3% (n. 4)
Low air loss beds	84% (n.79)	10.8% (n.10)	1.1% (n.1)	4.3% (n. 4)
Continuous bedside pressure mapping	91.5% (n.86)	4.3 % (n.4)		4.3% (n. 4)
Turning beds	47.9% (n.45)	42.8% (n.40)	5.3% (n.5)	4.3% (n. 4)
Patient repositioning	3.2% (3)	23.4% (22)	69.1% (65)	4.3% (n. 4)
Ice friction	95.7 % (n.90)			4.3% (n. 4)
Blow drying	94.7% (n.89)	1.1% (n.1)		4.3% (n. 4)
Bolstering of the heels	47.9% (n. 45)	43.6% (n. 41)	4.3% (n. 4)	4.3% (n. 4)
Floating heels	38.3% (n.36)	52.1% (n.49)	5.3% (n.5)	4.3% (n. 4)
Hydrating body moisturizers	24.5% (n.23)	60.6% (n. 57.4)	1.1% (n. 1)	4.3% (n. 4)
Soft silicone multi layered foam dressing	37.2% (n.35)	57.4% (n.54)	1.1% (n.1)	4.3% (n. 4)
Other preventive measures	63.8% (n.60)	31.9% (n.30)		4.3% (n. 4)

Supplementary Table 2 - Primary diagnosis

Primary diagnosis	n	frequency (%)
Gastro-intestinal perforation/obstruction/rupture	97	7.39
Community-acquired bacterial pneumonia	84	6.4
Cardiac arrest	66	5.03
Other respiratory diseases	45	3.43
Other digestive tract diseases	43	3.28
Other diseases	38	2.9
Other neurological diseases	35	2.67
Other trauma- and skin-related diseases	35	2.67
Pancreatitis	32	2.44
Healthcare-associated bacterial pneumonia	31	2.36
Valvular heart surgery	31	2.36
CABG	31	2.36
Drug overdose, intoxication	31	2.36
Polytrauma, without brain trauma	31	2.36
Seizures	30	2.29
Subarachnoid hemorrhage	29	2.21
Intracerebral hemorrhage	27	2.06
Other (cardio)vascular diseases	27	2.06
Acute kidney injury	26	1.98
Hepatic failure	23	1.75
Urosepsis	22	1.68
Neoplasm of the upper digestive tract	21	1.6
Stroke by ischemic or hemorrhagic mechanism	19	1.45
Exacerbation of chronic pulmonary disease	19	1.45
Neoplasm of the lower digestive tract	19	1.45
Gastro-intestinal bleeding due to varices, ulcer or diverticulitis	18	1.37
Neurologic infection	17	1.3
Acute myocardial infarction	17	1.3

Head trauma (isolated)	17	1.3
Polytrauma, with brain trauma	17	1.3
Spinal cord injury	17	1.3
Aortic aneurysm	16	1.22
Diabetic ketoacidosis	16	1.22
Burn injury	14	1.07
Inhalation pneumonia	12	0.91
Other metabolic diseases	12	0.91
Mechanical airway obstruction	11	0.84
Malignant gynecological diseases	11	0.84
Spinal cord surgery	10	0.76
Pulmonary embolism	10	0.76
Cardiopathy	10	0.76
Polyneuritis and polyradiculoneuritis	9	0.69
Respiratory neoplasm	9	0.69
Malignant hematological disease	9	0.69
Inflammatory disease of the digestive tract	9	0.69
Skin lesions requiring intensive care, non-traumatic	9	0.69
Respiratory arrest	8	0.61
Rhythm disturbance	8	0.61
Dissecting/ruptured aorta	8	0.61
Other renal/Genito-urinary tract diseases	8	0.61
Pulmonary edema	7	0.53
Viral pneumonia	7	0.53
Elective abdominal aneurysma repair	7	0.53
Chronic renal failure	7	0.53
Neuromuscular disease	6	0.46
Pleural effusion	6	0.46
Cardiogenic shock	6	0.46
Neutropenic sepsis	6	0.46
Peripheral vascular surgery	5	0.38
Endocrinopathy	5	0.38
Asthma attack	4	0.3
Congestive heart failure	4	0.3

Peripheral artery bypass graft	4	0.3
Renal neoplasia	4	0.3
Neurologic neoplasm	3	0.23
Unstable angina	3	0.23
Hypertension	3	0.23
Endocarditis	3	0.23
Non-malignant gynaecological diseases	3	0.23
Thrombocytopenia, coagulopathy	3	0.23
Non-malignant haematological disease	3	0.23
Other hematological diseases	3	0.23
Metabolic coma	3	0.23
Other pregnancy-related diseases	2	0.15
Pressure injury requiring surgical debridement or extensive wound care	2	0.15
Severe surgical wound infection	2	0.15
Fungal pulmonary infection	1	0.08
Near-drowning	1	0.08
Perivascular disease	1	0.08
Carotid endarterectomy	1	0.08
Transfusion reaction	1	0.08
Eclampsia, preeclampsia	1	0.08
Delivery hemorrhage	1	0.08

Supplementary Table 3: Primary trigger for extra preventative measures (90 units responded)

Trigger	Frequency	% of sites reporting
High risk profile as indicated by a risk assessment scale	69	76.6
Mechanical ventilation	4	4.4
Anticipated ICU stay>3days	1	1.1
Coma/sedation	2	2.2
Malnutrition	1	1.1
Obesity	1	1.1
Presence of pressure injury	7	7.7
Other	5	5.5
Total	90	

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	5-6
Methods			
Study design	4	Present key elements of study design early in the paper	7-9
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7-10
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	7-10
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-10
Bias	9	Describe any efforts to address potential sources of bias	*N/A*
Study size	10	Explain how the study size was arrived at	N/A
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	N/A
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	8-9
		(*c*) Explain how missing data were addressed	8-9
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9 et seq.
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1, 26 et seq Supplementary Table 2
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	9-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-10 Mixed model is in Table 3, page 31
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	See above
Discussion			
Key results	18	Summarise key results with reference to study objectives	10-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	12-14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	21

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.