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Care-Related Risk Factors for Hospital-Acquired Pressure Ulcers Among Elderly Hip Fracture Patients

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Abstract

OBJECTIVES—To identify care-related factors associated with increased incidence of hospital-acquired pressure ulcers (HAPU)

DESIGN—Prospective cohort study

SETTING—Nine hospitals in Baltimore Hip Studies network

PARTICIPANTS—658 patients age ≥65 years who underwent surgery for hip fracture

MEASUREMENTS—Skin examinations at baseline and alternating days until hospital discharge. Patients were deemed to have a HAPU if they developed ≥1 new pressure ulcers stage 2 or higher during the hospital stay.

RESULTS—Longer emergency department stays were associated with lower HAPU incidence (>4-6 hours: adjusted incidence rate ratio [aIRR] 0.68, 95% confidence interval [CI] 0.48-0.96; >6

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hours: aIRR 0.68, 95% CI 0.46-0.99, both compared to ≤4 hours). Patients with ≥24 hours between admission and surgery had a higher post-surgery HAPU rate than those with <24 hours (aIRR 1.62, 95% CI 1.24-2.11). Surgery with general anesthesia had a lower post-surgery HAPU rate than surgery with other types of anesthesia (aIRR 0.66, 95% CI 0.49-0.88). There was no significant association of HAPU incidence with timing or type of transport to hospital, or surgery duration.

CONCLUSION—Most of the factors hypothesized to be associated with higher pressure ulcer incidence were either associated with lower incidence or were not significantly associated, suggesting that HAPU development may not be as sensitive to care-related factors as commonly believed. Rigorous studies of innovative preventive interventions are needed to inform policy and practice.

Keywords

Pressure ulcers; Hospitals; Hip fracture; Risk factors

INTRODUCTION

Pressure ulcers are areas of injury that can develop when there is prolonged compression of skin or underlying tissue between a bony prominence (such as the sacrum or heels) and an external surface (such as a mattress or chair seat) (1). Pressure ulcers in elderly hospital patients can have significant negative effects in terms of pain, quality of life, length of hospital stay, cost of care, medical complications, and mortality (2). The prevention of pressure ulcers is an important goal in hospital settings, especially because the Centers for Medicare and Medicaid Services considers hospital-acquired pressure ulcers (HAPUs) to be preventable complications of medical care and does not reimburse hospitals for the cost of their treatment (3).

The major pressure ulcer risk factor is immobility; other patient characteristics such as incontinence and poor nutritional status have also been found to increase pressure ulcer risk (4). Elderly patients undergoing surgical repair of a hip fracture constitute a high-risk population given their potential for long periods of immobility and the presence of other pressure ulcer risk factors (5). However, characteristics of the care provided to these patients may also contribute to higher pressure ulcer risk. The purpose of this study was to determine whether care-related factors involving potentially long periods of immobility before and during hospitalization are associated with a higher incidence of HAPUs among older adults undergoing surgery for hip fracture.

METHODS

Design

The methods for this study of acquired pressure ulcers in elderly hip fracture patients have been previously reported in detail (5). Briefly, this cohort study was carried out between 2004 and 2007 in nine hospitals that are part of the Baltimore Hip Studies network (6). Patients were included if they were age 65 years or older and had surgery for hip fracture (ICD-9 code 820) at one of the study hospitals. Written informed consent was obtained from cognitively intact patients. If the patient's Mini-Mental State Exam (MMSE) (7) score was less than 20, verbal assent was obtained from the patient and written informed consent from a proxy. Proxy consent was also obtained for patients who were unconscious or noncommunicative. The study was approved by the Institutional Review Boards of the University of Maryland, Baltimore, and of each participating hospital.

Study patients were examined at baseline and on alternating days for 21 days (a total of 11 assessments). We attempted to perform the baseline examination as soon as possible after hospital admission but, due to delays in obtaining informed consent, the baseline examination was performed, on average, 2.9 days after the patient was admitted (Table 1). The current analysis is based only on assessments performed while the patient was still in the acute care setting.

