Pressure ulcer risk factors and prevention in ICU

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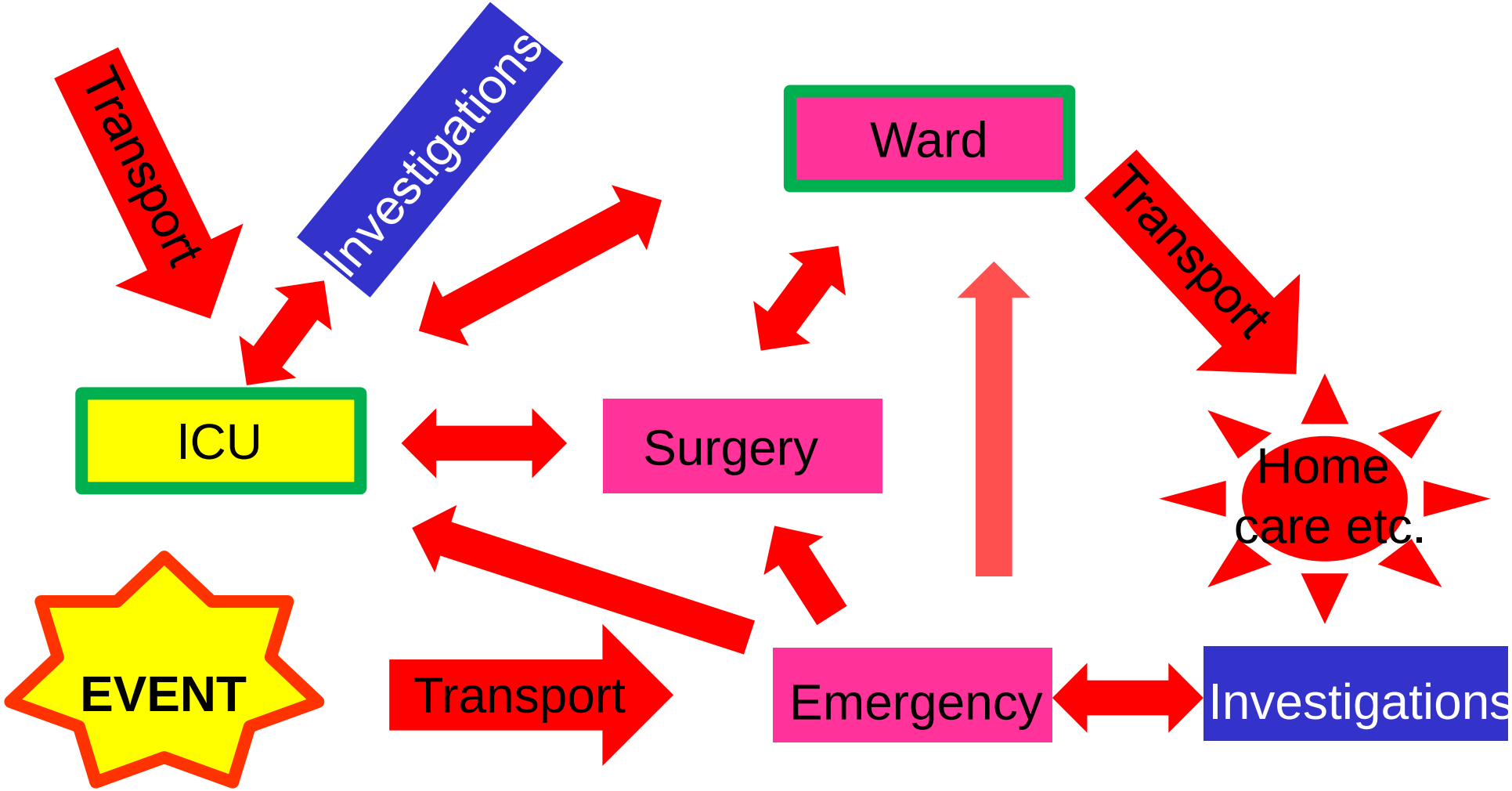
BRNO 2019

Declaration of Financial Interests

Speaker Name: Maarit Ahtiala

I have no financial interests or relationships to disclose with regard to the subject matter of this presentation.

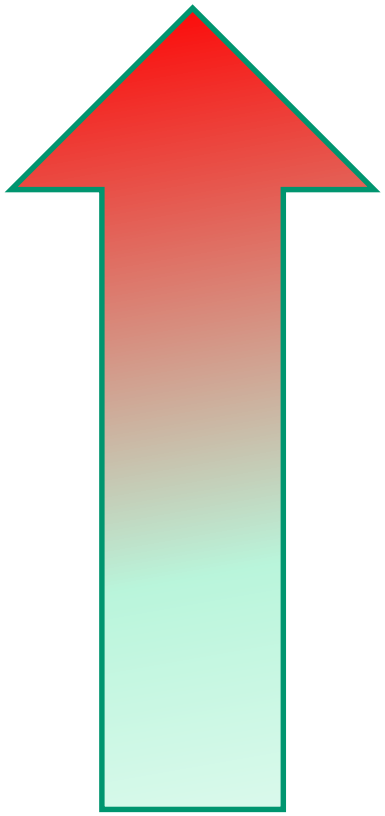
The patients treatment chain



Pressure ulcers in ICUs over time

Reference	PU incidence*/ prevalence (%)	Scale
Ahtiala et al 2018	4*	mJ/C
VanGilder et al 2017	3-9*	Braden
Becker et al 2017	18*	Braden
Bly et al 2015	31*	No scale
Ahtiala et al 2010	11*	mJ/C
Bours et al 2001	29	Braden
Takala et al 1996	54*	Norton
Inman et al 1993	76*	Norton

Increased severity of patients. New patient groups



Surveys by VanGilder et al 2008, 2009

- ~11,000 patients in more than 500 ICUs
- PU incidence varied between 8.8 - 12.3 %

VanGilder et al. OWM 2008, 2009

General pressure ulcer risk indicators

Main domains

- Mobility/activity
- Perfusion (including diabetes)
- Skin/pressure ulcer status particularly relating to stage/grade 1
- "Overall there is no single factor which can explain pressure ulcer risk, rather a complex interplay of factors which increase the probability of pressure ulcer development." Coleman et al 2013.

