Effect of mattress deployment on pressure ulcer development: a real-world observational cohort experience

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The role that different types of mattresses play in preventing pressure ulcer (PU) development in intensive care unit (ICU) patients is unclear. The effect of mattresses on the development of PUs was retrospectively investigated in 8,956 ICU patients in a clinical observational study over a 6-year period. The annual PU incidence decreased from 11.1% to 3.7% during the study period, although the severity of the patients' medical condition did not change. The four most prevalent support surfaces deployed as a first mattress were foam; alternating air; dynamic, low pressure mattress system; and the computerised, individually and precisely adaptive minimum pressure air mattress system (MPA). The significant reduction in PU incidence was concomitant with a reduction in foam mattresses from 53% to 4% and an increase in non-alternating MPA mattresses as the first mattress from 0% to 57.2%. The incident of PUs among patients on MPAs was significantly lower than on any of the other mattresses.

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Some 25 years ago, advanced support surfaces were shown to reduce the development of pressure ulcers (PUs) compared to old-fashioned standard foam support surfaces in critically ill intensive care unit (ICU) patients (Inman et al, 1993; Gebhardt et al, 1996; Takala et al, 1996). Since then, there has been uncertainty about the role of different types of support surfaces in the prevention of PUs, but there is consensus that higher specification foam mattresses reduce the incidence of PUs in patients at risk compared to standard hospital foam mattresses (Russell et al, 2003; National Pressure Ulcer Advisory Panel [NPUAP] et al, 2014; McInnes et al, 2015, Soppi et al, 2015). However, very little is known about the influence of different types of mattresses on the development of PUs (Chou et al, 2013; McInness et al, 2015). Alternating air pressure mattresses are considered to be the gold standard for PU prevention, although data are very limited (Nixon et al, 2006; Vanderwee et al, 2008; NPUAP et al, 2014; McInnes et al, 2015).

Many types of patients with different therapy and intervention requirements are treated in mixed medical surgical ICUs. Consequently, the need for different types of support surfaces varies considerably. The possibility of repositioning the patient can be limited due to instable haemodynamics and impaired oxygenation or a need for hypothermia. (Ahtiala et al, 2018a; 2018b). The requirement for elevation of the head to 30–40° to avoid ventilation-associated pneumonia or to decrease a high intracranial pressure may limit the functionality and use of certain mattresses because of the risk of buttocks bottoming out (Sugama et al, 1995). The head of the bed elevation is a known PU risk factor (European Pressure Ulcer Advisory Panel [EPUAP] et al, 2019).

Other factors that need to be taken into consideration include contraindications, such as multiple fractures and patient weight limits, management during CPR (Sainio et al, 2014; Soppi et al, 2016), safety precautions and local legislation. An example of a standard safety precaution is the ISO (2009) standard, according to which the mattress thickness is to be maintained at a level that fulfills the distance requirement from the mattress level to the top of the side rail to reduce the possibility of a patient accidentally falling from the bed.

In 2010, the authors launched an intervention project to reduce ICU-acquired PUs and to study the risk factors related to the development of PUs. One of the means to reduce ICU-acquired PUs was to focus on mattress deployment. The authors report the influence of different types of support surfaces deployed on admission on the development of PUs over a 6-year period (2010–2015).

Patients, materials and methods

The Turku University Hospital has an adult mixed ICU with 24 beds and serves a population of 700,000. All surgical and medical intensive care patients in the region are treated in this tertiary hospital, except for patients with major burns and those undergoing solid organ transplantation. Approximately 1,650 adult patients are treated annually. In 2012–2013, a new intensive care unit was opened which allowed the management to acquire evidence-based new mattresses in collaboration with the procurement office of the hospital (Takala et al, 1996).

On admission, one of the intensive care physicians defines the initial treatment needs. They determine the main admission and other diagnoses and are responsible for the input of patient data into the electronic ICU database. The nurses, who have been trained in the deployment of the modified Jackson/Cubbin (mJ/C) risk scale, as well as wound identification and care, assist with this. In the mixed ICU, one nurse is responsible for for PU prevention is in accordance with general guidelines (NPUAP and EPUAP, 2009). A bed bath is carried out once or twice a day and patients' skin is inspected during every turn or position change, if their condition allows. The patients' positions are changed approximately every 2 hours, if there are no contraindications.

