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Extrinsic Risk Factors for Pressure Ulcers Early in the Hospital Stay: A Nested Case–Control Study

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Abstract

Background—Little is known about the impact of extrinsic factors on pressure ulcer risk. The objective of this study was to determine whether risk of pressure ulcers early in the hospital stay is associated with extrinsic factors such as longer emergency department (ED) stays, night or weekend admission, potentially immobilizing procedures and medications, and admission to an intensive care unit (ICU).

Methods—A nested case–control study was performed in two teaching hospitals in Philadelphia, Pennsylvania. Participants were medical patients age ≥65 years admitted through the ED. Cases (*n* = 195) had ≥1 possibly or definitely hospital-acquired pressure ulcers. Three controls per case were sampled randomly from among noncases at the same hospital in the same month (*n* = 597). Pressure ulcer status was determined by a research nurse on the third day of hospitalization. Pressure ulcers were classified as preexisting, possibly hospital-acquired, or definitely hospital-acquired. Information on extrinsic factors was obtained by chart review.

Results—The odds of pressure ulcers were twice as high for those with an ICU stay as for those without (adjusted odds ratio [aOR] 2.0, 95% confidence interval [CI], 1.2–3.5). The aOR was 0.6 (95% CI, 0.3–0.9) for use of any potentially immobilizing medications during the early inpatient period.

Conclusions—Many of the procedures experienced by patients in the ED and early in the inpatient stay do not confer excess pressure ulcer risk. Having an ICU stay is associated with a doubling of risk. This finding emphasizes the importance of developing and evaluating interventions to prevent pressure ulcers among patients in the ICU.

Keywords

Pressure ulcers; Intensive Care Unit; Hospital patients; Risk factors

The incidence of pressure ulcers among elderly hospital patients is high (1) despite increased awareness of the clinical and economic impact of pressure ulcers (2,3). Although there have

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been numerous studies of intrinsic patient characteristics (such as immobility, nutritional status, and incontinence) in relation to pressure ulcer risk [e.g., (4)], little is known about the impact of extrinsic factors. We define extrinsic factors as procedures and events that may contribute to pressure ulcer risk because they involve periods of immobility-related pressure. Because health care providers influence these extrinsic factors, understanding their association with pressure ulcers may make it possible to reduce the risk of pressure ulcers by modifying provider behavior.

The pathologic processes resulting in pressure ulcers may begin after a few hours of immobility-induced pressure on bony prominences (5,6). There is ample opportunity early in the hospital stay for periods of immobility that are long enough to increase elderly patients' pressure ulcer risk. In the emergency department (ED), patients may lie on a stretcher for many hours awaiting tests, treatments, or transfer (7,8): Stretchers may lack adequate cushioning or be too narrow for regular repositioning (9). Lengthy surgical and radiologic procedures and the use of certain devices (e.g., restraints) can immobilize the patient. Similarly, medications that cause sedation can result in long periods of immobility (10-13). Because mobilization of patients depends partly on the availability of hospital staff, pressure ulcer risk may be higher on night and weekend shifts (14,15). In the intensive care unit (ICU), patients may be bedbound, unconscious, or otherwise immobilized for significant periods of time.

The aim of the study was to determine whether the risk of pressure ulcers early in the hospital stay is associated with extrinsic factors such as longer stays in the ED, night or weekend admission, potentially immobilizing procedures and medications, and admission to an ICU.

Methods

Design and Participants

Cases and controls for this nested case–control study were selected from among patients enrolled in a cohort study performed in 1998–2001 in two teaching hospitals in Philadelphia. The cohort study has been described in detail (16). Eligible patients were age ≥65 years; admitted through the ED to the inpatient Medical Service; and still in the hospital on day 3, with day 1 being day of inpatient admission. Verbal consent was obtained from the participant or proxy. The protocol was approved by the Institutional Review Board of the University of Pennsylvania.