Other important domains

- Skin moisture
- Age
- Haematological measures
- Nutrition
- General health status
- *Body temperature* and *immunity* may be important but require further confirmatory research. There is limited evidence that either race or gender is important.

Coleman et al. Int J Nurs Stud 2013

Risk factors for PU development in ICU

Tayyib et al 2013

- Older age
- Length of stay (LOS ≥ 3 days)
- Norepinephrine infusion
- Prolonged immobility
- *Conclusions:*
  - *Risk factors for potential pressure ulcer development are inconsistent*
  - *No consistent evidence to demonstrate any scale to be better or more effective than another*

Tayyib et al. Nurs Educ Pract 2013 ,
Tayyib et al. Systematic review ongoing 2018

- *Becker et al 2017* (N=332)
  - Severity of the patient's condition - Braden score
  - Length of lack of nutrition
  - MV duration
  - Acute renal failure, pneumonia, and the need for vasoactive drugs
- *Bly et al 2016* (N=345)
  - Any transport off the unit
  - Number of days to mattress change
  - Systolic blood pressure less than 90mmHg
  - Use of more than 1 vasopressor
  - History of pulmonary disease
  - Presence of a feeding tube

Risk factors for PU development in ICU

43 significant risk factors were grouped into 6 broad categories

1. Patient characteristics
2. Comorbidities
3. Intrinsic factors
4. Iartogenic/Care factors
5. PU risk assessment scales
6. Severity of illness/Mortality risk scales (APACHE II, SAPS II, SOFA)

Significant factors in multivariate analysis

- Age (1),
- ICU length of admission (1),
- Diabetes mellitus (2),
- Cardiovascular disease (2),
- Hypotension (3),
- Prolonged mechanical ventilation (4),
- Vasopressor agents (4).

Cox OWM 2017

Patient demographics Turku ICU

Gender	PU+	PU-	SUM
Female	136 (5.9)	2171	2307
Male	323 (7.9)	3746	4069
SUM	459	5917	6376

p=0.0029, χ2-test for male PU predominance

Age	PU+	PU-	All
< 40	52 (6.6)	739	791
40-54	70 (6.6)	986	1056
55-70	170 (6.6)	2401	2571
> 70	139 (7.5)	1718	1857
Total	431	5844	6275

p=0.0682, χ2-test for increasing age

PUs and LOS in ICU

LOS	PU Yes N (%)	PU No (N)	N
< 3	52 **(2.4)**	2120	2172
≥3*	230 **(24,5)**	710	940
Total	282 **(9.1)**	2830	3112

Ahtiala et al 2018 OWM

Hemoglobin concentration and PU risk

Hemoglobin	Pressure ulcer		All
(g/l)	No, N	Yes*, N (PU incidence, %)	N
< 75	181	29 **(13.8)**	210
75 - 100	1054	117 **(10.0)**	1171
> 100	1679	136 **(7.5)**	1815
Total N (%)	2914	282 **(8.8)**	3196

Nixon et al 2006
Nijs et al 2008
Beattie et al 2009
Ahtiala et al 2018

* P< 0.001

SOFA and PU development

SOFA-score	PU Yes* N (%)	PU No*, N	N
<6	55 (18.0)	260	305
6-11	186 (20.4)	724	910
≥12	63 (29.2)	153	216
Total	304	1137	1441

ICU LOS > 3 days, * P< 0.001

- SOFA score
  - Respiratory: PaO2/FiO2
  - Renal: creatinine (µmol/l)
  - Hepatic: bilirubin (µmol/l)
  - Cardiovascular: Hypotension
  - Hematologic: platelet count
  - Neurologic: Glasgow Coma Scale score

Manzano et al 2010
Ahtiala et al 2018

Studies on the validity of the scales in ICU

Seongsook et al 2004

- A comparison of the J/C, Braden, and Douglas Scales included 112 ICU patients.
- They found the specificity (61%) and positive predictive value (51 %) of the J/C scale to be better than those of Braden (26 %; 37 %) and Douglas (18 %; 34 %) scales, respectively.

Shahin et al 2007

- A comparison of the J/C, Braden, Douglas, Waterlow, and Norton scales included 1150 ICU patients in 7 studies.
- Sensitivity and specificity, which indicate the ability of the scale to differentiate correctly between patients at risk and those not at risk, are unsatisfactory for all scales.

Seongsook et al. Int J Nurs Stud 2004, Shahin et al World Crit Care Nurs 2007

Modified Jackson / Cubbin risk scale

- Each subcategory is rated linearly as 1 (high risk) and 4 (low risk)
- The maximum score is 48 (low risk) and the minimum score 9 points signifying high risk
Cut-off point is 29.