Use of protective dressings, heel protectors or skin protectants are recommended for use in high-risk patients, but they are used based on the nurses' clincial judgement and individual patient needs. All the patients in this ICU have a urinary catheter to prevent urinary incontinence-associated skin failure. If there is faecal incontinence, modern absorbent diapers or a faecal management system are used, along with protective sacrum dressing and/or skin protectants.

Prior to the intervention project (before 2010) one-layer foam mattresses were replaced with multilayer foam mattresses (height 10–15 cm), which were then gradually replaced by multilayer mattresses that formally fulfilled the criteria of higher specification foam mattresses (HSFM; NPUAP, et al, 2014; Soppi et al, 2015). Since this transition to HSFMs was not documented, all foam mattresses are pooled in this paper (support surface type foam, SS1, weight limit up to 140 kg). The support surfaces used are listed in *Table 1*.

The goal of the intervention project was to limit the development of PUs. The number of different types of support surfaces were limited to ensure appropriate use and to reduce the possibility of error in support surface selection among the 180 members of staff.

The PU risk was assessed using the mJ/C risk scale (Ahtiala et al, 2014; 2016). The baseline

Table 1. The support surfaces used in the study.

Support surface (SS)	Used in the ICU (years)	Definition	Height of SS (cm)	Weight limit (kg)
SS1	2010–2015	Polyurethane foam	10–15	Up to 140
SS2	2010–2015	One-cell, dynamic, low pressure air mattress system	15	Up to 140
SS3	2010–2014	Alternating dynamic air mattress, every fourth cell	24	Up to 250
SS4	2011–2015	Non-alternating, dynamic, minimum pressure air mattress (MPA) system, with a double-cell structure and reactive adjustment technology	13	Up to 300
SS5	2010–2011	Alternating dynamic air mattress, with 20 cells within the cell system cycle time 15 min	20	Up to 160
SS6	2010–2012	Alternating/continuous low pressure, dynamic air mattress, with 24 cells	21	Up to 180
SS7	2012–2015	Complete therapy bed		Up to 250

The pressure ranges neither for mean internal cushion pressures nor average interface pressures of the support surfaces are disclosed in any of the clinical situations by the manufacturers.

PU risk assessment was carried out when the patient was admitted to the ICU, assessments were performed daily thereafter. An electronic version of the mJ/C scale was introduced into the clinical documentation and information system (Clinisoft, GE Healthcare) for use by the ICU staff after appropriate training. If the mJ/C score is ≤29 points, the PU risk is considered to be high or extremely high (Jackson, 1999; Ahtiala et al, 2014). The instruction in these cases is that patients are to be allocated to an appropriate protective mattress based on their condition, therapy and repositioning needs, unless they are on one already on admission, as indicated by internal guidance. Otherwise, care regarding PU prevention followed general guidelines (NPUAP and EPUAP, 2009), and positioning therapy was intensified as far as possible with consideration for the condition of the patient. Other routine measures to prevent PUs were skin inspection and care, floating of the heels, incontinence control, controlled nutrition and paying attention to the potential risk from medical devices. The care package remained essentially the same throughout the 6 years.

The severity of the patients' condition was assessed by the Sequential Organ Failure Assessment (SOFA) scores — the higher the score, the more severe the patient's condition. The score was recorded at baseline (admission) and daily thereafter (Vincent et al, 1996; Minne et al, 2008).

The data were retrospectively derived and anonymised from the ICU clinical database (Clinisoft) by the database administrator from the clinical documentation and information system used in the ICU (covering all ICU admissions between from January 2010 to December 2015 (9,965 adult patients). Then the datasets were transferred by the statistician to SAS® version 9.4 (SAS Institute).

Among the data collected were information to calculate the patients' mJ/C and SOFA scores on admission, mattress deployment on admission and development of PU (first PU, any class) during the ICU stay. The outcome was the incident of PUs during the ICU stay as reported in the clinical database by ICU nurses.

