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The prevalence, prevention and multilevel variance of pressure ulcers in Norwegian hospitals: A cross-sectional study

Ida Marie Bredesen [a,*], Karen Bjøro [a], Lena Gunningberg [b], Dag Hofoss [c]

[a] Department of Orthopaedic Surgery, Oslo University Hospital, Norway
[b] Department of Public Health and Caring Sciences, Caring Sciences, Uppsala University, Sweden
[c] Institute of Health and Society, University of Oslo, Norway

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ABSTRACT

Background: Pressure ulcers are preventable adverse events. Organizational differences may influence the quality of prevention across wards and hospitals.
Objective: To investigate the prevalence of pressure ulcers, patient-related risk factors, the use of preventive measures and how much of the pressure ulcer variance is at patient, ward and hospital level.
Design: A cross-sectional study.
Setting: Six of the 11 invited hospitals in South-Eastern Norway agreed to participate.
Participants: Inpatients ≥18 years at 88 somatic hospital wards ($N = 1209$). Patients in paediatric and maternity wards and day surgery patients were excluded.
Methods: The methodology for pressure ulcer prevalence studies developed by the European Pressure Ulcer Advisory Panel was used, including demographic data, the Braden scale, skin assessment, the location and severity of pressure ulcers and preventive measures. Multilevel analysis was used to investigate variance across hierarchical levels.
Results: The prevalence was 18.2% for pressure ulcer category I–IV, 7.2% when category I was excluded. Among patients at risk of pressure ulcers, 44.3% had pressure redistributing support surfaces in bed and only 22.3% received planned repositioning in bed. Multilevel analysis showed that although the dominant part of the variance in the occurrence of pressure ulcers was at patient level there was also a significant amount of variance at ward level. There was, however, no significant variance at hospital level.
Conclusions: Pressure ulcer prevalence in this Norwegian sample is similar to comparable European studies. At-risk patients were less likely to receive preventive measures than patients in earlier studies. There was significant variance in the occurrence of pressure ulcers at ward level but not at hospital level, indicating that although interventions for improvement are basically patient related, improvement of procedures and organization at ward level may also be important.

* Corresponding author. Tel.: +47 91628047.
E-mail address: uxidbr@ous-hf.no (I.M. Bredesen).

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What is already known about the topic?

- Hospital patients are at risk of pressure ulcer development.
- Reduced activity and mobility are the most powerful predictive risk factors, as well as high age.
- Few studies have examined the impact of organizational structures on pressure ulcer prevalence.

What this paper adds.

- Data on pressure ulcer prevalence of a large sample in Norway.
- Indications that organizational differences across ward units may explain some of the variance in pressure ulcer prevalence.

1. Background

Pressure ulcer (PU) prevention has been included as a quality indicator for nursing care in many patient safety campaigns. It is also a target for the reduction of adverse events in the ongoing Norwegian Patient Safety Programme under the direction of the Ministry of Health and Care Services in Norway. A PU is a skin injury that affects hospitalized patients with impaired health and reduced mobility. Elderly patients are at particularly high risk (National Pressure Ulcer Advisory Panel and European Pressure Ulcer Advisory Panel, 2009).

Patient-related PU risk factors are well documented, but no single patient risk factor can alone explain the risk (Coleman et al., 2013; National Pressure Ulcer Advisory Panel and European Pressure Ulcer Advisory Panel, 2009). However, most PUs can be prevented if effective measures are implemented. Evidence-based guidelines recommend the use of preventive measures including systematic skin examination, risk assessment, bed and chair support surfaces, repositioning and mobilization, and nutritional support (National Pressure Ulcer Advisory Panel and European Pressure Ulcer Advisory Panel, 2009; Reddy et al., 2006). Despite increasing research on the effectiveness of preventive measures of the recent decades, there is still a knowledge deficit in PU prevention among health personnel (Beeckman et al., 2011; Gunningberg et al., 2013b; Meesterberends et al., 2014) and PUs are an all-too-common clinical problem (Dealey et al., 2013; National Pressure Ulcer Advisory Panel and European Pressure Ulcer Advisory Panel, 2009).

There is some evidence that organizational characteristics of hospitals and wards may increase the risk of PU. Sving et al. (2014) found significant differences between both hospital type and ward type and PU prevention. More at-risk patients in a university hospital received pressure-redistributing mattresses than in a general hospital, but more patients in a general hospital received planned repositioning. Furthermore, patients at medical units were more likely to have planned repositioning, but less likely to have pressure-redistributing mattresses than geriatric wards. Bosch et al. (2011) investigated the relationship between organizational culture, team climate and quality of management at ward level and the PU prevalence. They used a model of PU quality management (QM) with 11 QM indicators at institutional level and 8 indicators at ward level. The QM sum scores for institutional and ward levels were positively correlated. However, they were unable to show an association between QM at institutional and ward level and the PU prevalence. Thus more research is needed to clarify whether characteristics of hospitals and wards affect the risk of PU.