To determine pressure ulcer status (stages 1–4) (17), research nurses visually inspected patients' skin on hospital day 3. Examining patients on the third day of hospitalization ensured that the risk interval was long enough for pressure ulcers initiated early in the hospital stay to become clinically apparent, but short enough that observed pressure ulcers were plausibly related to exposures occurring early in the hospital stay.

Standardized examinations (8,18) were performed with the patient in flat supine position and 45 degree supine–lateral positions on both sides. Lesions in areas with active skin disease, wounds on the plantar surface of the forefoot or midfoot, and wounds in the area above the malleolus to midcalf were not considered pressure ulcers. Using multiple sources of information, each pressure ulcer was classified as definitely preexisting, possibly hospital-acquired, or definitely hospital-acquired (Table 1).

All patients with ≥1 possibly or definitely hospital-acquired pressure ulcer were included as cases. For each case, three controls were randomly sampled from among all noncases in the study cohort who were admitted to the same hospital in the same month.

Extrinsic Factors

Information on extrinsic factors was obtained by review of medical charts. Length of ED stay was defined as time between arrival in the ED and time of the first recorded encounter with a health care provider on the inpatient unit. Potentially immobilizing procedures in the ED included physical restraints, immobilizing orthopedic devices (e.g., spinal board, traction), potentially lengthy radiologic and cardiologic procedures, and potentially lengthy invasive procedures (e.g., wound debridement). Patients were considered to have potentially immobilizing medications in the ED if there was a record of use (of any dose and any duration) in the ED of any of 65 medications, selected from the formulary in use at the study hospitals, that had sedation or somnolence as a possible side effect. The medications were in four classes (narcotic analgesics, sedatives/anxiolytics/sedating antihistamines, antipsychotics/phenothiazines, and antidepressants). Patients were considered to have inpatient use of potentially immobilizing medications if there was a record of any of these medications during the inpatient stay preceding the skin examination. Night admission was defined as ED admission between 12:01 AM and 6:00 AM. Number of weekend days (range 0–2) was defined as the number of days that occurred on a Saturday or Sunday between day of ED admission and day before skin examination (inclusively). For example, a patient admitted on Friday and examined on Sunday would have one weekend day. Information on physical restraints; immobilizing devices; compression devices; surgical, radiologic, cardiologic, and invasive procedures; and ICU stay was ascertained for the inpatient period preceding the day of skin examination.

Confounding Variables

Information on incontinence, confusion/delirium, and activities of daily living (ADL) (eating/drinking, bathing, dressing, toileting, bed mobility, and transfers) was abstracted from the admission nursing assessment in the hospital chart. For each ADL, patients were considered to have an impairment if they required maximal assistance for that ADL. The research nurses assessed risk of nutrition-associated complications using the Subjective Global Assessment of Nutritional Status, a validated method that integrates information on clinical symptoms and signs (19). Comorbidity was measured using the Charlson comorbidity index (20), a summary measure of chronic disease based on 17 comorbid diseases to which severity weights are assigned; information on comorbid conditions was obtained from the chart. To assess reliability, 40 randomly selected charts were reabstracted. Based on the results, charts of all patients with outlying values for time of start or end of ED stay ($n = 121$), and a random sample of all others ($n = 123$), were reviewed by the project coordinator and corrected, if necessary.

Analysis

All analyses were performed using conditional logistic regression in Stata v9.1 (Stata Corp., College Station, TX) with 12 analysis strata (two hospitals by six half-year time periods). Potential confounders that did not influence the estimated odds ratios (OR) for the exposures of interest were excluded from the analysis. Three prespecified secondary analyses were conducted, two that used alternate case definitions and one that excluded patients with preexisting pressure ulcers.