When the patients' condition improved or deteriorated, the mattress was ocassionally changed to a less advanced support surface (*n*=66) to improve the patients' capabilities to change their position independently or to a more advanced support surface (*n*=156) to mitigate the risk of PU development.

Statistical analysis

The duration of follow-up from baseline was until development of the first PU, change of mattress, or death or discharge from the ICU, whichever occurred first. Change of mattress (*n*=334) was considered to be a censoring event (end of follow up).

The comparison of proportions was done using the chi-squared test and the length of stay (LOS) in ICU was compared by the Wilcoxon rank-sum test.

The authors' primary interest was to analyse how the incidence of PUs until death, discharge or mattress change is dependent on mattress at admission. Statistical evaluation of mattress effect was based on survival analysis and Cox proportional hazards model, a regression model, which delivers a direct comparison of the efficacy of different support surfaces. For the initial assessment of the effect of different support surfaces, the data were analysed for their first day mJ/C (≤29 or ≥30) scores (Ahtiala et al, 2016). Thereafter, the effect of mattress or the mJ/C scores on the probability of PU development was done utilising the grouped values (≤20, 21–29, 30–39, ≥40) of the mJ/C score (Ahtiala et al, 2018). The results of modelling are presented with hazard ratios (risk of developing PU), together with confidence intervals.

Ethics

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

Results

A total of 9,965 adult patients were admitted to the ICU during the study period *[Table 2]*. Patients with PUs that were present on admission (*n*=420) were not included in the study. Patients with exclusively nasal PUs (*n*=49) caused by non-invasive ventilation were not included, because these PU were definitely not related to the use of support surfaces. Furthermore, there were not enough data to include a further 540 patients, evenly distributed across the years. This left 8,956 patients for the analysis. The mean age was 61.4 (range 18–95) years and 63.9% were men. The mean LOS in the ICU was 3.6 days (range <1–64 days).

There was no decrease of patients at PU risk (mJ/C score ≤29, *P*=0.3171, chi-squared test) with increased disease severity (SOFA score, *P*=0.1151, analysis of variance) over the the study period. The mean incidence of PUs over the 6-year period was 5.9% (584/9,965). The incidence decreased from 11.1% in 2010 to 3.7% in 2015, and both the annual change and the overall decrease from 2010 to 2015 were statistically very significant (*P*<0.0001, chi-squared test) *[Table 2]*.

Table 2. Intensive care patients followed for development of pressure ulcers 2010-2015.				
Year	Total number of patients	PU incidence, % (*n*)	Proportion of patients with mJ/C score ≤29*	SOFA score† mean (SD)
2010	1,629	11.1 (181)	49.6%	6.9 (3.2)
2011	1,633	6.2 (101)	48.8%	6.8 (3.2)
2012	1,637	6.6 (108)	50.1%	7.0 (3.2)
2013	1,683	4.4 (74)	51.5%	7.2 (3.3)
2014	1,689	3.4 (58)	52.0%	7.1 (3.1)
2015	1,694	3.7 (62)	50.2%	7.4 (3.2)
Overall	**9,965**	**5.9 (584)**	**50.4%**	**7.1 (3.2)**

PUs included stages I–IV and unstageable ulcers graded according to NPUAP and EPUAP (2009). *mJ/C score ≤29 indicates a high risk for PU development (Ahtiala et al, 2014). Decrease in the incidence of PUs from 2010 to 2015 is significant (p<0.0001, χ^2 test, a trend analysis over all 6 years, as well as comparison between 2010 and 2015). †Sequential Organ Failure Assessment (SOFA; Vincent et al, 1996).