1. **AGE**
2. **WEIGHT/TISSUE VIABILITY**
3. **PAST MEDICAL HISTORY**
4. **GENERAL SKIN CONDITION**
5. **MENTAL CONDITION**
6. **MOBILITY**
7. **HEMODYNAMICS**
8. **RESPIRATION**
9. **OXYGEN REQUIREMENTS**
10. **NUTRITION**
11. **INCONTINENCE**
12. **HYGIENE**

Deduct 1 point, if patient has been in surgery or transported to CT, MRI **or HBO** during the last 48h.
Deduct 1 point, if patient has required blood or clotting factors **during last 24h.**
Deduct 1 point, if patient has hypothermia **of 35ºC or under (core temperature).**

Ahtiala et al. JICS 2014

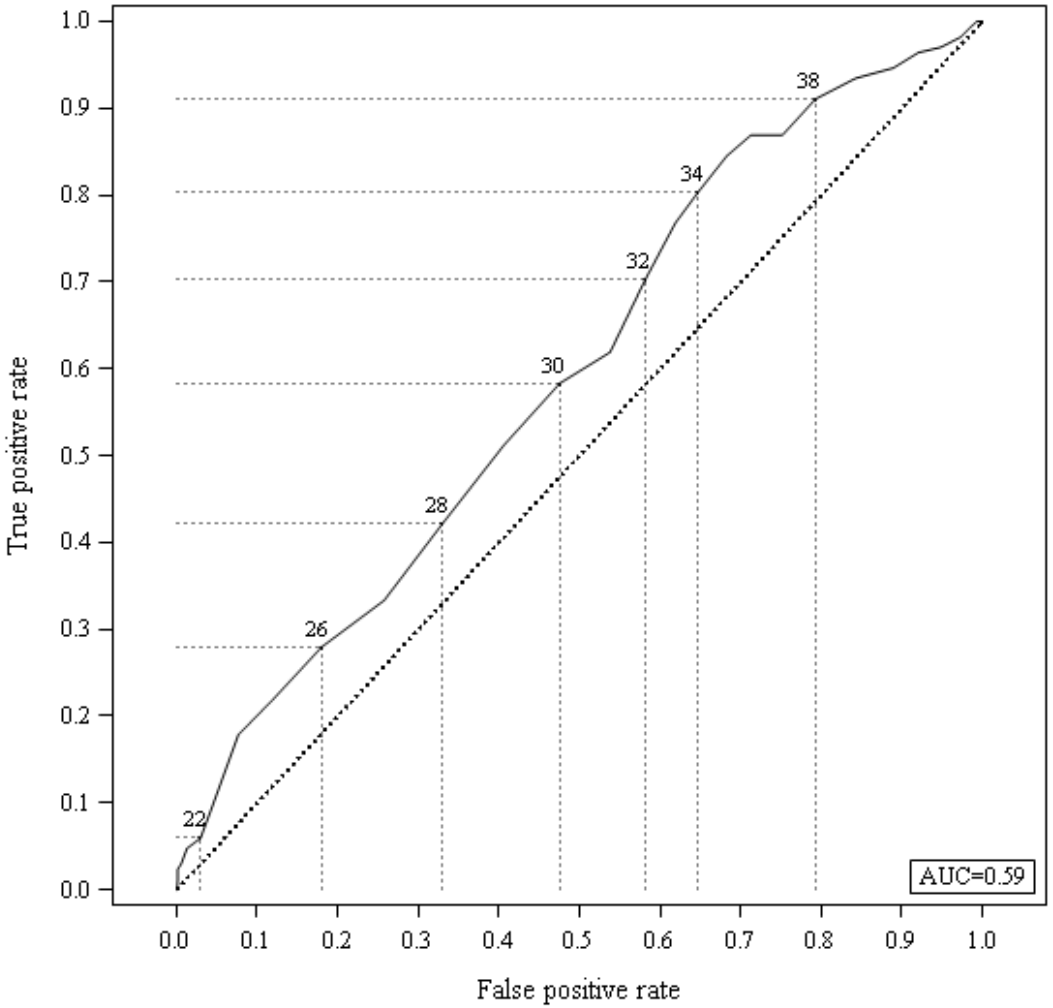
mJ/C score as PU risk indicator in ICU

mJ/C score	PUs present-on- admission N (%)	ICU acquired PUs N (%)	No PUs N (%)
≤29	236 (59.1)*	232 (64.1)*	3380 (47.7)*
≥30	163 (40.9)	130 (35.9)	3707(52.3)
Total	399 (100)	362 (100)	7087 (100)

* $p < 0.0001$

Validity of the modified Jackson/Cubbin risk scale

ROC-curve for mJ/C



Sensitivity specificity,

PPV and NPV for mJ/C scale

- The sensitivity 58.3
- The specificity 52.4
- The positive predictive value (PPV) was 12.8
- The negative predictive value (NPV) was 91.3

Ahtiala et al 2018 EWMA Journal

Year	Total number of patients	PU incidence % (N)	Proportion of patients with mJ/C score ≤ 29#	SOFA score& mean (SD)
2010	1629	11.1 (181)	49.6 %	6.9 (3.2)
2011	1633	6.2 (101)	48.8 %	6.8 (3.2)
2012	1637	6.6 (108)	50.1 %	7.0 (3.2)
2013	1683	4.4 (74)	51.5 %	7.2 (3.3)
2014	1689	3.4 (58)	52.0 %	7.1 (3.1)
2015	1694	3.7 (62)	50.2 %	7.4 (3.2)
Overall	**9965**	**5.9 (584)**	**50.4 %**	**7.1 (3.2)**