Recent European studies have shown PU prevalence rates from 8.3 to 26.7% (Gallagher et al., 2008; Gunningberg et al., 2013a; James et al., 2010; Tannen et al., 2008; Vanderwee et al., 2007, 2011). We are unaware of any recent multi-centre studies from Norwegian hospitals. However, a 2008 pilot study conducted in medical and surgical wards in one university hospital showed a PU prevalence of 18%, indicating that the PU prevalence in Norwegian hospitals may be a significant clinical problem (Bjøro and Ribu, 2009).

Moreover, prior to implementation of the prevention of PU as a target in the National Patient Safety Campaign in Norway in 2012, the description of PU prevalence and current practice in a larger sample of hospitals was deemed appropriate. The main objectives of this study were (1) to describe patient risk factors, the prevalence of PUs and measures to prevent them in a sample of Norwegian hospitals, and (2) to investigate if there is a variance in hospital acquired PU prevalence at patient level and organizational levels (ward and hospital).

2. Methods

2.1. Design

The study was a cross-sectional multi-centre study.

2.2. Setting and sample

Six of the 11 invited hospitals (nine trusts and two private hospitals) in the South-Eastern Norway Regional Health Authority agreed to participate, supplying data from 88 somatic wards. South-Eastern Norway is Norway's largest health region, covering some 50% of the Norwegian population (Helse Sør-Øst, 2013). Data were collected in one day between 9 and 11 October 2012 at each hospital. Inpatients 18 years and above admitted to somatic hospital wards at 07:00 on the data collection day were invited to participate. Day surgery, paediatric and maternity wards were excluded since PUs are rarely observed on such wards (Bours et al., 2002).

As the hospitals varied in organizational structure and size, the concept *ward* was not unambiguous. At some of the participating hospitals, wards are specialized by patient group, disease or conditions, e.g. orthopaedic ward. At other hospitals, wards are more general and include a mixed group of patients, e.g. general surgical ward. Thus, we analyzed descriptive data stratified by the type of ward classified as surgical, medical, intensive care units including postanaesthesia recovery (ICU), oncology and rehabilitation as well as a group called *other*.

2.3. Outcomes

The outcome of primary interest was the prevalence of patients with PUs category I–IV. The secondary outcome was PUs category II–IV. PUs were classified according to the European Pressure Ulcer Advisory Panels (EPUAP)/ National Pressure Ulcer Advisory Panel's (NPUAP) classification: category I: non-blanchable erythema; category II: partial thickness skin loss; category III: full thickness skin loss; and category IV: full thickness tissue loss including also unstageable and suspected deep tissue injury (National Pressure Ulcer Advisory Panel and European Pressure Ulcer Advisory Panel, 2009). To calculate hospital-acquired PU (HAPU) prevalence we included in the numerator only those patients with no documented PU on admission to hospital.

2.4. Variables/instruments

We used the EPUAP methodology (Vanderwee et al., 2007). The adjusted Norwegian version of the EPUAP data collection form was tested in a pilot study (Bjøro and Ribu, 2009). The form includes the following data:

- General information (treatment centre, ward, length of stay (LOS)).
- Patient characteristics included age, gender, residence, height and weight, PUs present or not on hospital admission, elective or emergency admission, and surgical procedure or not within the previous 14 days. Of these variables the original EPUAP form included only age and gender.
- The Braden scale was used to assess risk factors including sensory perception, nutrition, mobility, activity, moisture and shear/friction (Bergstrom et al., 1987). The six subscales produce a total risk score from 6 to 23 with lower scores indicating a higher risk. We used a cut point of below 17 to indicate increased risk as this is the generally accepted cut point in European studies (Vanderwee et al., 2007, 2011). Further we constructed an increased risk-level group including patients with a Braden total score below 17 and/or patients with a PU. Furthermore, the incontinence subscale of the Norton scale was included.
- Skin observation for PU location and category (see Section 2.3).
- PU preventive measures included the type of any pressure-redistributing support surfaces (no special equipment, non-powered or powered device) and the frequency of repositioning in bed and chair (no planned repositioning or repositioning planned every 2, 3 or 4 h). Furthermore, we added a variable regarding elevation of the heels or not in bed.

2.5. Procedure

Each hospital appointed a coordinator responsible for internal logistics. The head nurse of each participating ward appointed at least one registered nurse to perform the data collection.