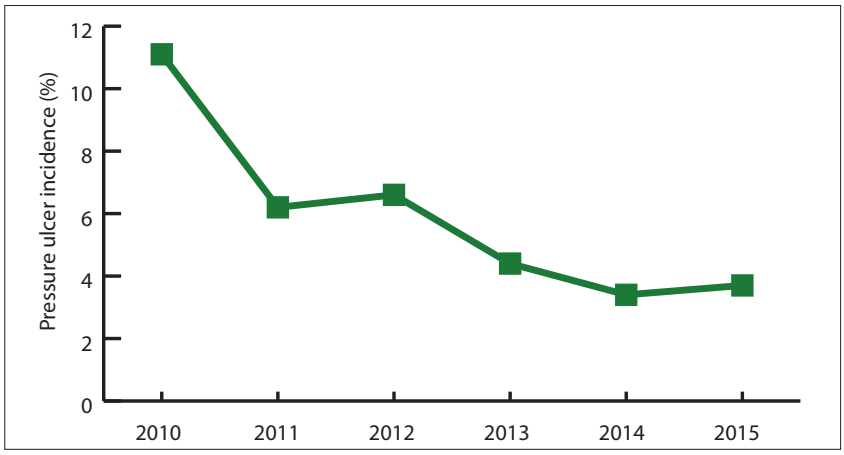

Figure 1a. Pressure ulcer incidence (%) years 2010–2015.

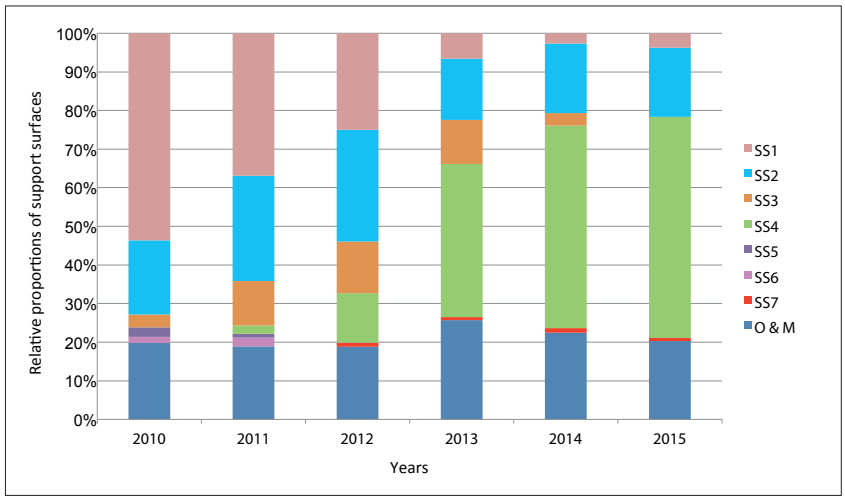

Figure 1b. Relative proportions of different support surfaces used in the intensive care unit. SS = support surface; O & M = others and missing.

The four most common support surfaces deployed during the 6-year study period were foam mattresses (SS1), dynamic, low pressure mattress system (SS2), alternating air mattress (SS3) and computerised, individually and precisely adaptive minimum pressure air mattress system (SS4). The majority of patients (78.1%) were treated on these four support surfaces on admission and these four surfaces hosted 91.5% of all patients with PUs *[Table 3]*.

There was a high risk of PUs in 49.8% of patients (mJ/C score ≤29). Among the high-risk group, the incidence of ICU-acquired PUs was 7.2%, significantly higher than the low-risk group (4.2%, mJ/C score ≥30; *P*<0.0001, chi-squared test, *Table 3*).

In concordance with the significant reduction in the incidence of PUs during the 6-year period, the primary deployment of foam mattresses decreased from 53% to 4% and of SS4 increased from 0% to 57.2% (*P*< 0.0001 in both cases) *[Table 3 and Figure 1b]*.

Out of the four most common support surfaces, only foam mattresses (SS1) were significantly more often used by low-risk patients (*P*<0.0001 in all cases, chi-squared test, *Table 3*). The lowest PU incidence was associated with the SS4 mattresses *[Table 3]*.

The PU incidence density (per 100 days in ICU) was significantly lower when the patients were on SS4 than other mattresses (SS1–SS3, *P*<0.005, *Table 4*). In general, patients who developed PUs had equal or significantly longer ICU LOS than those without PUs, except for those on SS4 and SS5 (alternating dynamic air mattress). However, the SS5 had a high PU incidence density and a very short time to PU development *[Table 4]*.