Ahtiala et al. 2019 submitted

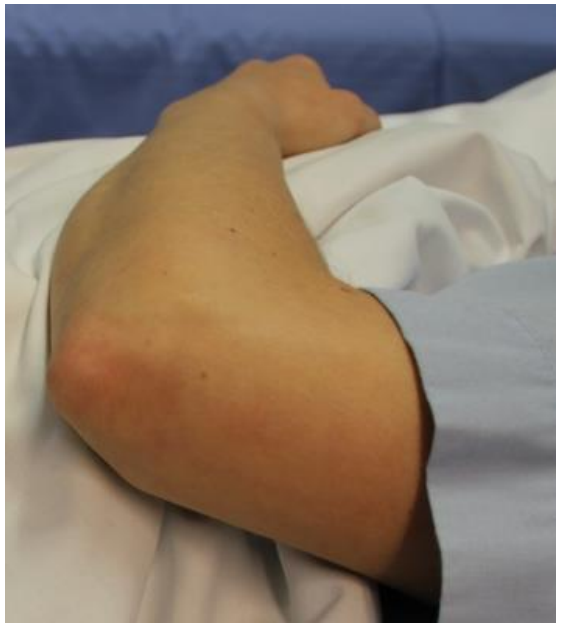
Diagnostic group	PUs present-on-admission (Prevalence %)		ICU acquired PUs (Incidence %)		No PUs		All (Distribution %)	
	2011 - 2013	2014 - 2015	2011 - 2013	2014-2015	2011-2013	2014-2015	2011-2013	2014-2015
Infections including sepsis and DIC&	20 (13.0)	18 (13.5)	*21 (13.6)*	7 (5.3)	113	108	154 (3.1)	133 (3.9)
Heart failure	4 (7.2)	3 (6.7)	*6 (10.9)*	4 (8.8)	45	38	55 (1.1)	45 (1.3)
Abdominal diseases	9 (3.6)	24 (11.5)	*25 (10.1)*	12 (5.8)	214	172	248 (5.0)	208 (6.1)
Pulmonary disturbances	45 (11.9)	28 (8.8)	*38 (10.0)*	15 (5.6)	296	225	379 (7.7)	268 (7.9)
Pulmonary and abdominal traumas	8 (6.9)	5 (10.5)	*11 (9.5)*	2 (3.5)	97	50	116 (2.3)	57 (1.7)
Resuscitation	11 (6.9)	11 (7.2)	*11 (6.9)*	5 (3.3)	138	137	160 (3.2)	153 (4.5)
Heart diseases other	13 (1.8)	17 (3.5)	*30 (4.1)*	13 (2.7)	688	449	731 (14.8)	479 (14.2)
Ischemic heart disease & BP	10 (1.6)	7 (1.5)	*18 (2.9)*	10 (2.2)	588	443	616 (13.8)	460 (13.6)

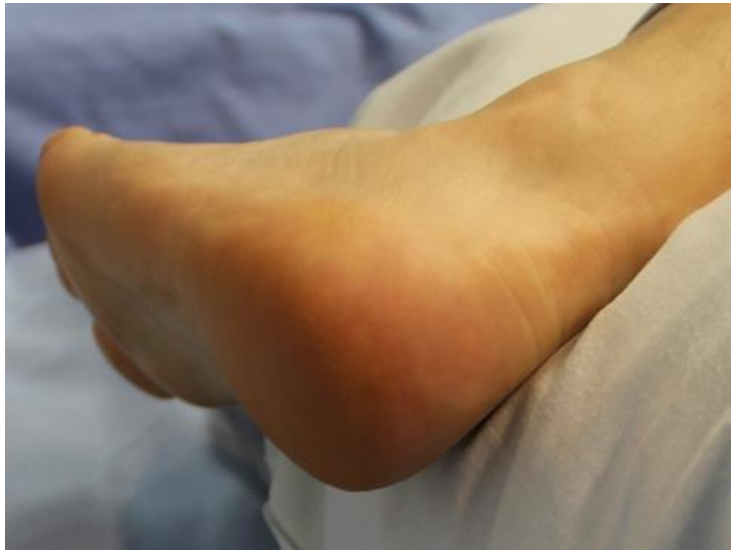
Ahtiala et al. Wounds Infternational 2018, Vol 9 Issue 1.

Prone position is a very high risk for PUs

Some practical prevention methods

Skin/tissue assessment and skin care





Incontinence control

- *Skin assessment frequently*

  -skin protectors, wound care products

  -modern diapers

  -urinary catheter

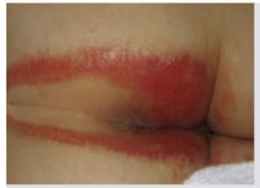
  -faecal management system

GLOBIAD

Ghent Global IAD Categorisation Tool

Category 1: Persistent redness

1A - Persistent redness without clinical signs of infection



Critical criterion

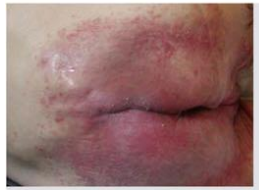
- Persistent redness
  A variety of tones of redness may be present.
  Patients with darker skin tones, the skin may be paler or darker than normal, or purple in colour.

Additional criteria

- Marked areas or discolouration from a previous (healed) skin defect
- Shiny appearance of the skin
- Macerated skin
- Intact vesicles and/or bullae
- Skin may feel tense or swollen at palpation
- Burning, tingling, itching or pain

1A

1B - Persistent redness with clinical signs of infection



Critical criteria

- Persistent redness
  A variety of tones of redness may be present. Patients with darker skin tones, the skin may be paler or darker than normal, or purple in colour.
- Signs of infection
  Such as white scaling of the skin (suggesting a fungal infection) or satellite lesions (pustules surrounding the lesion, suggesting a Candida albicans fungal infection).

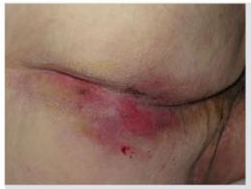
Additional criteria

- Marked areas or discolouration from a previous (healed) skin defect
- Shiny appearance of the skin
- Macerated skin
- Intact vesicles and/or bullae
- The skin may feel tense or swollen at palpation
- Burning, tingling, itching or pain

1B

Category 2: Skin loss

2A - Skin loss without clinical signs of infection



Critical criterion

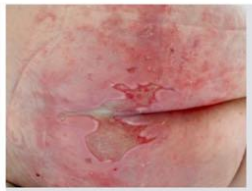
- Skin loss
  Skin loss may present as skin erosion (may result from damaged/eroded vesicles or bullae), denudation or excoriation.
  The skin damage pattern may be diffuse.