Data collectors received training by an e-learning program or by a classroom session. The two programs were similar and included training in the classification of PUs (including differentiating PU and incontinence associated dermatitis), risk assessment with the Braden scale, and a review of the study protocol. The training lasted between 2 and 3 h depending on the type of program and the amount of time spent on the tests. For training and calibration purposes all data collectors from the 88 wards completed a Braden scale test scoring five patient cases. Additionally they scored 20 PU pictures for category. The mean exact percent agreement between the data collectors and the set formula ranged from 81.7% to 93.3% on the Braden subscale scores of the five cases. Not all of our data collectors achieved the targeted goal on the classification test of 80% correct classification. However, only 2 of the 44 (4.5%) teams were not adequately prepared.

To further ensure better identification of PUs, we assembled teams of two nurses, assessing each patient on their wards and auditing the patient records, preferably from different wards to reduce the potential for assessment bias. We also developed a detailed guideline for completion of the EPUAP form. The coordinator collected completed anonymous patient registration forms and submitted the forms to the research study team. The forms were scanned and stored on the research server at a university hospital. Participating hospitals received a report with the main results for their own hospital from the research study team.

3. Analysis methods

Descriptive data were analyzed using SPSS (version 18). We used the Chi-square test to compare the age distribution of excluded and included patients. We compared patients with and without PUs using the Chi-square test for gender and age and the Mann–Whitney *U* test for LOS and total Braden score. We interpreted missing data for mattress and repositioning as no pressure redistributing mattress and no planned repositioning respectively.

In order to investigate whether there were differences across hospitals and/or wards regarding the occurrence of HAPUs, the variance of the dependent variable HAPU was partitioned by multilevel analysis using the MLwiN program 2.26 (University of Bristol's Centre for Multilevel Modelling) (Twisk, 2006). Two dichotomous versions of the HAPU outcome variable were analyzed: (1) *No HAPU* versus *HAPU categories I–IV* and (2) *No HAPU or category I HAPU* versus *HAPU categories II–IV*. The three-level model with hospital, ward and patient levels included only five of the six hospitals in the study as one hospital that participated with only one ward was excluded. The two-level model with ward and patient levels included all 88 wards.

The appropriateness of multilevel analysis was investigated by calculating the Intraclass Correlation Coefficient (ICC) of *the empty model* containing no explanatory variables. This model investigates the distribution of the variance of the dependent variable across levels (i.e. hospital/ward/patient) (Field, 2009; Rasbash et al., 2012; Twisk, 2006; Tabachnick and Fidell, 2013). The ICC is the

higher level variance fraction of the total variance in HAPU: (hospital variance + ward variance)/(hospital variance + - ward variance + patient-level variance). A high ICC indicates that organizational factors may be important in exploring variability in HAPU (Field, 2009). As patient-level variance does not automatically appear in multilevel logistic regression output, we estimated it by using the idea of looking at the logistic model as a latent response model, as suggested by Rabe-Hesketh and Skrondal (2012) and Twisk (2006), who recommend approximating the patient-level variance by the expression $\pi^2/3$.

4. Ethical review

The Norwegian pilot study in 2008 was considered by the Regional Ethics Committee for Medical Research in Eastern Norway to be a quality control study, thus not requiring ethical review board approval. The privacy protection official for each participating hospital approved the multicentre study protocol. Although this study was conducted as an internal quality audit at each hospital, the patients or their relatives received verbal and written information about the study and were informed that they could choose not to participate and that the decision would not affect the care they were given. Data were collected according to the standards laid down by the Declaration of Helsinki. The participating hospitals provided written approval allowing the authors to publish data from the study.

5. Results

A total of 1334 patients were eligible for the study. One hundred and twenty-five patients were excluded because they were on leave from the hospital, did not wish to participate, had not had their skin examined, or were considered too ill to participate. Thus, the final sample included 1209 patients (90.6%) for further analysis. Excluded patients were younger than the included patients ($\chi^2 = 17.169$, $p = 0.004$).

Approximately 40% of the sample were 70 years or above, over 70% of the patients were admitted to surgical or medical wards (Table 1) and most patients were admitted from home (94.6%). The mean total Braden score was 19.7 (SD 3.4) with a median of 21 (range 8–23). The lowest Braden mean score was 16.7 (SD 4.4) registered in the ICUs. Seventeen percent of all the participating patients were at risk of PU development with a Braden total score less than 17 (Table 1). For the patients with PUs, half were at risk on data collection day based on their total Braden score. About 80% of the patients were continent for both urine and feces.

There was no gender difference between patients with and without PUs ($\chi^2 = 0.862$, $p = 0.353$); however, age 70 or above ($\chi^2 = 70.347$, $p < 0.001$) differed significantly. Furthermore, the total Braden score for patients with and without PUs differed (PU 16.0 (SD 3.5) versus no PU 20.5 (SD 2.8) ($p < 0.001$)). Patients with PUs had significantly longer LOS (9.7 (SD 12.0) days) than patients with no PUs (8.6 (SD 17.5) days) ($p < 0.001$).

