Characteristics of intensive care unit (ICU) patients with pressure ulcers present on admission, acquired in ICU or no ulceration: a retrospective cohort study

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A programme was initiated to study pressure ulcer (PU) risk factors in a large, mixed intensive care unit and to reduce intensive care-acquired PUs (ICaPUs). All adult patients treated in 2011–2015 (*n*=8,336) were included in this retrospective observational cohort study. The characteristics of patients with PUs present on admission, ICaPUs or no PUs were analysed. The modified Jackson/Cubbin (mJ/C) risk score and length of stay were used to assess the PU risk and severity of illness. The measures to prevent ICaPUs seem to be effective in spite of an increasing risk for PUs.

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Patients in intensive care units have a high risk of developing pressure ulcers (PU). Patients are severely ill and their ability to move is limited; they may have difficulties in expressing pressure-induced discomfort, pain and the need for changing position (Takala et al, 1996; Bours et al, 2001; Kottner et al, 2008; Nijs et al, 2009; VanGilder et al, 2009; Bly et al, 2016; Becker et al, 2017). PUs have a considerable risk of complications and their management is expensive and labour intensive (National Pressure Ulcer Advisory Panel [NPUAP] et al, 2014).

PUs are multifactorial in origin and more than 100 different risk factors for their development have been highlighted. The most common risk factors are mobility, nutrition, incontinence, activity, skin condition and mental state/sensory perception (Benoit and Mion 2012; Coleman et al, 2013; García-Fernández et al, 2014; Bly et al, 2016; Becker et al, 2017). These risk factors are included in the Braden score (VanGilder et al, 2009) and the Jackson/Cubbin score (Ahtiala et al, 2014), both of which are used to assess PU risk in intensive care unit (ICU) patients. The SOFA score may also be used for risk assessment (Manzano et al, 2010; Ahtiala et al, 2018). The PU risk of severely ill patients is also affected by the length of stay (Theaker et al, 2000; Manzano et al, 2010; Tayyib et al 2013; Ahtiala et al, 2018). Common comorbidities associated with PUs include diabetes, pulmonary and vascular disease, circulation disturbances, hypotension and vasopressor use (Theaker et al, 2000; Cox 2011, Tayyib et al, 2013; NPUAP et al 2014; Bly et al, 2016).

In this paper, we examine a large cohort of intensive care patients with no PUs during their stay at the ICU, with PUs present on admission (PUsPoA) and with ICU-acquired PUs (ICaPUs). Our purpose was to examine if these patient cohorts differ with regard to investigated risk factors and, if so, how this might be reflected in how preventive measures are focused in future.

Methods

Hospital unit and patients

The Turku University Hospital is a tertiary referral hospital for a population of approximately 700,000 people. The adult ICU has 24 beds and also serves as a national centre for hyperbaric oxygen therapy. Patients with major burns and solid organ transplantation are treated elsewhere. Both surgical and medical patients needing high-dependency care (i.e. step-down unit) or intensive care are treated.

Modified Jackson/Cubbin PU risk scale

A modified version of the Jackson/Cubbin PU risk calculator (mJ/C) was introduced for PU risk assessment in 2010 (Jackson, 1999; Ahtiala et al, 2014, 2016). Slight modifications were made to increase the reproducibility of the scale in clinical use. The scale consists of 12 categories, graded from 1 (highest risk) to 4 (lowest risk). The maximum

score is 48. The lower the score, the higher the risk of pressure ulcers.

The first PU risk assessment was carried out on a patient's admission to the ICU, with daily assessments after that. A score ≤29 indicates a high or extremely high risk of PU. Patients scoring ≤29 were transferred onto an appropriate protective mattress, if not already on one. Otherwise, the care regarding PU prevention followed the general guidelines (NPUAP and EPUAP, 2009), and positioning therapy was intensified as far as possible with regard to the condition of the patient. An electronic version of the mJ/C-score was introduced into the clinical database (Clinisoft, GE Healthcare) and was brought into use after appropriate training of the ICU staff.