Results

The parent cohort has been described (16). Of 3233 patients in the cohort, 201 had ≥1 possibly or definitely hospital-acquired pressure ulcer. Six patients were excluded because their hospital chart was not found, resulting in a total of 195 cases. There were 3032 patients with no hospital-acquired pressure ulcers: 2390 were not sampled, 45 were replaced because the hospital chart was not found, and the remaining 597 were included as controls.

Reabstraction of 40 randomly-selected hospital charts revealed that interrater agreement was 98.8% for medication items, 96.9% for ED procedures, 89.1% for inpatient procedures, and 90.6% for the remaining items. The mean difference between the two abstractions was 2.3 hours for ED start time and 2.7 hours for ED end time. After review and correction of charts with outlying values for start or end of ED stay, and of a random sample of all others, the estimated accuracy for ED length of stay was 90.4%.

As previously reported (16), there were 266 pressure ulcers among the 201 patients with pressure ulcers (mean 1.3, standard deviation [*SD*] 0.6). Most pressure ulcers were stage 2 (partial thickness skin loss involving epidermis and/or dermis) (54.1%) or stage 1 (pressure-related alteration of intact skin) (27.1%). Sixty-six percent of pressure ulcers were on the sacrum, ischium, or trochanter, and 16.5% were on the heel. One hundred forty-one (53%) of the pressure ulcers were definitely hospital-acquired.

More than 20% of study patients were age ≥85, and nearly 12% were admitted from a nursing home (Table 2). Nearly three-quarters were African American. The prevalence of intrinsic risk factors was high, particularly among cases. Mean length of ED stay was 7.2 hours (*SD* 3.1) for cases and 7.4 hours (*SD* 3.4) for controls ($p = .607$) (not tabulated).

The odds of pressure ulcers were twice as high among patients with an ICU stay as among those without an ICU stay (adjusted OR 2.0; 95% confidence interval [CI], 1.2–3.5) (Table 3). Use of any potentially immobilizing medication during the early inpatient period was associated with lower odds of pressure ulcers (adjusted OR 0.6; 95% CI, 0.3–0.9). In exploratory analysis, each medication class (except sedatives/anxiolytics/sedating antihistamines) used in the early inpatient period was associated with lower risk of pressure ulcers, although the ORs were not significant and the CIs were wide. Use of medications in the sedative class was associated with a higher risk (OR 1.6; 95% CI, 0.96–2.7). None of the ORs for the other extrinsic factors was statistically significant. Estimated ORs from analyses using more restrictive case definitions or excluding patients with preexisting pressure ulcers were similar to each other and to those from the primary analysis (Table 4).

Discussion

In this nested case–control study of elderly hospital patients, having an ICU stay was associated with a 2-fold increase in the odds of having ≥1 possibly or definitely hospital-acquired pressure ulcers early in the hospital stay. Similarly, in a study of elderly hip fracture patients, Baumgarten and colleagues (21) found that having a preoperative ICU stay was associated with increased risk. Some (22,23) but not all (24) studies have found that length of ICU stay is significantly associated with increased pressure ulcer risk. The ICU patient may be at high risk due to factors related to the underlying disease, such as pain, coma, prolonged low blood pressure, malnutrition, and activation of catabolic inflammatory factors. Although we controlled for comorbidity, the severity of the illness responsible for the ICU admission may be more closely related to pressure ulcer risk than mortality risk due to comorbidity (which the Charlson index represents). Immobility may be induced through intubation, sedation, or restraints (25,26). Regular repositioning, which is a standard nursing approach to the prevention of pressure ulcers, may be difficult in the ICU because of its impact on hemodynamic stability and ventilator management (27). Pressure-redistributing surfaces such as low-air-loss mattresses have been proposed for the prevention of pressure ulcers in the ICU (25) although there is uncertainty about the relative effectiveness of different types of devices (28,29).