Additional criteria

- Persistent redness
  A variety of tones of redness may be present. Patients with darker skin tones, the skin may be paler or darker than normal, or purple in colour
- Marked areas or discolouration from a previous (healed) skin defect
- Shiny appearance of the skin
- Macerated skin
- Intact vesicles and/or bullae
- Skin may feel tense or swollen at palpation
- Burning, tingling, itching or pain

2A

2B - Skin loss with clinical signs of infection



Critical criteria

- Skin loss
  Skin loss may present as skin erosion (may result from damaged/eroded vesicles or bullae), denudation or excoriation.
  The skin damage pattern may be diffuse.
- Signs of infection
  Such as white scaling of the skin (suggesting a fungal infection) or satellite lesions (pustules surrounding the lesion, suggesting a Candida albicans fungal infection), slough visible in the wound bed (yellow/brown/greyish), green appearance within the wound bed (suggesting a bacterial infection with Pseudomonas aeruginosa), excessive exudate levels, purulent exudate (pus) or a shiny appearance of the wound bed.

Additional criteria

- Persistent redness
  A variety of tones of redness may be present. Patients with darker skin tones, the skin may be paler or darker than normal, or purple in colour
- Marked areas or discolouration from a previous (healed) skin defect
- Shiny appearance of the skin
- Macerated skin
- Intact vesicles and/or bullae
- Skin may feel tense or swollen at palpation
- Burning, tingling, itching or pain

2B

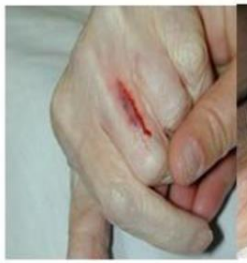
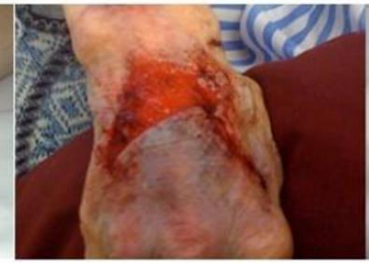
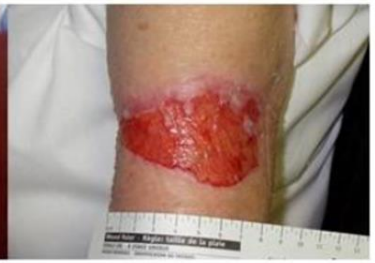
SKINT skin integrity research group
www.skintghent.com

Beeckman D, Van den Bussche K, Alves P, Beele H, Ciprandi G, Coyer F, de Groot T, De Meyer D, Dunk AM, Fourie A, García-Molina P, Gray M, Iblasi A, Jelnes R, Johansen E, Karadağ A, LeBlanc K, Kis Dadara Z, Long MA, Meaume S, Pokorna A, Romanelli M, Ruppert S, Schoonhoven L, Smet S, Smith C, Steininger A, Stockmayr M, Van Damme N, Voegeli D, Van Hecke A, Verhaeghe S, Woo K & Kottner J. The Ghent Global IAD Categorisation Tool (GLOBIAD). Skin Integrity Research Group- Ghent University 2017.

University Centre for Nursing and Midwifery
GHENT UNIVERSITY

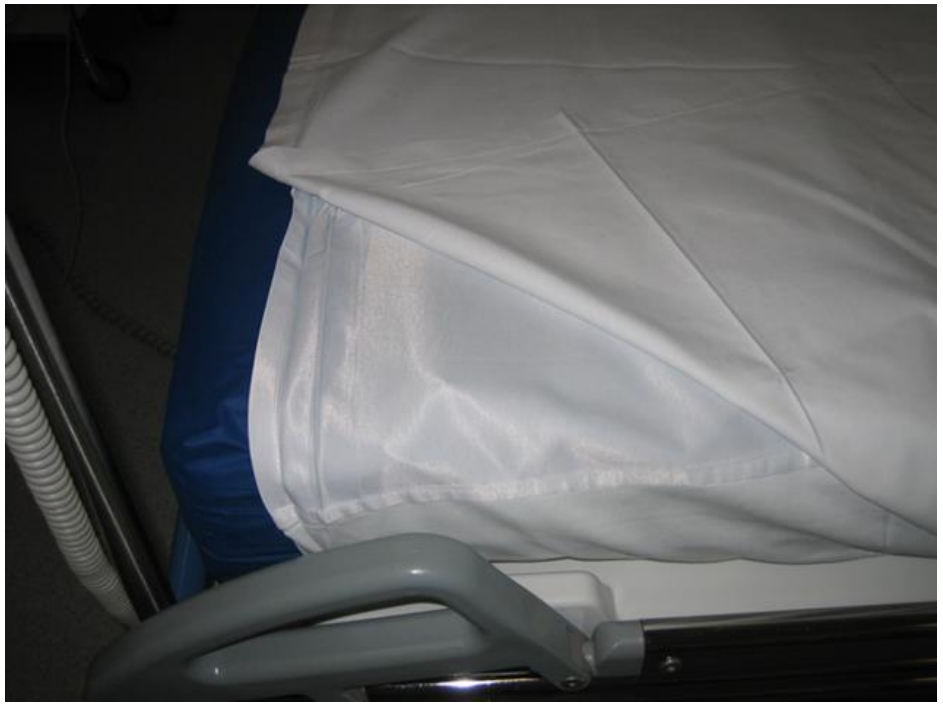
Skin Tear Classification

ISTAP

Type 1: No Skin Loss	Type 2: Partial Flap Loss	Type 3: Total Flap Loss
		
Linear or Flap* Tear which can be repositioned to cover the wound bed	Partial Flap Loss which cannot be repositioned to cover the wound bed	Total Flap Loss exposing entire wound bed