The overall prevalence was 18.2% (220/1209) for PU category I–IV and 7.2% (87/1209) for category II–IV. The HAPU prevalence rate was 15% (182/1209). Intensive care units had the highest prevalence, followed by medical wards. Almost 75% of the patients with PU were admitted to medical or surgical wards (Table 2). In total, 220 patients had 359 PUs, yielding an average of 1.6 PU per patient (range 1–7).

The sacrum and heel were the most common locations of the most severe PUs (Table 2). The elbow, ankle or head were the most common anatomical locations in the category *other location*. For those with the most severe PU on the heel, only 24 of 59 (40.7%) had a cushion/heel protection for elevating the heels in bed.

A total of 305 patients (25.2%) were at risk with a Braden score below 17 and/or with a PU (Table 3), and 51.1% (156 patients) received neither pressure-redistributing mattress nor planned repositioning and 17.7% (54 patients) received both. Of the at-risk patients not

Table 1
Patient characteristic by ward

($N = 1209$).

	Surgical wards, $n = 480$		Medical wards, $n = 389$		Rehab. wards, $n = 99$		Oncology wards, $n = 139$		ICU[a], $n = 88$		Other wards, $n = 14$		Total, $N = 1209$	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Age	476	99.2	384	98.7	99	100	139	100	85	96.6	14	100	1197	99
18–39	71	14.9	51	13.3	18	18.2	11	7.9	13	15.3	1	7.1	165	13.8
40–59	123	25.8	89	23.2	32	32.3	31	22.3	26	30.6	8	57.1	309	25.8
60–69	101	21.1	64	16.7	29	29.3	35	25.2	21	24.7	2	14.3	252	21.1
70–79	89	18.7	81	21.1	12	12.1	41	29.5	15	17.6	2	14.3	240	20.1
80–89	77	16.2	78	20.3	7	7.1	19	13.7	9	10.6	0		190	15.9
>89	15	3.2	21	5.5	1	1	2	1.4	1	1.2	1	7.1	41	3.4
Gender	468	97.5	377	96.9	98	99	138	99.3	88	100	13	92.9	1182	97.8
Female	229	48.9	162	43	30	30.6	76	55.1	32	36.4	4	30.8	533	44.1
Male	239	51.1	215	57	68	69.4	62	44.9	56	63.6	9	69.2	649	55.8
Braden score	465	96.9	355	91.3	97	98	121	87	86	97.7	14	100	1138	94.1
(<17)	58	12.5	69	19.4	17	17.5	11	9.1	38	44.2	1	7.1	194	17

[a] Intensive care units includes both postanaesthesia recovery and intensive care units.

Table 2
PU prevalence, location and category of most severe PU by ward ($N = 1209$).

	Surgical wards, $n = 480$		Medical wards, $n = 389$		Rehab. wards, $n = 99$		Oncology wards, $n = 139$		ICU[a], $n = 88$		Other wards, $n = 14$		Total, $N = 1209$	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
PU prevalence														
Category I–IV	77	16.0	85	21.9	13	13.1	17	12.2	28	31.8	0	0	220	18.2
Category II–IV	30	6.2	30	7.8	8	8.0	7	5.0	12	13.6	0	0	87	7.2
PU documented at admission to hospital	12	15.6	13	15.3	6	46.2	2	11.8	5	17.9	0	0	38	17.3
Location of most severe PU														
Sacrum	26	33.8	34	40.0	5	38.5	6	35.3	9	32.1	0	0	80	36.4
Heel	27	35.1	18	21.2	2	15.4	4	23.5	8	26.8	0	0	59	26.8
Hip	4	5.2	4	4.7	2	15.4	2	11.8	2	7.1	0	0	14	6.4
Other location	20	26.0	29	34.1	4	30.8	5	29.4	9	32.1	0	0	67	30.5
Category of most severe PU														
Category I	47	61.0	55	64.7	5	38.5	10	58.8	16	57.1	0	0	133	60.5
Category II	17	22.1	19	22.4	3	23.1	5	29.4	8	28.6	0	0	52	23.6
Category III	4	5.2	8	9.4	1	7.7	1	5.9	3	10.7	0	0	17	7.7
Category IV	9	11.7	3	3.5	4	30.8	1	5.9	1	3.6	0	0	18	8.2

[a] Intensive care units includes both postanaesthesia recovery and intensive care units.

confined to bed (201 patients), few had preventive measures while seated in a chair. Only 13.9% (28 patients) had a cushion and 2% (4 patients) had planned repositioning while seated. For those patients not at risk, 83.7% (757/904 patients) received no pressure-redistributing mattress.

Multilevel analysis showed that the variance in the presence of HAPUs was primarily at patient level. Still, there was considerable variance at organizational levels: this variance was at ward level and not at hospital level (Table 4). There was less across-ward variance for the dichotomous variable for HAPUs with categories II–IV collapsed into one group, indicating more severe skin damage, compared to the models including all four categories of PUs as one group (ICC 8.12 versus 21.51) (Table 4).