Measures

At each visit, research nurses assessed the presence and severity of pressure ulcers, using a standard research protocol whose validity and reliability have been reported (8). The following definitions were used for pressure ulcer staging (9): stage 1 (alteration of intact skin with persistent redness), stage 2 (partial thickness dermal loss or serum-filled blister), and stages 3 and 4 (full thickness tissue loss without/with exposed bone, tendon, or muscle). Lesions in an area with active skin disease, wounds on the plantar surface of the forefoot and midfoot, and wounds on the leg between the malleolus and the popliteal fossa were not considered to be pressure ulcers. Patients were classified as having a HAPU if they developed one or more new pressure ulcers stage 2 or higher during their acute hospital stay, whether or not they had a pressure ulcer at the time of admission to the hospital. Pressure ulcers observed at the baseline assessment were classified as pre-existing, possibly hospital-acquired, or definitely hospital-acquired, based on pressure ulcer stage and on agreement among multiple sources of information (patient, family, chart or transfer form, and hospital staff), using criteria that have been previously described (10). For this analysis, possibly and definitely acquired pressure ulcers were considered to be HAPUs.

The medical chart was abstracted to obtain information on time from fracture to arrival at the hospital; type of transport to the hospital (ambulance, other); length of stay in the emergency department (ED); time from inpatient admission to surgery; duration of surgery; and type of anesthesia (general anesthesia; other type). Weight and height were also abstracted from the medical chart or, when missing, were obtained by interviewing the patient or proxy. Body mass index (BMI) was calculated from weight and height (kg/m^2). History of chronic cognitive deficit was assessed from the medical chart; if missing in the chart, it was assumed to be absent. Severity of illness was measured using the Rand Sickness at Admission Scale (hip fracture version) (11) which provides the weighted sum of 12 clinical and laboratory variables (e.g., age, blood pressure, blood gases, heart failure, creatinine), abstracted from the medical record. Albumin level was obtained from the medical chart, with normal defined as ≥3.0 g/dL or missing.

Information on other covariates was obtained by clinical examination. The Subjective Global Assessment of Nutritional Status (12) was used by the research nurses to classify patients as being at low, moderate, or high risk of nutrition-related complications at baseline. Mental status was measured at baseline with the MMSE (7); patients who were unconscious or noncommunicative received a score of 0. At each assessment visit, the patient's current activity level (walks, chairbound, bedbound) was evaluated based on observation and discussion with clinical staff. Also, at each assessment visit, the patient was classified according to the number of dimensions (person, place, and time) to which he or she was oriented (range 0-3) and the research nurse recorded whether there was a pressure-redistributing mattress or overlay on the patient's bed.

Analysis

All analyses were performed in SAS version 9.1 (SAS Institute, Inc., Cary, NC). To account for different patients having different lengths of follow-up, a time-to-event analysis was performed. Follow-up was defined as the time at risk in the study, from hospital admission

to the first HAPU, discharge from the hospital, or loss to follow-up, whichever came first. We used a Poisson regression model with a log link function, treating the first HAPU as the outcome of interest and treating loss to follow-up and HAPU-free discharge as censoring. Log of time was included as an offset term in the model.

Two groups of care-related factors were considered. Group 1 consisted of three factors assessed prior to surgery: timing and type of transport to the hospital, and length of stay in the ED. Group 2 consisted of three surgery-related factors: time between inpatient admission and surgery, duration of surgery, and type of anesthesia. For each care-related factor in Group 1, an unadjusted model was fit. Then an adjusted model was fit that included the three Group 1 care-related factors, along with covariates (MMSE score, history of chronic cognitive deficit, risk of nutrition-related complications, BMI, activity level, pre-existing pressure ulcers, Rand Sickness at Admission score, age, sex, pre-admission residence, albumin level, number of orientations at baseline, and admission hospital). An additional adjusted model was fit that included the three Group 1 care-related factors, and the covariates listed above, plus use of pressure-redistributing overlays or mattresses as a time-varying covariate. For models assessing Group 1 factors, follow-up included time from inpatient admission to first HAPU, hospital discharge, or loss to follow-up, whichever came first. All in-hospital observations were included in these models.

A similar modeling strategy was used for Group 2 care-related factors, but with the following differences. First, to ensure that outcomes could be plausibly related to predictors, the outcome for Group 2 factors was limited to HAPUs that occurred after surgery and patients with a pre-surgery HAPU (N=19) were excluded from analyses. Second, the Group 1 care-related factors were included as covariates in the adjusted models. Finally, for models assessing Group 2 care-related factors, follow-up included time from surgery to first HAPU, hospital discharge, or loss to follow-up, whichever came first.