The development of ICU-acquired PUs was further analysed using a Cox proportional hazards model with mJ/C score and first support surface as predictive variables. Both the mJ/C score (*P*=0.0002) and the type of first mattress (*P*<0.0001) had a statistically significant effect on PU development. When the ability of SS4 to prevent PUs was compared to other mattresses, SS4 was significantly more effective. Hazard ratios of all other mattresses were 2.6–5.1 times higher compared to SS4 *[Table 5]*.

Discussion

The main finding of this study was that the non-alternating, dynamic, minimum pressure air mattress system (SS4) had a low incidence density of PU development (PUs developed per 100 days in ICU). Furthermore, the patients without PUs had a significantly longer LOS than those who developed PUs, which indicates that

Table 3. PU incidence among different types of support surfaces as a function of mJ/C risk class and the first support surface (SS) type deployed upon admission to ICU.

First mattress type	Admission mJ/C score	ICU-acquired PUs (%)*	ICU-acquired PUs (%)*	No PUs	All	Admission mattress distribution (%)	Total distribution (%)	*n*	Exposure days
SS1	≤29	70 (9.0)	134 (6.8)	707	777	8.7	22.0	1,972	5,251
	≥30	64 (5.4)		1,131	1,195	13.3			
SS2	≤29	121 (10.9)	180 (9.5)	989	1,110	12.4	21.2	1,900	8,886
	≥30	59 (7.5)		731	790	8.8			
SS3	≤29	41 (10.7)	53 (8.5)	342	383	4.3	7.0	625	2,893
	≥30	12 (5.0)		230	242	2.7			
SS4	≤29	71 (5.1)	98 (3.9)	1,327	1,398	15.6	27.9	2,499	18,890
	≥30	27 (2.5)		1,074	1,101	12.3			
SS5	≤29	4 (15.4)	7 (12.3)	22	26	0.3	0.6	57	175
	≥30	3 (9.7)		28	31	0.3			
SS6	≤29	3 (7.5)	6 (10.0)	37	40	0.4	0.7	60	228
	≥30	3 (15.0)		17	20	0.2			
SS7	≤29	3 (11.5)	6 (10.3)	23	26	0.3	0.7	58	180
	≥30	3 (9.4)		29	32	0.3			
Others† and missing‡	≤29	8 (1.1)	24 (1.3)	690	698	7.8	19.9	1,785	2,304
	≥30	16 (1.5)		1,071	1087	12.1			
All		**508 (5.7)**	**508**	**8,448**	**8,956**	**100**	**100**	**8,956**	**38,807**

*PU incidence percentage. Patients from whom the mJ/C scores were not available are not included in the table. Patients with exclusively nasal PUs (N=49) are not included in the PU positive patients. †Includes patients who were admitted to ICU with their beds and miscellaneous support surfaces from other departments of the hospital. ‡These patients had a very short length of stay at ICU (<24 hours).

Table 4. PU density, mean LOS [(days (SD)] in ICU with or without PU development by the support surface type until death, discharge from ICU or mattress change.

Mattress type	PU density/100 ICU days on the SS	Development of ICU-acquired PUs	PUs did not develop in ICU	p-value* (PUs vs no PUs)
SS1	2.55	4.28 (3.64)	2.55 (2.82)	<0.0001
SS2	2.03	5.61 (5.44)	4.58 (8.20)	<0.0001
SS3	1.83	5.49 (4.18)	4.56 (14.36)	<0.0001
SS4	0.52	5.35 (5.00)	7.64 (46.27)	0.0004
SS5	4.00	1.43 (0.79)	3.48 (2.81)	0.0278
SS6	2.63	6.17 (6.65)	3.54 (4.77)	0.2314
SS7	3.75	6.75 (3.77)	3.02 (4.46)	0.0104
Others	1.04	1.71 (0.76)	1.92 (2.00)	0.4526

*Wilcoxon rank-sum test

patients on SS4 had longer LOS in ICU without PU development. Further analysis showed that SS4 was about three times more effective in preventing PUs than any other support surface used in critically ill patients.