The odds of receiving any potentially immobilizing medication early in the hospital stay was 40% lower in cases than controls. This apparent protective effect is in contradiction to the

results of the only other study that examined this factor (30). There are several possible explanations for our finding. First, it may be that use of these medications is a marker for other factors that lower pressure ulcer risk; the fact that the protective effect persisted after controlling for a series of pressure ulcer risk factors makes this explanation unlikely. Second, the finding may indicate the presence of confounding by indication: Sedating medications may be prescribed for agitation, and agitated patients may be at lower risk for pressure ulcers. Finally, it is possible that patients who are in pain become more mobile after receiving analgesic medication, resulting in lowered pressure ulcer risk. In exploratory analysis, use of medications in the sedative class (which included sedatives, anxiolytics, and sedating antihistamines) was associated with a higher risk of pressure ulcers. The other three medication classes examined in this study were associated with lower risk of pressure ulcers, although the ORs were not significant and the CIs were wide.

The hypothesis that length of the ED stay would be associated with pressure ulcer risk was not supported in our study or in three other studies that examined this association (31-33). The duration of immobility in the ED may not be long enough to result in skin breakdown: In our study, the mean time spent in the ED was just over 7 hours. Alternatively, it may be that sicker patients (those at higher risk of pressure ulcers) are transferred more quickly out of the ED to, for example, the ICU. However, the fact that we controlled for ICU stay makes this an unlikely explanation.

None of the other extrinsic risk factors was significantly associated with hospital-acquired pressure ulcers. Among patients with spinal cord injury, pressure ulcer risk is associated with longer time to reach the hospital, longer time having x-rays taken, and longer time on a spinal board (34,35). In patients with major trauma, pressure ulcer risk is strongly associated with increasing duration of cervical collar use (36). Among surgical patients, some studies have found duration of surgery to be positively related to pressure ulcer risk [e.g., (4,21,37,38)], whereas others have not [e.g., (32,39,40)]. Among adult hospital patients, having surgery during the hospital stay is associated with higher pressure ulcer incidence (41,42). In one study with no comparison group (43), use of physical restraints was associated with high pressure ulcer incidence (22%). Baumgarten and colleagues (21) found that preoperative physical restraint use among hip fracture patients was not significantly associated with pressure ulcer risk, after adjusting for pressure ulcer risk factors.

Although this study has an adequate sample size and was conducted with careful attention to design and analysis, it has some limitations. A relatively low prevalence of some of the extrinsic factors may have reduced statistical power. Also, there may be misclassification of the outcome, although in a related substudy, sensitivity and specificity of the research nurses' ascertainment of pressure ulcers were 97% and 81%, respectively (44). In addition, secondary analyses using more restrictive definitions of case status yielded results that were similar to the primary analysis.

Given that information on extrinsic factors was obtained from medical records, there is the potential for misclassification of exposure. Reliability of the risk factor information, estimated in the course of the study, was high for many items. However, reliability of information on ED length of stay was low; therefore, a systematic reabstraction was performed for this variable. Although the estimated accuracy of the corrected dichotomous ED duration variable was 90.4%, and use of alternative definitions and thresholds for this variable did not alter the results, residual misclassification cannot be ruled out. Exposure misclassification is likely to be nondifferential, resulting in bias toward the null; this could explain the low ORs observed in this study.

Many diagnostic and therapeutic procedures that hospital patients undergo involve exposure to pressure, shearing, and friction. The results of this study suggest that many of the procedures experienced by patients in the ED and early in the inpatient stay do not confer excess pressure ulcer risk or that hospitals are able to mitigate excess risk through the use of appropriate preventive measures. Having an ICU stay, however, is associated with a doubling of risk. Although it is not possible to avoid an ICU stay for patients who are critically ill, the results of this study emphasize the importance of developing and evaluating interventions to prevent pressure ulcers among patients in the ICU.