Because the number of outcomes in some of the study hospitals was small, admission hospital was treated as a three-category variable (one category for each of the two largest hospitals and one category for all others combined).

RESULTS

A total of 658 patients were enrolled, representing 62% of the eligible patients who were screened for the study (5). Baseline characteristics of study participants are shown in Table 1. Among the 658 study participants, 96 (14.6%) developed one or more HAPUs. Patients who went on to develop a HAPU had greater severity of illness, poorer mental status, and much higher risk of nutrition-related complications at baseline than patients who did not develop a HAPU ($p<0.05$). They were also more likely to be incontinent, to be bedbound, and to have a longer hospital stay.

The mean length of follow-up (defined as the interval from baseline assessment to first HAPU, hospital discharge, or loss to follow-up) was 3.0 days (range 0.5-21 days) and the total number of person-days was 1,984, for an incidence rate of 4.8 per 100 person-days of observation.

Among the 96 patients with at least one HAPU, there were 121 HAPUs (Table 2). Most of these (88%) were stage 2 when first observed and the remainder were unstageable due to eschar, necrotic tissue, or dressing. Fifty-five percent of HAPUs were on the sacrum or posterior iliac crest, and 13% were on the heels.

Table 3 shows the unadjusted and adjusted incidence rate ratios (aIRRs) and 95% confidence intervals (CIs) for the care-related factors of interest. A longer ED stay was

associated with significantly lower HAPU incidence rate (>4-6 hours compared to ≤4 hours: aIRR 0.68, 95% CI 0.48-0.96; p=0.03); >6 hours compared to ≤4 hours: aIRR 0.68, 95% CI 0.46-0.99; p=0.047). Also, having an interval of ≥24 hours between inpatient admission and surgery was associated with a higher post-surgery HAPU rate (aIRR 1.62, 95% CI 1.24-2.11; p<.001). Patients who had surgery under general anesthesia had a lower post-surgery HAPU rate than patients who had surgery with other types of anesthesia (aIRR 0.66, 95% CI 0.49-0.88; p=0.005). There was no significant association of HAPU incidence with time between fracture and transport to the hospital, type of transport to the hospital (ambulance versus other type), or duration of surgery.

DISCUSSION

The aim of this study was to identify care-related factors associated with an increased risk of HAPUs. Contrary to expectation, for many of the factors, there was either no association or the association was not in the hypothesized direction.

A surprising finding was that the incidence of HAPUs was inversely associated with length of ED stay. One possible explanation is that patients with longer ED stays have fewer pressure ulcer risk factors because sicker patients are transferred more quickly from the ED to an inpatient unit. Although the association between length of ED stay and HAPU incidence was unchanged after adjusting for a large number of pressure ulcer risk factors as well as admission hospital, confounding by unmeasured variables cannot be excluded as an explanation. A second possible explanation is that the number of staff-patient interactions may be higher, and patients may be assessed and treated more quickly, in the ED than on an inpatient unit resulting in better pressure ulcer outcomes among those with longer stays in the ED. For example, prompt attention to pain control in the ED may make it easier for the patient to change body position independently, and continuous monitoring of blood pressure, urinary output, and hydration in the ED may reduce the patient's vulnerability to pressure ulcer development. This suggests that more intensive monitoring and more frequent staff-patient interactions could help prevent HAPUs once the hip fracture patient moves to an inpatient unit.

There was a significant association between higher HAPU rates and longer intervals between inpatient admission and surgery. This association may be attributable to greater disease severity among patients with longer surgical wait times. Although the association between time to surgery and HAPU incidence was unchanged after adjusting for pressure ulcer risk factors (including two measures of disease severity), confounding by unmeasured variables is still a possibility. Surgical delays may be the result of patient-related medical factors which, although not modifiable, could alert hospital staff to the need for aggressive preventive interventions. Alternatively, it may be that the higher incidence of HAPUs is caused by longer periods of immobility among patients with a longer wait for surgery. Surgical delays that are caused by system factors (such as operating room availability) are potentially modifiable (13).