Retrospective data collection

Patient demographics, characteristics, PU status and stage, Sequential Organ Failure Assessment score (SOFA; Vincent et al, 1996), Apache II score (Knaus et al, 1985), mJ/C score, length of stay (LOS; <3 or ≥3 days) and primary admission diagnoses were collected retrospectively from the database for 2011–2015. The patient cohorts were split into two periods for analysis: 2011–2013 and 2014–2015, based on appearance of PUs present on admission and ICaPUs *[Tables 1 and 2]*. The patients who had PUsPoA and then developed further PUs were included in the ICaPUs group (8 in 2011–2013 and 6 in 2014–2015). If any data point was not available for a given patient, the patient was excluded from further analysis.

Statistical methods

Analysis of variance (ANOVA) was used to evaluate the relationship among the groups and the distribution of the SOFA and Apache scores. Fisher's exact test and Wald χ^2 test were used to test statistical significance. Both tests were used to determine whether the incidence rates of PUs were the same between groups compared pairwise.

Ethics

The study plan was approved by the Ethics Committee of the Hospital District of Southwest Finland (T25/2011, 14.06.2011 §172).

Results

During 2011–2015, the PUsPoA increased significantly and the ICaPUs decreased significantly (χ^2 test, $P<0.0001$ for both, *Table 1*). PUsPoA prevalence was 3.83% (190/4,953) in 2011–2013 and 5.71% (219/3,383) in 2014–2015 ($P<0.0001$). The corresponding PU incidences, excluding nasal PUs, which were clearly medical device-related, were 5.27% (260/4,930) and 3.15% (106/3,370) ($P<0.0001$).

Both the SOFA and the Apache scores for patients without PUs in both periods were significantly lower than the patients with PUs ($P<0.0001$) *[Figures 1 and 2]*. Based on the SOFA scores, there were no differences in the severity of the PUs between patients with PUsPoA or ICaPUs in either period, while patients with ICaPUs had a significantly higher average Apache score than patients with PUsPoA ($P<0.001$).

There was no difference between the groups as to age, weight or BMI *[Table 2]*. In both periods, a significantly higher proportion of males developed ICaPUs ($P=0.0377$ and $P=0.0007$, respectively). There was no gender distribution difference between the PUsPoA group and the no PU group.

In 2011–2013, patients with PUsPoA tended to have a slightly longer length of stay ($P=0.0937$) and lower mJ/C score (i.e., higher risk; $P=0.7184$) than patients in 2014–2015 *[Table 3]*. The same was seen for ICaPUs, but the differences were

Table 1: Patient material 2011–2015.

Year	Patients	PUs present on admission, *n* (%)*	Intensive care-acquired PUs, *n* (%)	PU incidence % (*n*); nasal PUs excluded	SOFA score, mean (SD)	Apache II score, mean (SD)
2011	1,633	55 (3.4)	101 (6.2)	5.7 (93)	6.8 (3.2)	17.9 (7.1)
2012	1,637	49 (3.0)	108 (6.6)	6.3 (103)	7.0 (3.2)	18.0 (7.3)
2013	1,683	86 (5.1)	74 (4.4)	3.8 (64)	7.2 (3.3)	18.4 (7.6)
2014	1,689	119 (7.0)	57(3.4)	3.0 (50)	7.1 (3.3)	17.7 (7.4)
2015	1,694	100 (5.9)	62 (3.7)	3.3 (56)	7.4 (3.2)	17.6 (7.7)
Total	8,336	409 (4.9)	402 (4.8)	4.4 (366)	7.1 (3.2)	17.8 (7.4)

SD = standard deviation. *The PUs included stage I–IV and unstageable PUs according to NPUAP and EPUAP (2009). In 2011, 8 patients had PUs only in the nose caused by a noninvasive BiPAP/CPAP ventilation mask. The corresponding figures in 2012, 2013, 2014 and 2015 were 5, 10, 7 and 6. These patients were excluded from the analyses in Table 3. The mean age of the patients was 61.6 years. 64.0% of patients were male.

significant for both LOS and mJ/C ($P<0.0001$, *Table 3*). Among the patients without PUs, the proportion of LOS ≥3 days was significantly higher ($P<0.0001$) in 2014–2015 than in 2011–2013, but the mJ/C scores were significantly higher ($P=0.0024$). These figures show that the risk was smaller for those who never had a PU *[Table 3]*.

In 2011–2013, the proportion of patients with a longer LOS was significantly greater for ICaPUs than PUsPoA ($P<0.0001$). This difference was not seen for mJ/C scores ($P=0.6468$; *Table 3*).