Advanced support surfaces had been reported to reduce the development of PUs compared to standard foam in critically ill intensive care patients and this implied that the choice of certain support surfaces might prevent the development of PUs in intensive care patients (Inman et al, 1993, Gebhardt et al, 1996, Takala et al, 1996). However, the relative efficacy of different type of support surfaces in the prevention of PUs has been contested since these early publications (Chou et al, 2013; McInnes et al, 2015).

It has been suggested that alternating pressure air mattresses (APAMs) could to be more effective than standard hospital mattresses in preventing PUs, although this suggestion has been refuted (Vanderwee et al, 2008; McInnes et al, 2015).

There are two large randomised controlled trials of APAMs. The first did not show any difference in the risk of PUs between the alternating mattress and the alternating mattress overlay; around 10% of patients in both groups developed one or more new grade 2 PUs (Nixon et al, 2006). The second study compared APAMs and higher specification foam mattresses and found that the APAMs were not superior to foam mattresses in preventing the PUs (Nixon et al, 2019). It has previously been suggested that higher specification foam mattresses are more effective that standard foam mattresses in the prevention of PUs (Chou et al, 2013, McInnes et al, 2015). Furthermore, a recent study in nursing

Table 5. Ability of dynamic, minimum pressure air support surface (SS4) to prevent the development of pressure ulcers was compared to the other type of mattresses.

Mattress type	Hazard ratio	95% Wald confidence limits		*P*-value
SS1	3.330	2.537	4.370	<0.0001
SS2	2.866	2.235	3.677	<0.0001
SS3	2.693	1.931	3.757	<0.0001
SS5	5.066	2.346	10.940	<0.0001
SS6	3.410	1.493	7.785	0.0036
SS7	2.877	1.057	7.830	0.0386
Others	3.051	1.410	6.602	0.0046

home residents has shown that one type of static air mattress is significantly more effective than APAMS in preventing the development of PUs (Beeckman et al, 2019).

Until recently, the key properties of higher specification foam mattresses (HSFM) were not clearly defined (McInnes et al, 2015). Initially, NPUAP et al (2014) specified HSFMs, by foam type, thickness of the mattress and density-hardness.

In a study by Soppi et al (2015), HSFMs were defined by their foam specifications. In the trial by Nixon et al (2019), the HSFMs were made of high density foam, visco-elastic (memory) foam or a combination of both, and could be castellated (for ventilation and profiling), which corresponds to foam mattress in this study and, thus, their definition of "higher specification foam mattress" is not met (Nixon et al, 2019, supplemental material). Vanderwee et al (2008) have shown that APAMs seem to be as effective or more effective than standard hospital foam mattresses.

Randomised controlled trials (RCTs) are expensive and may need thousands of patients at the current incidence of PUs, which is 10% or less (Russell et al, 2003; Nixon et al, 2006; Nixon et al, 2019). Less costly alternatives are need, such as reports of real-world experience (Food and Drug Administration, 2017). Real-world experiences provide information on the extent to which an intervention does what is intended to do under routine circumstances of patient care.

In the authors' material, there was a significant reduction of PU incidence during the 6-year study period *[Figure 1a]*. During the study period, there was no decrease of patients at PU risk as defined by mJ/C and SOFA scores *[Table 2]* showing that the decreasing PU incidence during the study period was not due to any reduction in the severity of the patients' average condition. Furthermore, the authors' previous study showed that the patient groups within the study period did not change (Ahtiala et al, 2018).

Staff attention to the risk of PU development increased before and during the study period. The education of personnel most probably has contributed to the decreased PU incidence, especially at the beginning of the project (Coyer et al, 2015). However, the results still show that the choice of specific support surfaces is of a crucial importance.