General anesthesia was associated with lower HAPU incidence. It may be that the complete lack of sensation in the lower body that is temporarily induced by regional anesthesia prevents the patient from making even small shifts to redistribute pressure, resulting in greater immobility and higher pressure ulcer risk than with general anesthesia. Alternatively, these results may be attributable to patient characteristics (such as health status), or to anesthesiologists' preferences, that guide choice of anesthesia type.

There was no significant association between HAPU incidence and time between fracture and transport to the hospital. The lack of association may be attributed to the fact that we did

not have data on the exact time of the fracture and could only define time of transport to the hospital as being on versus after the day of fracture.

HAPU incidence was not significantly associated with the duration of the surgical procedure. However, only about 30% of procedures lasted two hours or more; it may be that pressure ulcer risk is only increased when the surgical operation is very long.

Finally, although very high interface pressures have been observed during ambulance transport (14), there was no evidence in this study that pressure ulcer incidence differed according to type of transport to the hospital. However, the number of patients who were not transported by ambulance was small.

There is considerable variation in results from previous studies. The care-related factor that has received the most attention is interval from hospital admission to surgery. Most studies found a positive association between surgical delay and HAPU occurrence (15-19), as in the current study, although three studies found no association (20-22) and one found a negative association (23). For duration of surgery, there was no association with HAPU occurrence in two studies (19, 22), which is consistent with the current study. However, surgery duration was positively associated with pressure ulcer occurrence in three studies (16, 21, 24) and negatively associated in one study (23). Results were similarly inconsistent in the studies that addressed each of the other care-related factors of interest in this study.

Of 10 previous studies on care-related factors and pressure ulcers among hip fracture patients (15-24), only one was conducted in the US (16), and that study included patients hospitalized several decades ago (1983-1993). The fact that care-related factors are likely to be sensitive to differences in time period and location may help explain the startling lack of consistency in findings across studies. Another explanation for disparate results is variation in study methods. Only two previous studies (22, 24) used dedicated research staff to perform skin examinations to identify pressure ulcers; other studies used less reliable chart review or did not report the pressure ulcer identification method. Similarly, fewer than half of the previous studies (15-18) used multivariable statistical methods to adjust for possible confounding.

Among the strengths of this study are the inclusion of a large number of patients from multiple hospitals and the availability of detailed time-varying patient information that allowed us to adjust for a large number of pressure ulcer risk factors when assessing the impact of care-related factors. Another strength is the use of intensive pressure ulcer detection methods by expert research nurses using a validated assessment protocol (8). One limitation is that information on care-related factors, which was obtained from the medical chart, may have been incomplete or inaccurate. However, since it is unlikely that misclassification of this type would depend on pressure ulcer status, any bias would be towards the null. Second, we only included pressure ulcers that were detected while the patient was still in the hospital. Because pressure ulcers may not become apparent until several days after an initial insult, we may have missed HAPUs that appeared after discharge. However, we believe that the probability of missing a HAPU that was related to hospital factors is low, especially since the risk factors examined in this study all occurred early in the hospital stay and, therefore, HAPUs related to these insults would probably be detectable while the patient was still in the hospital. Third, because it was often impossible to perform the baseline assessment immediately after hospital admission, some of the pressure ulcers observed at baseline might have been present before admission. To distinguish pre-existing from hospital-acquired pressure ulcers, we used a retrospective method based on pressure ulcer stage and agreement among multiple sources of information (10). Although there may have been some misclassification related to this approach, the

misclassification was most likely similar among those with and without the care-related factors so any bias would be towards the null. Finally, because the frequency of many of the care-related factors varied by study hospital, we adjusted for hospital in the statistical analysis. This statistical control was imperfect, however, because seven of the hospitals had to be combined to address data sparseness issues. Since the hospitals that were combined contributed only 21% of the HAPUs, these hospitals are unlikely to have had a large influence on the outcome. Therefore, even if the hospitals differed with respect to the predictors, residual confounding would be negligible.