In 2014–2015, the proportion of patients with a longer LOS was significantly greater for ICaPUs than PUsPoA ($P<0.0001$). In this group there was also a significant difference between the groups regarding the mJ/C score; the proportion of patients with a low mJ/C score (< 29) was significantly higher among ICaPUs ($P=0.0386$; *Table 3*).

In both periods the proportions of patients with longer LOS and lower mJ/C scores among patients without PUs were significantly lower than among those with PUsPoA or with ICaPUs ($P<0.0001$ in all cases, *Table 3*).

The distribution of patients between the two time periods and the different ICD10 diagnosis groups were practically identical *[Table 4]*. The highest and lowest PU prevalences and incidences were detected in the same ICD10 groups *[Table 4]*. At admission, the PU prevalences in 2011–2013 vs 2014–2015 were about the same in six ICD10 groups (A, B, D, F, G and L); these groups included 52.1% and 35.1% of the PUsPoA, respectively (*Table 4*). In 2014–2015 the PUsPoA increased, especially in diagnostic groups C, G, H, I, J, K and M, where the prevalence was low (<4%) in 2011–2013. The prevalence increase was significant in group C (abdominal diseases, $P=0.0339$).

In 2014–2015, the ICaPUs incidence was lower in all diagnostic groups except J, musculoskeletal traumas and burns, but the difference was not statistically significant in any of the groups *[Table 4]*.

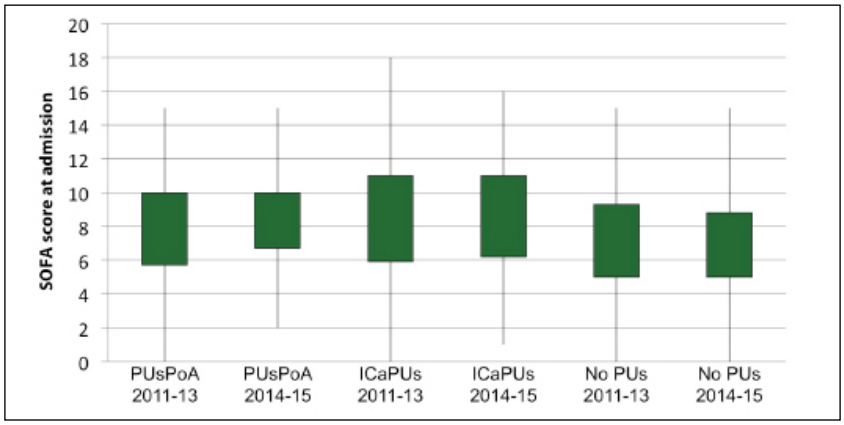

Figure 1. *Distribution of SOFA scores between patient groups (2011–2013 vs 2014–2015). There was no difference between the groups with PUs present on admission (PUsPoA) or intensive care-acquired PUs (ICaPUs). Patients with no PUs had significantly lower SOFA scores in both periods compared to the groups with PUs (P<0.001). The box plots indicate the standard deviation and the lines show the range.*

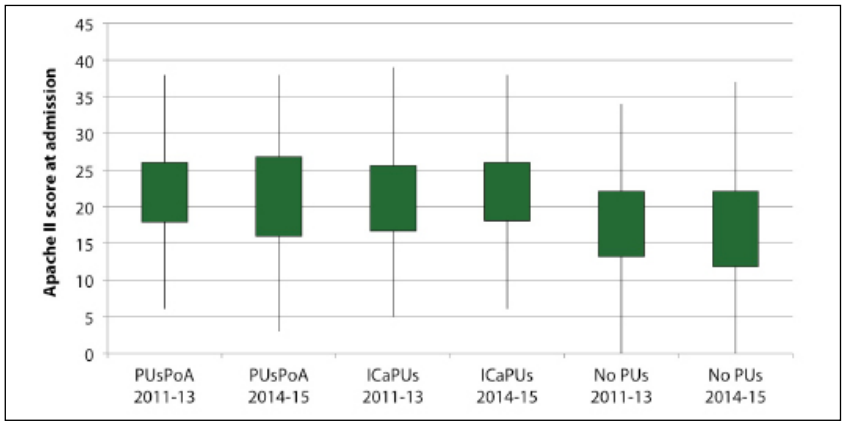

Figure 2. *Distribution of Apache II scores. Patients with no PUs had significantly lower Apache II scores in both periods compared to those with PUs (P<0.001). In both periods patients with intensive care-acquired PUs (ICaPUs) had significantly higher Apache II scores than those with PUsPoA (P<0.01). The box plots indicate the standard deviation and the lines show the range.*