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Table 1

Rules for Determining Whether Pressure Ulcer Was Hospital Acquired

Available Information	Stage 1	Stage 2	Stage 3	Stage 4	Stage Unknown
≥1 Source says present at admission, and no source says absent at admission	Definitely preexisting	Definitely preexisting	Definitely preexisting	Definitely preexisting	Definitely preexisting
≥1 Source says absent at admission, and no source says present at admission	Definitely not preexisting	Definitely not preexisting	Definitely not preexisting	Definitely preexisting	Definitely not preexisting
≥1 Source says present, and ≥1 source says absent at admission	Possibly preexisting	Possibly preexisting	Possibly preexisting	Definitely preexisting	Possibly preexisting
No source says present or absent at admission	Definitely not preexisting	Possibly preexisting	Possibly preexisting	Definitely preexisting	Possibly preexisting

Table 2

Characteristics of Cases and Controls

	Cases (*N* = 195)		Controls (*N* = 597)		All (*N* = 792)	
Characteristic	***N***	**%**	***N***	**%**	***N***	**%**
Incontinence						
None	102	52.3	495	82.9	597	75.4
Urinary, no fecal	39	20.0	59	9.9	98	12.4
Fecal, with or without urinary	54	27.7	43	7.2	97	12.2
Confusion or delirium	49	25.1	72	12.2	121	15.4
Risk of nutrition-related complications						
Low	91	46.9	461	77.3	552	69.9
Moderate	66	34.0	111	18.6	177	22.4
High	37	19.1	24	4.0	61	7.7
Age, y						
65 to <75	54	27.7	257	43.0	311	39.3
75 to <85	71	36.4	241	40.4	312	39.4
85 or more	70	35.9	99	16.6	169	21.3
Number of ADL impairments						
0	93	47.7	501	83.9	594	75.0
1–5	21	10.8	50	8.4	71	9.0
6 or more	81	41.5	46	7.7	127	16.0
Nursing home residence before hospital admission	55	28.2	39	6.6	94	11.9
Charlson comorbidity index >3	63	32.3	176	29.5	239	30.2
Male sex	80	41.0	237	39.7	317	40.0
African American	149	76.4	423	71.1	572	72.4
Medicaid coverage	26	13.3	38	6.4	64	8.1
Hospital						
A	75	38.5	294	49.2	369	46.6
B	120	61.5	303	50.8	423	53.4
ED stay ≥8 h	53	28.3	195	33.2	248	32.0

	Cases (*N* = 195)		Controls (*N* = 597)		All (*N* = 792)	
Characteristic	***N***	**%**	***N***	**%**	***N***	**%**
Any potentially immobilizing procedure in ED	24	12.3	53	8.9	77	9.7
Any potentially immobilizing medication in ED	28	14.4	90	15.1	118	14.9
Night arrival in the ED	15	7.8	42	7.1	57	7.2
Number of weekend days						
0	108	55.4	313	52.8	421	53.4
1	58	29.7	185	31.2	243	30.8
2	29	14.9	95	16.0	124	15.7
Any surgical, radiologic, cardiologic, or invasive procedure in the inpatient period	33	16.9	108	18.1	141	17.8
Any restraining, immobilizing, or compression device in the inpatient period	26	13.3	44	7.4	70	8.8
ICU stay	34	17.4	83	13.9	117	14.8
Any potentially immobilizing medication (inpatient)	33	16.9	151	25.3	184	23.2

Note: ADL = activities of daily living; ED = emergency department; ICU = intensive care unit.

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Table 3

Unadjusted and Adjusted Odds Ratios (95% Confidence Interval) Comparing Cases and Controls With Respect to Extrinsic Factors