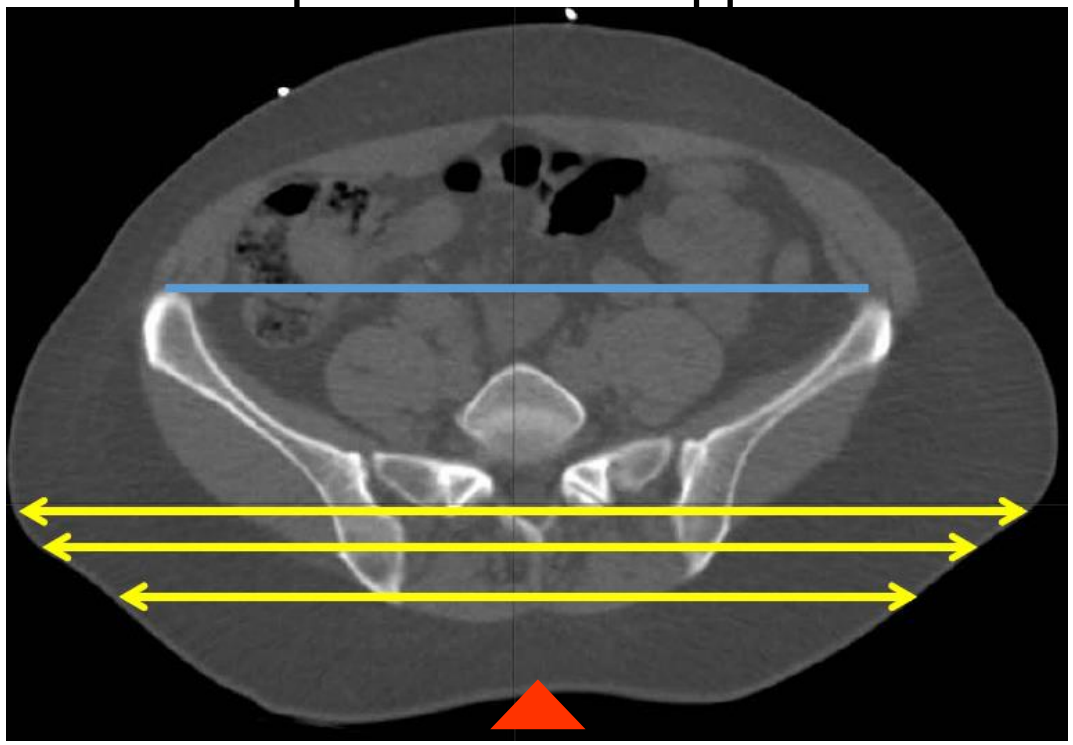
** A flap in skin tears is defined as a portion of the skin (epidermis/dermis) that is unintentionally separated (partially or fully) from its original place due to shear, friction, and/or blunt force. This concept is not to be confused with tissue that is intentionally detached from its place of origin for therapeutic use e.g. surgical skin grafting.*

Support surface according to PU risk

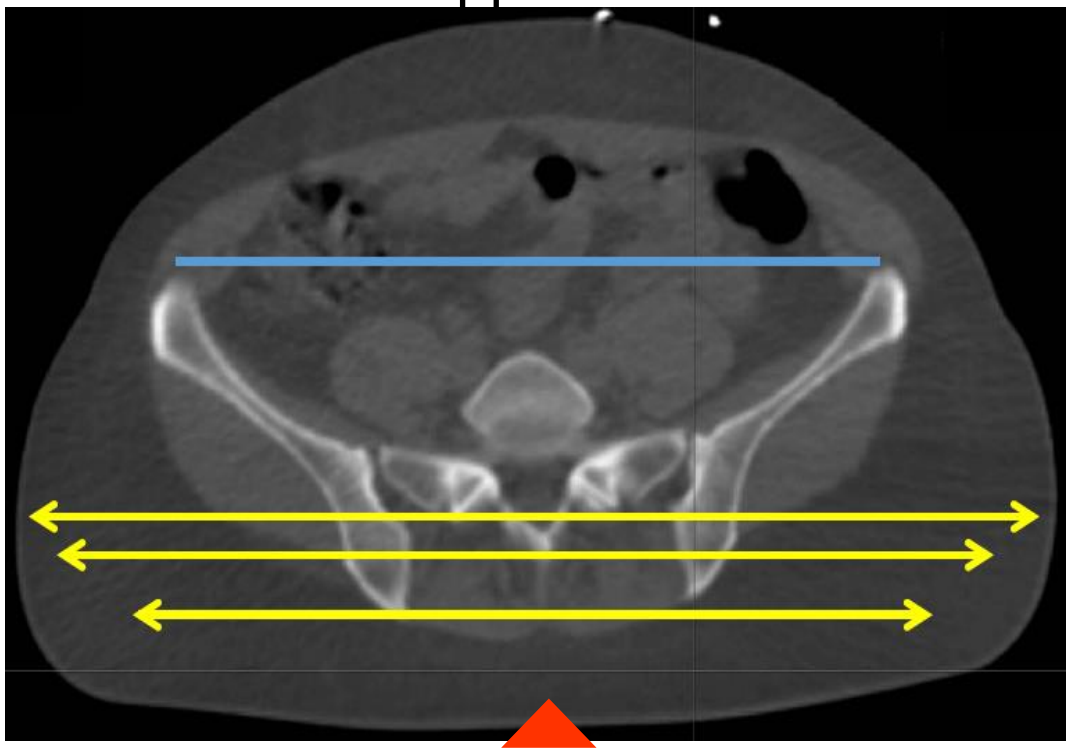


The effect of mattress type on the deep tissue strain due to the conformation change of the body