6. Discussion

The 18.2% PU prevalence documented in this Norwegian sample is similar to the prevalence rates of 16.6–18.5% found in comparable European studies (Gallagher et al., 2008; Gunningberg et al., 2013a; Vanderwee et al., 2007). In a Dutch and German study, the Dutch hospitals reported 18.1% PU prevalence whereas in the German the prevalence was only 9% (Tannen et al., 2008). Also other studies have showed a lower PU prevalence than ours. A UK study showed 14.8% (Briggs et al., 2013) and a Belgian national study had 12.1% PU prevalence (Vanderwee et al., 2011).

The PU prevalence at ward level was highest in ICUs, as was the case in the Belgian study (Vanderwee et al., 2011). Even though a high prevalence on these wards is not surprising given the low activity and mobility level and high severity of illnesses of the patients, the Norwegian ICU prevalence was much higher (31.8% vs. 19.9%). The reason for this result is unclear. However, Lahmann et al. (2012) showed that when controlled for surface, repositioning, immobility, shear forces, age and gender, the ICU unit is no longer a high-risk factor for the development of PU. Preventive measures such as mattress and repositioning were documented for over 70% of the patients at risk on ICU wards; however, given their high risk level, all ICU patients at risk should have preventive measures. PU prevalence studies have not been systematically conducted in Norwegian hospitals and thus continuous monitoring and prevention efforts may need to be

Table 3
Preventive measures for patients at risk (Braden score < 17 and/or with PU) by ward ($N = 305$).

	Surgical wards		Medical wards		Rehab. wards		Oncology wards		ICU[a]		Other wards		Total	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Patients at risk	102	21.3	110	28.3	25	25.3	21	15.1	46	52.3	1	7.1	305	25.2
Prevention in bed														
Pressure redistributing mattress	35	34.3	32	29.1	14	56.0	18	85.7	35	76.1	0	0	135	44.3
Heel protection/floating heels	43	42.2	30	27.3	10	40.0	6	28.6	20	43.5	0	0	109	35.7
Planned repositioning	12	11.8	11	10.0	9	36.0	3	14.3	33	71.7	0	0	68	22.3

[a] Intensive care units includes both postanaesthesia recovery and intensive care units.

Table 4
Variance components of the logistic multilevel analysis for (1) no HAPU versus HAPU I–IV and (2) no HAPU/HAPU I versus HAPU categories II–IV.

Model	No HAPU versus HAPU I–IV		No HAPU/HAPU I versus HAPU II–IV	
	Three level ($N = 1136$)	Two level ($N = 1168$)	Three level ($N = 1136$)	Two level ($N = 1168$)
Hospital variance (SE)	0.000 (0.000)[a]		0.000 (0.000)[a]	
Ward variance (SE)	0.921 (0.240)[b]	0.901 (0.227)[b]	13.516 (2.049)[b]	14.225 (2.097)[b]
Patient variance	3.287	3.287	3.287	3.287
Total variance	4.208	4.188	16.803	17.512
ICC ward	21.89	21.51	8.04	8.12

ICC = organizational level variance/total variance × 100.
[a] $p = 0.399$.
[b] $p < 0.001$.

intensified. Older patients are at high risk and two-thirds of the patients with PUs in our study were 70 years or above. Considering the expected increase in the number of elderly patients, hospitals must tailor care to meet the needs of these vulnerable patients (Coleman et al., 2013; National Pressure Ulcer Advisory Panel and European Pressure Ulcer Advisory Panel, 2009).

In our study 60.5% of the PUs were category I. This is a higher rate than shown in comparable studies, which demonstrate a rate of 50.2% or less (Gunningberg et al., 2013a; Vanderwee et al., 2007). This may mean that blanchable erythema or deep tissue injury (DTI) were incorrectly identified as non-blanchable erythema (category I) in our study. Accurate classification of PUs is difficult and studies have shown varying degrees of inter-rater reliability for classification (Bruce et al., 2012). A review article concluded that category I is a major predictor for greater PU severity, and ultrasound has shown evidence of deeper tissue injury in category I PUs than may be identified clinically (Coleman et al., 2013; Low et al., 2010). Thus, in clinical practice it is better to over-diagnose blanchable erythema and implement prevention than to under-diagnose non-blanchable erythema since category I may quickly progress to more serious PU. However, classification of PU in nursing education and in furthering clinical education should be emphasized to improve accuracy in practice and research.