Implications

HAPU frequency has declined very little in recent years (25) despite the adoption of national pressure ulcer prevention objectives (26) and clinical practice guidelines (27). Attention to this problem has increased since Medicare's decision not to reimburse hospitals for the cost of treating HAPUs (3). Medicare's designation of HAPUs as being reasonably preventable implies that the occurrence of HAPUs should be sensitive to the care provided to patients. Results of the current study and of previous studies on care-related factors provide only partial evidence for this assumption. Moreover, there is only limited evidence supporting the effectiveness of widely-used preventive interventions such as pressure-redistributing support surfaces (28) and frequent repositioning (29, 30). The premise of preventability, which is only tenable if effective interventions are available, merits critical examination. It may be that the current paradigm is no longer adequate and that innovative approaches to prevention are required. Rigorous studies of such interventions will be needed to inform policy and practice.

CONFLICT OF INTEREST CHECKLIST

Elements of financial/ personal conflicts	MB	SER	MDS	WGH	DJM	PL	DLO	MHP	PSJ	RS	BPK	JM*
Employment/affiliation	No	No	No	No	No	No	No	No	No	No	No	No
Grants/funds	No	No	No	No	No	No	No	No	No	No	No	Yes
Honoraria	No	No	No	No	No	No	No	No	No	No	No	No
Speaker forum	No	No	No	No	No	No	No	No	No	No	No	No
Consultant	No	No	No	No	No	No	No	No	No	No	No	Yes
Stocks	No	No	No	No	No	No	No	No	No	No	No	No
Royalties	No	No	No	No	No	No	No	No	No	No	No	No
Expert testimony	No	No	No	No	No	No	No	No	No	No	No	No
Board member	No	No	No	No	No	No	No	No	No	No	No	Yes
Patents	No	No	No	No	No	No	No	No	No	No	No	No
Personal relationship	No	No	No	No	No	No	No	No	No	No	No	No

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Table 1

Baseline Characteristics of Study Participants, by HAPU Status

Characteristics	Patients With No HAPUs (N=562)	Patients With HAPUs (N=96)	All Patients (N=658)	P Value*
	N (%) or mean (SD)			
Mean age (yrs)	83.2 (6.8)	83.2 (5.9)	83.2 (6.6)	.95
Age ≥ 85 yrs	260 (46%)	45 (47%)	305 (46%)	.91
Male sex	124 (22%)	28 (29%)	152 (23%)	.13
White race	550 (98%)	95 (99%)	645 (98%)	.70
Community resident before admission	389 (69%)	61 (64%)	450 (68%)	.27
Trochanteric fracture	247 (44%)	46 (48%)	293 (45)	.47
Partial or total arthroplasty	201 (36%)	35 (36%)	236 (36%)	.90
Mean Rand Sickness at Admission score	11.8 (5.4)	15.1 (8.1)	12.3 (6.0)	<.001
Albumin level < 3.0 g/dL	172 (31%)	34 (35%)	206 (31%)	.35
Mean MMSE score	19.0 (10.6)	14.6 (11.5)	18.4 (10.9)	<.001
History of chronic cognitive deficit	154 (27%)	41 (43%)	195 (30%)	.002
Mean BMI (weight [kg]/height [m]^2)	23.7 (4.9)	24.3 (6.0)	23.8 (5.1)	.32
High risk of nutrition-related complications	35 (6%)	23 (24%)	58 (9%)	<.001
Incontinence				
None	404 (72%)	57 (59%)	461 (70%)	.04
Urinary only	98 (17%)	22 (23%)	120 (18%)	
Fecal with or without urinary	60 (11%)	17 (18%)	77 (12%)	
Activity level				
Walks	91 (16%)	7 (7%)	98 (15%)	<.001
Chairbound	240 (43%)	25 (26%)	265 (40%)	
Bedbound	228 (41%)	64 (67%)	292 (45%)	
Arterial insufficiency	209 (37%)	45 (47%)	254 (39%)	.07
Pre-existing pressure ulcers	14 (3%)	5 (5%)	19 (3%)	.14
Mean length of hospital stay (days)	5.6 (2.9)	7.9 (4.0)	5.9 (3.2)	<.001
Mean interval between inpatient admission and baseline assessment (days)	2.9 (1.9)	2.7 (2.5)	2.9 (2.0)	.41
Baseline assessment before day of surgery	52 (9%)	25 (26%)	77 (12%)	<.001
Mean time from admission to surgery (hrs)	28.5 (24.4)	39.5 (35.1)	30.1 (26.4)	<.001
PRSS at baseline	324 (58%)	27 (28%)	351 (53%)	<.001
Heel protector and/or chair cushion at baseline	230 (41%)	34 (35%)	264 (40%)	.31

Abbreviations: HAPU=hospital-acquired pressure ulcer; SD=standard deviation; MMSE=Mini-Mental State Exam; BMI=body mass index; PRSS=pressure-redistributing support surfaces

Note: Number of missing values: BMI=20; incontinence=3; risk of nutrition-related complications=13; activity level=3. All other variables had no missing values.