Minimum pressure air support surface



Foam support surface

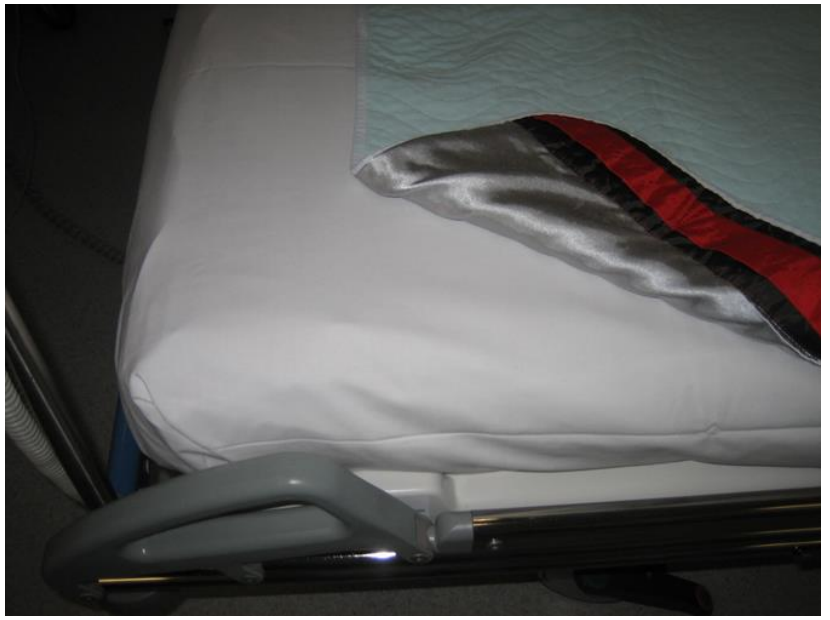


Tissue flattening on foam compared to minimum pressure air mattress (MPA) is here 3.4, 10.4, and 25.2% from top down, respectively. The range is from 1 to 26% depending on individual characteristics.

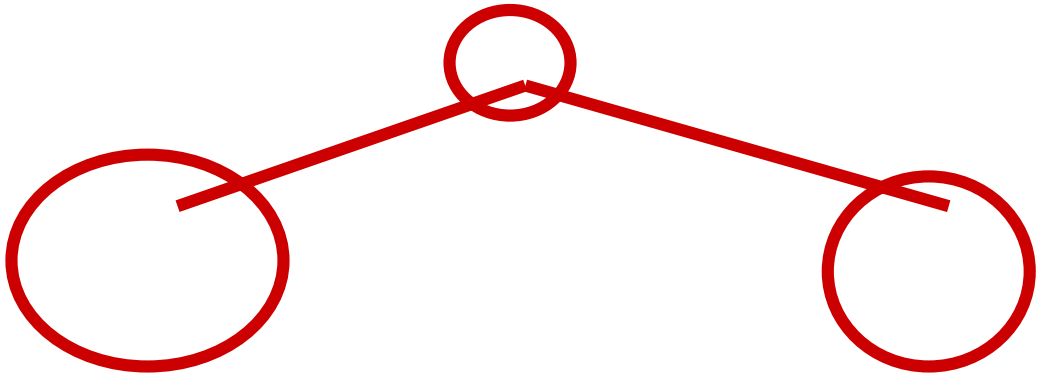
$p < 0.0001$

Soppi et al. Submitted 2019

How do you make the bed?