Discussion

In 2010, a research programme was launched to study the occurrence of PUs and related risk factors in a mixed ICU (Ahtiala et al, 2014). A modified Jackson/Cubbin risk scale was introduced to formalise the PU risk assessment (Ahtiala et al, 2014, 2016). The programme has been successful – ICU-acquired pressure ulcers (ICaPUs) have decreased significantly during the five study years. This is in line with previous results that a long-term approach is needed to achieve significant results (Stotts et al, 2013).

To assess patient characteristics, the different cohorts (PUsPoA, ICaPUs and no PUs) were analysed in two periods, 2011–2013 and 2014–2015. There were significantly more males among the ICaPUs patients than among those without PUs, as has been described previously (VanGilder et al, 2009; Ahtiala et al, 2014). Otherwise the patient characteristics were similar.

The severity of conditions of critically ill patients can be assessed by SOFA and Apache II scores (Knaus et al, 1985; Vincent et al, 1996). Based on these scores, the patients without PUs were less severely ill than those with PUsPoA or ICaPUs in both periods. The LOS and mJ/C scores of these patients were also lower *[Table*

3], indicating that patients without PUs are significantly less ill than those with PUs.

Very little is known about the characteristics of acute care patients with PUsPoA, and only two previous studies have addressed this question (Williams et al, 2000, Wann-Hansson et al, 2008).

Among adults with PUsPoA, 34 out of 267 (12.8%) and 53 out of 535 (9.9%) had significantly lower Braden scores than those without PUs, a finding which is in accordance with this study [Table 3]. In the previous studies, subjects were also significantly older than in our study. Neither of the two previous studies reported how many patients with PUsPoA developed ICaPUs, although a previous pressure ulcer is a major risk factor (NPUAP et al, 2014).

We observed that the number of PUsPoA decreased significantly over time (from 2011–2013 to 2014–2015). The proportion of patients with longer LOS and lower mJ/C scores tended to increase, indicating that as the severity of the illness increased, so did the occurrence of PUsPoA. This in line with the clinical impression that patients are referred to this tertiary hospital in a poorer condition than previously.

In the present study, only 14 (3.3%) of the PUsPoA patients developed ICaPUs, indicating that the preventive measures were successfully directed to these patients. This also holds true for all ICU patients, since the proportion of patients with both longer LOS and lower mJ/C scores increased among those with ICaPUs, while the number of patients with ICaPUs decreased significantly (Jackson, 1999; Theaker et al, 2000; Manzano et al, 2010; Ahtiala et al, 2014; Bly et al, 2016).

Table 2: Patient characteristics and demographics.

	2011–2013			2014–2015		
	PUs present on admission, *n* (%)	**Intensive care-acquired PUs, *n* (%)**	**No PUs, *n* (%)**	**PUs present on admission, n (%)**	**Intensive care-acquired PUs, n (%)**	**No PUs, n (%)**
Male	126 (66.3)	198* (70.0)	2,852* (63.7)	140 (63.9)	94† (79.0)	1,928† (63.3)
Female	64 (33.7)	85 (30.0)	1,628 (36.3)	79 (36.1)	25 (21.0)	1,117 (36.7)
Age, years Mean (range)	64.3 (18–92)	60.9 (19–91)	60.6 (18–94)	64.7 (19–88)	62.3 (19–85)	62.7 (18–95)
Weight, kg Mean (range)	82.1 (40–169)	85.1 (45–178)	80.9 (33–200)	81.5 (33–143)	88.1 (50–143)	81.8 (28–200)
BMI, kg/m^2 Mean (range)	27.9 (14.0–66.0)	27.4 (17.0–52.7)4	27.2 (13.0–70.0)	27.1 (12.4–50.5)	28.6 (17.6–43.1)	27.5 (11.3–69.5)

Intensive care-acquired PUs vs no PUs *P=0.0377, †P=0.0007, χ^2 –test.

Table 3: Association between length of stay, mJ/C score and PUs in 2011–2013 and 2014–2015.