International guidelines (National Pressure Ulcer Advisory Panel and European Pressure Ulcer Advisory Panel, 2009) and a Cochrane review (McInnes et al., 2011) conclude that the use of pressure-redistributing support surfaces in beds and chairs as well as repositioning is important PU preventive measures, especially for those with low mobility. In two previous studies utilizing the EPUAP methodology 71.6% and 91.2% of the patients at risk had either planned repositioning or support surfaces or both in bed (Vanderwee et al., 2007, 2011) but in our study less than half of the patients at risk did. Other studies have also found a much higher percentage of repositioning alone (38.2% and 47%) than our study (Gunningberg et al., 2013a; Vanderwee et al., 2007). Support surfaces are important preventive measures but should be utilized together with repositioning. Our study shows a lack of both indicating an increased risk that these patients may develop more severe categories of PU during their hospital stay. Repositioning is thought to be time-consuming and perhaps this is one reason for the low rate of planned repositioning in our patients.

About 17% of the most severe PUs were documented on admission, showing that not all PUs should be considered a reflection of the quality of care and preventive effort of the patient's current unit. Nevertheless, most PUs develop during the hospital stay: the prevalence of HAPUs was 15% in this study, which may be explained by the infrequent use of preventive measures. Guidelines recommend the use of a valid risk assessment scale together with skin assessment and clinical judgement (National Pressure Ulcer Advisory Panel and European Pressure Ulcer Advisory Panel, 2009) on admission with reassessment conducted when health condition changes during hospitalization. Implementation of these recommendations could probably reduce the PU problem in Norwegian hospitals.

Only half of the patients with PUs were identified as being at risk by the Braden scale on data collection day. However, since this was a point prevalence study, we were not able to determine if the patients had had lower Braden total scores earlier during their hospital stay. The hospital as well as the ward management must facilitate improvements in level of PU attention and knowledge among staff in relation to preventive measures including the use of pressure redistributing support surfaces and repositioning. Some patients are at higher risk than others, and it is important to identify them and tailor their care to their increased susceptibility (National Pressure Ulcer Advisory Panel and European Pressure Ulcer Advisory Panel, 2009).

The dominating result of the multilevel analysis was that most variance was at patient level. Still there was also significant variance at ward level, and the high ICC indicates that multilevel analysis is appropriate.

Ward-related factors might have an impact on the PU problem. Studies show that nurses place PU prevention low on the list in order to prioritize more urgent tasks (Aiken et al., 2013; Samuriwo, 2010). Sving et al. (2014) found a significant difference for type of hospital and ward, showing that PU prevention may be related to the hospital and ward to which one is admitted. However, we found only variance at patient and ward levels. To limit the PU problem, interventions must not aim solely at improving the care of the individual patient but also at developing ward-nursing routines which focus more closely on PU prevention. Wards with a lower prevalence may be regarded as an example of good care that others may learn from. The ward-level variance may also indicate that PU-improvement interventions should not be aimed indiscriminately at entire hospitals. However, there was less variance at ward

level for the dichotomous variable collapsing category II–IV (ICC 8.12) than when all four categories were collapsed (ICC 21.51). This difference in variance could be explained by difficulties in classifying category I PU. Outright skin damage, such as a blister, a skin wound or necrosis, is easier to classify as a PU than redness in the skin.

Few PU prevalence studies have used a multilevel approach to take into account the nested structure in health care organizations (Wilborn et al., 2010) and our study shows that the PU prevalence may be associated with organizational differences. It is, however, an empirical question whether the variance in the PU odds at ward level reflects inter-ward differences in organization and quality of care factors such as a higher staff-to-patient ratio or better patient-safety culture on some wards than on others. The variance at ward level may also reflect differences in case mix; some wards may just have more PU high-risk patients than other wards. Further research is warranted to more fully understand the importance of organizational characteristics at hospital and ward level.

One strength of our study is that both smaller and larger hospitals with patients from wards of different specialities were included, even though the study sample includes only one health region and thus cannot be generalized to the entire country. Another strength is the common study protocol based on the well documented methodology from EPUAP used at all participating hospitals and that the data collectors underwent the same training session. However, many variables which might explain PU development were not assessed, such as blood samples (serum hemoglobin, albumin, total protein), the date of PU discovery, the ward where the patient was admitted when the PU first appeared, the use of nutritional supplements, the patient's diagnosis and co-morbidities, and staff knowledge about and attitude to the PU prevention.

About 10% of patients were excluded and these patients were significantly younger. Since older patients have increased risk of PU, our prevalence result may be slightly inflated. However, even if all of the excluded patients had been included as PU free, the prevalence would still be as high as 16.5%.

We tried to limit bias by using a standardized training and testing program in the Braden scale scoring and PU classification prior to data collection. All the data collectors achieved the targeted goal of 80% agreement on the Braden subscale scores of the five cases. Further, in 95.5% of the 44 data collection teams at least one nurse in the teams did achieve the targeted goal of 80% correct classification. However, it may be a limitation that not both the nurses of the teams achieved the targeted goal on the PU classification test.