The present report is a real-world experience and we needed close to 9,000 patients to show differences at the average PU incidence of about 6%. The results are in line with the previous data, in which APAMs seem to be perform similarly to foam mattresses with regard to PU incidence (Vanderwee et al, 2008; Beeckman et al, 2019; Nixon et al, 2019). The dynamic, low pressure mattress system (SS2) did not differ from foam mattresses in its ability to prevent PUs. The authors were unable to differentiate different types of foam mattresses and are thus unable to draw a conclusion about the relative efficacy of different types of foam mattresses. Since the patients allocated to foam mattresses were at a lower risk for PUs than the patients on SS2 or SS3 *[Table 3]*. APAMs and low pressure mattresses might be marginally more effective than standard foam mattresses (Vanderwee et al, 2008).

The inverse relationship of PU incidence and deployment of the dynamic, minimum pressure air mattress (SS4) as the first mattress over the 6-year study period *[Figures 1a and 1b]* proved to have a causal relationship. No other mattress type demonstrated a similar effect in preventing PUs *[Tables 3, 4 and 5]*; results which are line with previous RCTs (Takala et al, 1996, García-Molina et al, 2012). Futhermore, it has been demonstated that SS4 has unique antideformation properties among others that are explaining the results reported here (Soppi et al, 2016; 2020).

It is possible that other types of mattresses in addition to SS4 may prevent PUs, since not all mattress types are used in the authors' ICU. The results on the efficacy of mattresses other than the ones used in this report are conflicting (Johnson et al, 2011; Black et al, 2012). According to a recent systematic review, powered active-air surfaces (including data from Takala et al, 1996) and powered hybrid air-surfaces may reduce the incidence of PUs compared with standard hospital surfaces (Shi et al, 2018). However, manufacturers of any specific type of support surface needs to establish the efficacy of the mattress by presenting appropriate and relevant data. In the EU, such data must be presented as written, summarised evidence in the form of a Clinical Evaluation Report as required by the Medical Device Directive 2007/47/EC, amended 2017/745 and coming into force on May 26 2020, and as advised by European Commission (2016) guidelines on medical devices.

Limitations of the study

This was a retrospective analysis, which carries a risk of unintentional bias. The analysis did not include all available support surfaces that were used in the unit in sufficient numbers to allow conclusions on efficacy. There may have been pillows, cushions or medical devices that could have generated PUs and such confounding effects can neither be controlled for nor ruled out. The primary interest was to analyse how the development of PUs until death, discharge from ICU or support surface change is dependent on the deployment of the support surface on admission. The analysis did not include any data collected after the change of the support surface, which may have had a minor effect on the results, although the number of support surface changes was small compared to the total number of patients included in the study.

The population in this study was large and thus confounding factors were most probably evenly distributed. Even if the personnel were advised to deploy patients at risk (mJ/C score was ≤29) onto an appropriate protective mattress on admission, the results show that mattresses were only moderately distributed according the patients' risk class *[Table 3]*.

Numerous patients at high risk for PU were allocated foam mattresses. This may partly be due to the availability of mattresses, since at the beginning of the study period, more than half of the mattresses were foam. Furthermore, nurses possibly used their own clinical judgement on top of the advised formal risk assessment. A marked reduction in PU incidence occured during the first year, before SS4 was available, indicating that initiating the study programme affected PU development. After that, the reduction in PUs was considered to be due to other support surfaces, such as SS4. Otherwise, the distributions between the first half and the second half of the study did not differ markedly from each other, apart from the significant reduction in use of foam mattresses.

Conclusion

To reduce the development of PUs in intensive care units, much effort and long-term commitment are required. The most important actions include increased awareness of the personnel and by periodic reviews on the prevalence and incidence of PUs for the personnel, implementation of evidence-based practices as a basis for prevention, and renewal of mattresses based on the available scientific evidence. The different type of support surfaces available should be limited to those with a good evidence base. The achievements are supported by structured risk assessment (modified Jackson/Cubbin risk score) combined with clinical assessment and documentation of results into the electronic clinical database.

Acquiring support surfaces to the ICU needs to be addressed as a strategic long-term investment. The role of different type of mattresses to prevent PUs needs to be readdressed. The results of this study indicate that the most appropriate mattress for a given patient needs to be deployed already on admission, since the admission mJ/C score predicts the PU development for the first 3 days (Ahtiala and Soppi, 2016). WINT

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