		PUs present on admission			Intensive care-acquired PUs			No PUs		
	mJ/C score	*LOS < 3 days, n (%)*	*LOS ≥ 3 days, n (%)*	*n (%)*	*LOS < 3 days, n (%)*	*LOS ≥ 3 days, n (%)*	*n (%)*	*LOS < 3 days, n (%)*	*LOS ≥ 3 days, n (%)*	*n (%)*
2011-13	≤29	33 (31.1)	73 (68.9)	106 (57.9)	23 (14.8)	132 (85.2)	155 (60.6)	1,398 (69.2)	621 (30.8)	2,019 (49.2)
	≥30	34 (44.2)	43 (55.8)	77 (42.1)	20 (19.8)	81 (80.2)	101 (39.4)	1,655 (79.5)	426 (20.5)	2,081¶ (50.8)
	Total	67 (36.6)	116* (63.4)	183†	43 (16.8)	213‡ (83.2)	256§	3,053 (74.5)	1,047‖ (25.5)	4,100
2014-15	≤29	31 (23.9)	99 (76.1)	130 (60.2)	2 (2.6)	75 (97.4)	77 (72.6)	847 (62.2)	514 (37.8)	1,361 (45.6)
	≥30	30 (34.9)	56 (65.1)	86† (39.8)	0 (0.0)	29 (100.0)	29 (27.4)	1,034 (63.6)	592 (36.4)	1,626¶ (54.4)
	Total	61 (28.2)	155* (71.8)	216†	2 (1.9)	104‡ (98.1)	106§	1,881 (63.0)	1,106‖ (37.0)	2,987

LOS = length of stay; mJ/C = modified Jackson/Cubbin; PU = pressure ulcer.

The table includes all patients whose LOS and mJ/C score were available.

PUs present on admission: * LOS distribution between 2011–2013 and 2014–2015 P=0.0937, χ^2 test. † mJ/C distribution between 2011–2013 and 2014–2015 P=0.7184, χ^2 test.

Intensive care-acquired PUs: ‡ LOS distribution between 2011–2013 and 2014–2015 P<0.0001 χ^2-test. § mJ/C distribution between 2011–2013 and 2014–2015 P<0.0001, Fisher probability exact test, 4.

No PUs: ‖ LOS distribution between 2011–2013 and 2014–2015 P<0.0001, χ2-test. ¶ mJ/C distribution between 2011–2013 and 2014–2015 P=0.0024, χ^2-test.

Table 4: Distribution of all patients by primary admission diagnosis according to ICD10 groups.									
ICD10 diagnostic group	**Primary admission ICD10 codes**	**PUs present on admission (Prevalence %)**		**Intensive care-acquired PUs (Incidence %)**		**No PUs**		**All (Distribution %)**	
		2011–2013	**2014–2015**	**2011–2013**	**2014–2015**	**2011–2013**	**2014–2015**	**2011–2013**	**2014–2015**
A. Infections including sepsis and DIC	A30-A49 B95-B97 D65	20 (13.0)	18 (13.5)	21 (13.6)	7 (5.3)	113	108	154 (3.1)	133 (3.9)
B. Heart failure	I50	4 (7.2)	3 (6.7)	6 (10.9)	4 (8.8)	45	38	55 (1.1)	45 (1.3)
C. Abdominal diseases	K00-K99, C15-C26	9 (3.6)	24 (11.5)	25 (10.1)	12 (5.8)	214	172	248 (5.0)	208 (6.1)
D. Pulmonary disturbances	J00-J99, C30-C39	45 (11.9)	28 (8.8)	38 (10.0)	15 (5.6)	296	225	379 (7.7)	268 (7.9)
E. Pulmonary and abdominal traumas	S20-S29, S30-S39	8 (6.9)	5 (10.5)	11 (9.5)	2 (3.5)	97	50	116 (2.3)	57 (1.7)
F. Resuscitation	I46	11 (6.9)	11 (7.2)	11 (6.9)	5 (3.3)	138	137	160 (3.2)	153 (4.5)
G. Urinary tract	N00-N99, C50-C68	9 (5.1)	10 (8.7)	11 (6.3)	5 (4.3)	156	100	176 (3.6)	115 (3.4)
H. CNS	A80-A89 C69-C72 G00-G09 I60-I69 S00-S09	19 (2.5)	29 (5.7)	40 (5.3)	18 (3.6)	694	458	753 (15.2)	505 (14.9)
I. Intoxications	T36-T98 Y90-Y99	8 (2.6)	21 (8.5)	14 (4.6)	8 (3.2)	284	219	306 (6.2)	248 (7.3)
J. Musculoskeletal traumas and burns	M00-M99 S40-S99 T00-T14 V01-W09 X01-Y89 T20-T35	3 (2.2)	6 (7.7)	6 (4.3)	4 (5.1)	131	69	140 (2.8)	79 (2.3)
K. Heart diseases other	I00-I99 (I10-I15, I20-I25, I46, I60-I69 excluded)	13 (1.8)	17 (3.5)	30 (4.1)	13 (2.7)	688	449	731 (14.8)	479 (14.2)
L. Ischemic heart disease and blood pressure	I20-I25 I10-I15	10 (1.6)	7 (1.5)	18 (2.9)	10 (2.2)	588	443	616 (13.8)	460 (13.6)
M. Others and missing*	All others	31 (2.8)	40 (6.1)	51 (4.6)	16 (2.5)	1,037	577	1,119 (22.6)	633 (18.7)
Total		190 (3.83)	219 (6.46)	283 (5.71)	119 (3.52)	4,480	3,045	4,953	3,383
DIC = disseminated intravascular coagulation. * 21 patients lacked the information									