This prevalence study was a snapshot of one day providing important PU baseline data prior to commencement of the Patient Safety Campaign on PUs. One must bear in mind that there are natural fluctuations in prevalence rates and prevalence does not provide the insight that can be gained from incidence studies (Baharestani et al., 2009). For our purpose of providing baseline data, a prevalence study was time-saving and less labor intensive for the participating hospitals than an incidence study would have been, and PU prevalence studies can be the first step in improving hospital quality of PU prevention and care (Halfens et al., 2013).

7. Conclusion

Overall the prevalence of PUs in Norwegian hospitals was similar to the prevalence found in other European hospitals. It is a serious concern that so many at-risk patients did not receive evidence-based preventive measures. Future improvement work in Norwegian hospitals should probably include emphasizing better implementation of PU preventive guidelines, in particular use of support surfaces and planned repositioning of patients at risk of developing PUs. Even though interventions for improvement are mostly patient related, improvement of procedures and organization at ward level may also be important since a variance of PU occurrence was found at ward level. Further research should study the effects of organizational factors on the odds of developing HAPUs as well as the effects of patient risk factors.

Conflict of interest

None.

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Ethical approval

The privacy protection official of each participating hospital provided sufficient formal approval to conduct this multi-centre study.

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References

Aiken, L.H., Sloane, D.M., Bruyneel, L., Van den Heede, K., Sermeus, W., 2013. Nurses reports of working conditions and hospital quality of care in 12 countries in Europe. Int. J. Nurs. Stud. 50 (2), 143–153.

Baharestani, M.M., Black, J.M., Carville, K., Clark, M., Cuddigan, J.E., Dealey, C., Defloor, T., Harding, K.G., Lahmann, N.A., Lubbers, M.J., Lyder, C.H., Ohura, T., Orsted, H.L., Reger, S.I., Romanelli, M., Sanada, H., 2009. Dilemmas in measuring and using pressure ulcer prevalence and incidence: an international consensus. Int. Wound J. 6 (2), 97–104.

Beeckman, D., Defloor, T., Schoonhoven, L., Vanderwee, K., 2011. Knowledge and attitudes of nurses on pressure ulcer prevention: a cross-sectional multicenter study in Belgian hospitals. Worldviews Evid. Based Nurs. 8 (3), 166–176.

Bergstrom, N., Demuth, P.J., Braden, B.J., 1987. A clinical trial of the Braden Scale for Predicting Pressure Sore Risk. Nurs. Clin. North Am. 22 (2), 417–428.

Bjøro, K., Ribu, L., 2009. Pilot study of pressure ulcer prevalence in a Norwegian hospital. Sykepl. Forsk. 4 (4), 299–305 (in Norwegian).

Bosch, M., Halfens, R.J., van der Weijden, T., Wensing, M., Akkermans, R., Grol, R., 2011. Organizational culture, team climate, and quality management in an important patient safety issue: nosocomial pressure ulcers. Worldviews Evid. Based Nurs. 8 (1), 4–14.

Bours, G.J., Halfens, R.J., Abu-Saad, H.H., Grol, R.T., 2002. Prevalence, prevention, and treatment of pressure ulcers: descriptive study in 89 institutions in the Netherlands. Res. Nurs. Health 25 (2), 99–110.

Briggs, M., Collinson, M., Wilson, L., Rivers, C., McGinnis, E., Dealey, C., Brown, J., Coleman, S., Stubbs, N., Stevenson, R., Nelson, E.A., Nixon, J., 2013. The prevalence of pain at pressure areas and pressure ulcers in hospitalised patients. BMC Nurs. 12 (1), 19.

Bruce, T.A., Shever, L.L., Tschannen, D., Gombert, J., 2012. Reliability of pressure ulcer staging: a review of literature and 1 institution's strategy. Crit. Care Nurs. Q. 35 (1), 85–101.

Coleman, S., Gorecki, C., Nelson, E.A., Closs, S.J., Defloor, T., Halfens, R., Farrin, A., Brown, J., Schoonhoven, L., Nixon, J., 2013. Patient risk factors for pressure ulcer development: systematic review. Int. J. Nurs. Stud. 50 (7), 974–1003.

Dealey, C., Brindle, C.T., Black, J., Alves, P., Santamaria, N., Call, E., Clark, M., 2013. Challenges in pressure ulcer prevention. Int. Wound J. (Epub ahead of print).

Field, A., 2009. Discovering Statistics Using SPSS: (and Sex and Drugs and Rock 'n' Roll). SAGE, Los Angeles.

Gallagher, P., Barry, P., Hartigan, I., McCluskey, P., O'Connor, K., O'Connor, M., 2008. Prevalence of pressure ulcers in three university teaching hospitals in Ireland. J. Tissue Viability 17 (4), 103–109.