*P values are derived from chi-square, Fisher's exact, or t-tests, as appropriate, comparing patients with and without HAPUs.

Table 2

Characteristics of Hospital-Acquired Pressure Ulcers (N=121)*

Characteristic	Number	%
Stage when first observed		
2	107	88.4
3 or 4	0	0
Unstageable (necrotic tissue or eschar)	13	10.7
Unstageable (dressing)	1	0.8
Site		
Sacrum or posterior iliac crest	66	54.5
Heel	16	13.2
Ischium	12	9.9
Spine, posterior ribs, or scapula	11	9.1
Upper leg	4	3.3
Elbow	3	2.5
Other	9	7.4
Mean time from admission to observation of HAPU (days) (standard deviation)	4.8 (2.6)	

*121 hospital-acquired pressure ulcers (HAPUs) were observed in 96 patients who had at least one HAPU on the first day that at least one HAPU was observed; 74 had one HAPU, 19 had two HAPUs, 3 had three HAPUs.

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Table 3

Care-Related Factors and Hospital-Acquired Pressure Ulcers: Unadjusted and Adjusted Incidence Rate Ratios

Care-related factors	N*	% HAPU	Unadjusted IRR (95% CI)*	Adjusted† IRR (95% CI)	Fully Adjusted‡ IRR (95% CI)	P-Value for Fully Adjusted IRR
Group 1 factors						
Day of transport to the hospital						
On day of fracture	550	14	Reference	Reference	Reference	–
After day of fracture	93	17	1.26 (0.89-1.78)	1.33 (0.89-1.98)	1.34 (0.90-2.01)	.15
Type of transport to the hospital						
Not ambulance	49	10	Reference	Reference	Reference	–
Ambulance	568	15	1.49 (0.83-2.66)	1.39 (0.68-2.83)	1.34 (0.66-2.73)	.42
Length of stay in ED						
0 to 4 hours	166	22	Reference	Reference	Reference	–
>4 to 6 hours	220	13	0.57 (0.42-0.79)	0.68 (0.48-0.96)	0.68 (0.48-0.96)	.03
>6 hours	174	12	0.46 (0.33-0.66)	0.68 (0.46-1.00)	0.68 (0.46-0.99)	.047
Group 2 factors §						
Time from inpatient admission to surgery						
Less than 24 hours	328	9	Reference	Reference	Reference	–
24 hours or more	288	18	1.69 (1.34-2.13)	1.64 (1.26-2.14)	1.62 (1.24-2.11)	<.001
Duration of surgery						
Less than 2 hours	453	14	Reference	Reference	Reference	–
2 hours or more	187	13	0.97 (0.77-1.24)	0.89 (0.68-1.15)	0.83 (0.64-1.08)	.16
General anesthesia						
No	313	18	Reference	Reference	Reference	–
Yes	328	10	0.42 (0.33-0.53)	0.63 (0.47-0.84)	0.66 (0.49-0.88)	.005

Abbreviations: HAPU=hospital-acquired pressure ulcer; IRR=incidence rate ratio; CI=confidence interval; ED=emergency department

*The numbers of patients included in the unadjusted analyses of Group 1 and Group 2 factors vary because of missing values for the factors.

†Adjusted for other predictors in the model plus MMSE score, history of chronic cognitive deficit, risk of nutrition-related complications, BMI, activity level, pre-existing pressure ulcers, Rand Sickness at Admission score, age, sex, pre-admission residence, albumin level, number of orientations at baseline, and admission hospital (N=475).

‡Adjusted for all variables listed above plus use of pressure-redistributing overlays/mattresses (N=456).

§Excludes patients who had a HAPU before the day of surgery