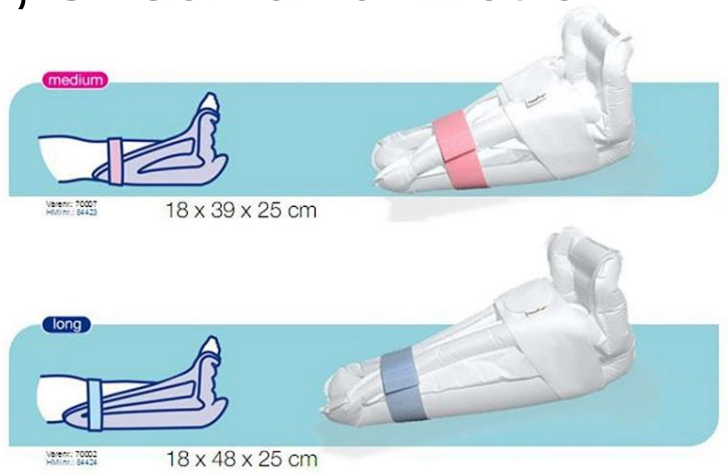


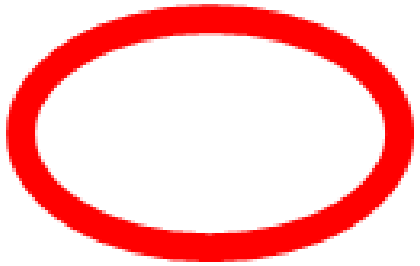
Transfer from/to the bed



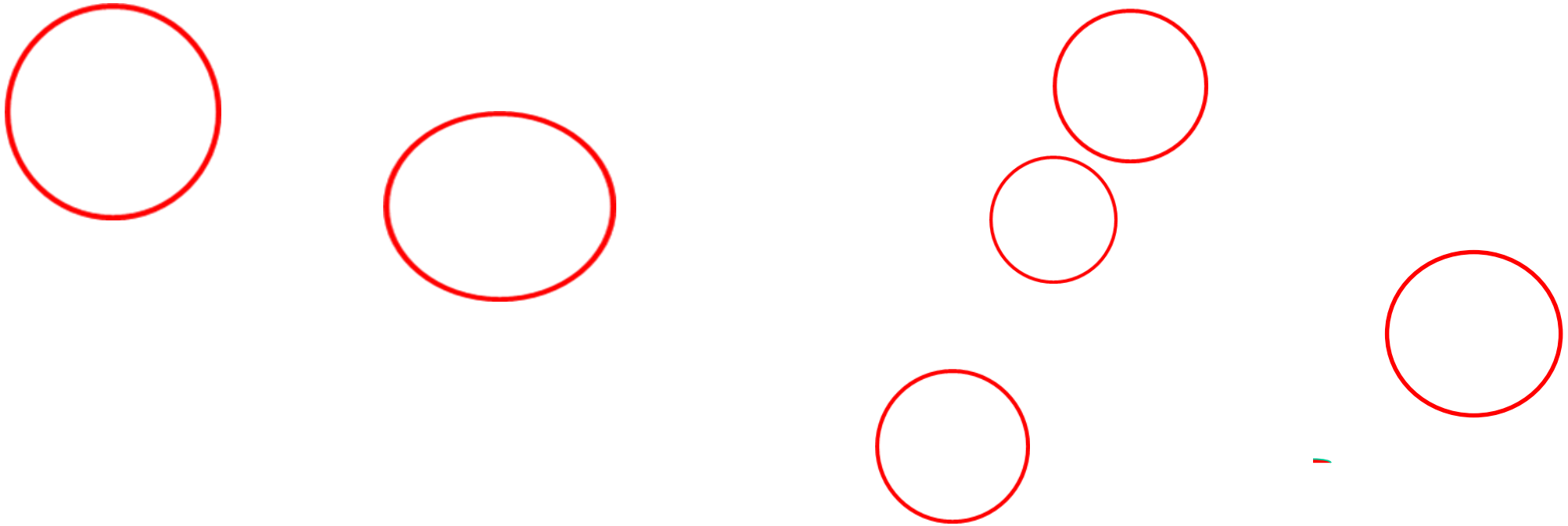
30° tilt position

Floating the heels or minimize the pressure, shear and friction.





Medical device related PUs



Nutrition

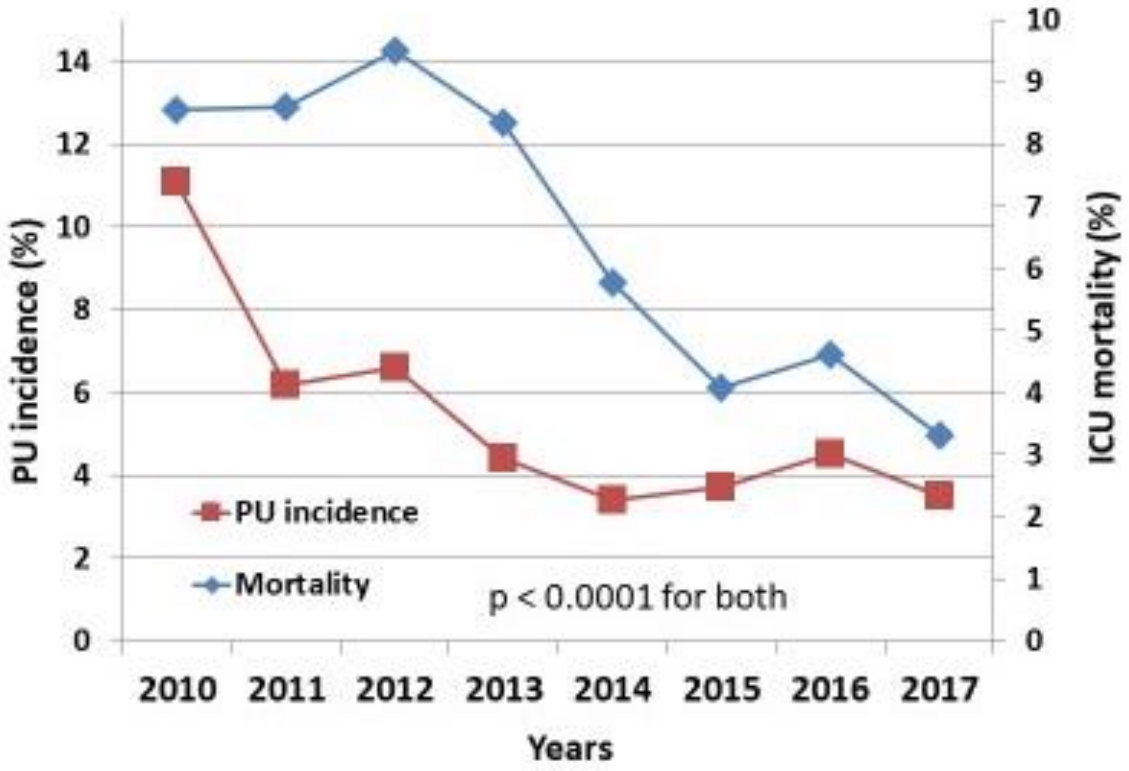
Documentation

Achievements

Reduced PU incidence

- Some > 400 patients did not develop PUs during 2010-2017
- Estimated calculatory savings >2.5 million euros

Reduced mortality



Ahtiala et al 2018 unpublished

Conclusions

- PU development remains a multifactorial phenomenon in critically ill patients
- Special subgroups are in the higher risk for PU development
- PUs on admission indicates higher risk to develop new PUs
- New validated pressure risk scale is needed for patients in ICUs; not all intensive care patients are in the same risk
- The clinical judgement
- PU development in ICUs is linked to increased mortality
- Huge monetary and other savings can be achieved
- PU in ICUs can be reduced, but it will take a long time and a multifactorial and interprofessional approach

Acknowledgements

- The whole staff of the intensive care unit
- Collaborators:
  - Juha Grönlund, MD, PhD
  - Minna Tallgren, MD, PhD
  - Teijo Saari, MD, PhD
  - Ruut Laitio, MD, PhD
  - Esa Soppi, MD, PhD
  - Riku Kivimäki, MSc, statistics

World Wide STOP Pressure Ulcer Day 21st of November