Gunningberg, L., Hommel, A., Baath, C., Idvall, E., 2013a. The first national pressure ulcer prevalence survey in county council and municipality settings in Sweden. J. Eval. Clin. Pract. 19 (5), 862–867.

Gunningberg, L., Martensson, G., Mamhidir, A.G., Florin, J., Muntlin, A.A., Baath, C., 2013b. Pressure ulcer knowledge of registered nurses, assistant nurses and student nurses: a descriptive, comparative multicentre study in Sweden. Int. Wound J. (Epub ahead of print).

Halfens, R.J., Meesterberends, E., van Nie-Visser, N.C., Lohrmann, C., Schonherr, S., Meijers, J.M., Hahn, S., Vangelooven, C., Schols, J.M., 2013. International prevalence measurement of care problems: results. J. Adv. Nurs. 69 (9), e5–e17.

Helse Sør-Øst, 2013. http://www.helse-sorost.no/omoss/english/Sider/page.aspx (14.02.14).

James, J., Evans, J.A., Young, T., Clark, M., 2010. Pressure ulcer prevalence across Welsh orthopaedic units and community hospitals: surveys based on the European Pressure Ulcer Advisory Panel minimum data set. Int. Wound J. 7 (3), 147–152.

Lahmann, N.A., Kottner, J., Dassen, T., Tannen, A., 2012. Higher pressure ulcer risk on intensive care? – comparison between general wards and intensive care units. J. Clin. Nurs. 21 (3-4), 354–361.

Low, C.J., Davenport, T.A., Luchs, J., 2010. 91C: the correlation between ultrasound findings and clinical assessment of pressure related ulcers: is extent of injury greater than what is predicted? Plast. Reconstr. Surg. 125 (6), 65.

McInnes, E., Jammali-Blasi, A., Bell-Syer, S.E., Dumville, J.C., Cullum, N., 2011. Support surfaces for pressure ulcer prevention. Cochrane Database Syst. Rev. (4), CD001735.

Meesterberends, E., Wilborn, D., Lohrmann, C., Schols, J.M., Halfens, R.J., 2014. Knowledge and use of pressure ulcer preventive measures in nursing homes: a comparison of Dutch and German nursing staff. J. Clin. Nurs. 23 (13–14), 1948–1958.

National pressure Ulcer Advisory Panel and European Pressure Ulcer Advisory Panel, 2009. Pressure Ulcer. Prevention and Treatment. Clinical Practice Guideline. National Pressure Ulcer Advisory Panel, Washington, DC, pp. 1–130.

Rabe-Hesketh, S., Skrondal, A., 2012. Multilevel and Longitudinal Modeling Using Stata. Stata Press, College Station, TX.

Rasbash, J., Steele, F., Browne, W.J., Goldstein, H., 2012. A User's Guide to MLwiN, v2.26. Centre for Multilevel Modelling. University of Bristol, Bristol.

Reddy, M., Gill, S.S., Rochon, P.A., 2006. Preventing pressure ulcers: a systematic review. JAMA 296 (8), 974–984.

Samuriwo, R., 2010. Effects of education and experience on nurses' value of ulcer prevention. Br. J. Nurs. 19 (20), S8–S18.

Sving, E., Idvall, E., Hogberg, H., Gunningberg, L., 2014. Factors contributing to evidence-based pressure ulcer prevention. A cross-sectional study. Int. J. Nurs. Stud. 51 (5), 717–725.

Tabachnick, B.G., Fidell, L.S., 2013. Using Multivariate Statistics. Pearson, Boston.

Tannen, A., Dassen, T., Halfens, R., 2008. Differences in prevalence of pressure ulcers between the Netherlands and Germany – associations between risk, prevention and occurrence of pressure ulcers in hospitals and nursing homes. J. Clin. Nurs. 17 (9), 1237–1244.

Twisk, J.W.R., 2006. Applied Multilevel Analysis: A Practical Guide. Cambridge University Press, Cambridge.

Vanderwee, K., Clark, M., Dealey, C., Gunningberg, L., Defloor, T., 2007. Pressure ulcer prevalence in Europe: a pilot study. J. Eval. Clin. Pract. 13 (2), 227–235.

Vanderwee, K., Defloor, T., Beeckman, D., Demarre, L., Verhaeghe, S., Van, D.T., Gobert, M., 2011. Assessing the adequacy of pressure ulcer prevention in hospitals: a nationwide prevalence survey. BMJ Qual. Saf. 20 (3), 260–267.

Wilborn, D., Grittner, U., Dassen, T., Kottner, J., 2010. The National Expert Standard Pressure Ulcer Prevention in Nursing and pressure ulcer prevalence in German health care facilities: a multilevel analysis. J. Clin. Nurs. 19 (23-24), 3364–3371.