Extrinsic factors	Unadjusted*	Adjusted†
ICU stay	1.4 (0.9–2.2)	2.0 (1.2–3.5)
Any potentially immobilizing medication in ED	1.0 (0.6–1.6)	1.2 (0.7–2.2)
ED stay ≥8 h	0.8 (0.6–1.2)	0.8 (0.5–1.2)
Any potentially immobilizing procedure in ED	1.6 (0.96–2.7)	1.3 (0.7–2.6)
Night arrival in the ED	1.0 (0.5–1.9)	1.1 (0.5–2.3)
Number of weekend days		
0	Reference	Reference
1	0.9 (0.6–1.3)	0.9 (0.5–1.4)
2	0.9 (0.5–1.4)	1.1 (0.6–1.9)
Any surgical, radiologic, cardiologic, or invasive procedure in the inpatient period	1.1 (0.7–1.7)	0.9 (0.5–1.5)
Any restraining, immobilizing, or compression device in the inpatient period	2.4 (1.4–3.8)	1.5 (0.7–2.9)
Any potentially immobilizing medication (inpatient)	0.6 (0.4–0.9)	0.6 (0.3–0.9)

Notes:

*Unadjusted odds ratios were obtained by conditional logistic regression within strata of matching factors (hospital and 6-month time period).

†Adjusted odds ratios were obtained by conditional logistic regression within strata of matching factors (hospital and 6-month time period) and adjusted for age, sex, race, Medicaid coverage, incontinence, confusion/delirium, risk of nutrition-related complications, functional impairment, nursing home residence before hospital admission, and Charlson comorbidity score.

ICU = intensive care unit; ED = emergency department.

Table 4

Results of Secondary Analyses (Odds Ratios and 95% Confidence Intervals)*

Variable	Primary Analysis (*N* = 757)†	Excluding Patients with Preexisting PrUs (*N* = 694)	Limiting Cases to Definitely Hospital-Acquired PrUs (*N* = 757)	Limiting Cases to Stage 2 or Higher PrUs (*N* = 735)
ED stay ≥8 h	0.8 (0.5–1.2)	0.8 (0.5–1.3)	1.0 (0.6–1.6)	0.8 (0.5–1.3)
Any potentially immobilizing procedure in ED	1.3 (0.7–2.6)	1.1 (0.5–2.3)	1.2 (0.5–2.5)	0.7 (0.3–1.6)
Any potentially immobilizing medication in ED	1.2 (0.7–2.2)	1.3 (0.7–2.3)	1.3 (0.7–2.6)	1.4 (0.7–2.7)
Night arrival in the ED	1.1 (0.5–2.3)	1.5 (0.6–3.5)	1.4 (0.6–3.1)	1.2 (0.5–2.9)
Number of weekend days				
0	Reference	Reference	Reference	Reference
1	0.9 (0.5–1.4)	1.0 (0.6–1.6)	1.0 (0.6–1.7)	1.0 (0.6–1.6)
2	1.1 (0.6–1.9)	1.2 (0.6–2.2)	1.1 (0.5–2.2)	1.3 (0.7–2.6)
Any surgical, radiologic, cardiologic or invasive procedure in the inpatient period	0.9 (0.5–1.5)	0.8 (0.4–1.4)	0.9 (0.5–1.8)	0.9 (0.5–1.7)
Any restraining, immobilizing or compression device in the inpatient period	1.5 (0.7–2.9)	1.9 (0.9–4.0)	1.0 (0.5–2.3)	1.3 (0.6–2.8)
ICU stay	2.0 (1.2–3.5)	2.2 (1.3–4.0)	1.7 (0.9–3.2)	2.2 (1.2–4.1)
Any potentially immobilizing medication (inpatient)	0.6 (0.3–0.9)	0.6 (0.4–1.1)	0.6 (0.3–1.1)	0.6 (0.3–1.2)

Notes:

*All results were obtained by conditional logistic regression within strata of matching factors (hospital and 6-month time period) and adjusting for age, sex, race, Medicaid coverage, incontinence, confusion/delirium, risk of nutrition-related complications, functional impairment, nursing home residence before hospital admission, and Charlson comorbidity score.

†Same as adjusted results in Table 3, presented for purpose of comparison with secondary analyses.

PrU = pressure ulcer; ED = emergency department; ICU = intensive care unit.