PUs are associated with diabetes, cardiovascular and pulmonary disease, circulation disturbances, hypotension and vasopressor use (Theaker et al, 2000; Nijs et al, 2009; Cox 2011; Tayyib et al, 2013; NPUAP et al, 2014; Bly et al, 2016).

Diabetes is not a common admission diagnosis in intensive care and its role was not analysed separately.

When the patient populations were analysed by primary admission diagnoses, the prevalence of PUsPoA was highest (>10%) in the groups with infections, including sepsis and disseminated intravascular coagulation and pulmonary diseases. Infections raise the body temperature which, in turn, is associated with an increased PU risk (Takala et al, 1996; Soppi et al, 2014; NPUAP et al, 2014). Infections are also often associated with circulation disturbances, hypotension and vasopressor use. These risk factors are included in the mJ/C score.

Pulmonary disturbances are associated with decreased oxygen perfusion, which increases the risk for PUsPoA (Williams et al, 2000; Bly et al, 2016). Vascular diseases were not identified as a major risk factor for PUsPoA.

The prevalence of the six diagnostic groups A, B, D, F, G and L *[Table 4]* exceeded 10% among patients with ICaPUs in 2011–2013. This implies a high prevalence of circulation disturbances, hypotension and decreased oxygen perfusion (Bly et al, 2016). However, vascular disturbances (diagnostic groups B, F, K and L) do not seem to be a uniform risk indicator among PUsPoA or ICaPUs patients.

In spite of the severity and risk for PUs increasing in the period 2014–2015, the rate of ICaPUs decreased across all diagnostic groups. This indicates that neither the PU risk nor the diagnostic group make ICU patients resistant to effective measures to prevent pressure ulcers.

These measures include a structured risk assessment (mJ/C risk score), documentation in an electronic clinical database, increased awareness through training, periodic reviews of the prevalence and incidence of PUs, implementation of evidence-based practices for prevention and renewal of mattresses and limiting the number of different types of mattresses available (Takala et al, 1996; Ballard et al, 2008; Barker et al, 2013; de Laat et al, 2013).

Conclusion

Patients who do not develop PUs during their ICU stay are less severely ill than those with PUs present on admission or who acquire PU during their ICU stay. The latter two groups have illnesses of equal severity. Between 2011–2013 and 2014–2015, the distribution of admission diagnoses remained about the same. The prevalence and incidence of PUs were highest among certain diagnostic groups – infections (including sepsis and disseminated intravascular coagulation), abdominal disturbances and pulmonary disturbances. In spite of the increased risk for PU development during treatment in the ICU, a significant reduction in the occurrence of ICaPUs is achievable across all diagnostic groups. This requires substantial effort and long-term commitment that should be directed to the most severe patients, as indicated by the mJ/C risk score and the predicted length of stay in ICU.

Limitations of the study

This is a retrospective analysis which carries a risk of unintentional bias. However, this is one of the largest unselected adult cohorts of ICU patients ever studied, which evens out the probability of bias inherent to retrospective studies. WINT

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