# Pressure Ulcer Trends in the United States: A Cross-Sectional Assessment from 2008-2019

Phoebe B. McAuliffe, BA, Eric E. Winter, BS, [...], and John P. Fischer, MD, MPH +3 View all authors and affiliations

Volume 89, Issue 12 | https://doi.org/10.1177/00031348231158691

## Abstract

### Introduction

Decubitus ulcers are a morbid and costly problem faced by healthcare systems and patients across the country. We aim to examine current patterns and characteristics of patients admitted to the hospital with a pressure ulcer.

### Materials and methods

From a nationally representative sample of hospital discharge records, the Nationwide Inpatient Sample (NIS), patients with a diagnosis of pressure ulcer 2008-2019 were identified. Patient volume, demographic and clinical data were analyzed for change over time.

### Results

The volume of pressure ulcer patients as a proportion of all hospital patients remained constant from 2008 to 2019 ($P = .479$). During the study period, the proportion of ulcer patients that underwent an ulcer-related procedure significantly decreased ($P < .001$) while the proportion of ulcers considered severe significantly increased ($P < .001$).

### Conclusions

Our analysis suggests the prevalence of decubitus ulcers remained stable during the time period, with increased severity but reduced frequency of operative intervention.

---

## Key Takeaways

- Decubitus ulcers are a morbid and costly condition. Recent policy changes aim to decrease decubitus ulcer prevalence.
- The Nationwide Inpatient Sample (NIS) was used to assess ulcer prevalence 2008-2019.
- Despite policy changes, pressure ulcer prevalence remained stable, with increasing severity and decreasing rates of surgical intervention.

## Introduction

Pressure injuries (PIs) are caused by unrelenting physical pressure damaging underlying tissue, particularly when soft tissue is compressed against a bony surface. Although most pressure injuries are preventable,[1] they remain a persistent source of morbidity and cost in the US. Treatment can be complex and associated with high recurrence rates – particularly in later-stage full-thickness wounds.[2] National cost estimates range from \$3.3 billion[3] to \$26.8 billion,[2] representing a significant expense to patients and the healthcare system as a whole. And the costs of management of this preventable disease continue to grow as technological advances in wound care and surgical technique arise.[2] Risk factors for pressure ulcers including immobility and malnutrition have previously been identified, particularly involving factors that impair the microcirculatory system.[4] The rate of pressure injury among critically ill patients is particularly high, at an estimated 14.3%, while the overall rate of hospital-acquired pressure injury is estimated to be 5.85%.[5]

The incidence of decubitus ulcers has been established as a healthcare facility quality indicator, drawing increased attention to this disease. As the US healthcare system has moved toward quality measurements and performance incentives for healthcare institutions, several policy initiatives have addressed the need to prevent hospital-acquired conditions such as PIs. In 2008 the US Centers for Medicare and Medicaid Services (CMS) introduced a non-payment model for hospital-acquired conditions (HACs).[6] This was reportedly successful at reducing hospital-acquired pressure ulcer incidence at academic medical centers.[7] And in 2015, the CMS went a step further and implemented use of the Patient Safety Indicator 90 (PSI90) to adjust payments and score hospitals on quality.[8] The PSI90 is a composite rate of hospital-acquired conditions, including PI. This policy effectively penalized hospitals for high rates of selected hospital-acquired conditions. However, despite these incentives, pressure ulcers remain a significant burden on the US healthcare system.[9]

In an effort to understand pressure ulcer prevalence and patient characteristics over time, this study examined the volume of pressure ulcer diagnoses among hospital admissions using the Nationwide Inpatient Sample (NIS) annually from 2008 to 2019. The NIS is a nationally representative sample of US hospital discharges, and provides information about patient demographic and clinical variables. The aim of this study was to report trends in pressure ulcer prevalence, as well as ulcer-related procedure prevalence, with respect to patient characteristics.

## Methods

### Database and Selection of Patients

In this retrospective analysis we conducted a cross-sectional study of hospital discharges in the United States using the 2008 through 2019 years of the Nationwide Inpatient Sample (NIS). The NIS is part of the Healthcare Cost and Utilization Project (HCUP), Agency for Healthcare Research and Quality,[10] and is a 20%, representative sample of discharges from US hospitals, which is weighted to allow for national and longitudinal estimates. The database contains no direct patient identifiers and is consistent with a "limited data set" under the HIPAA Privacy Rule. Population estimates were obtained via incorporation of provided discharge weights.

From this database, patients over 18 years of age with an International Classification of Disease (ICD) 9 or ICD-10 diagnosis code indicating diagnosis of pressure ulcer were identified. As the change from ICD-9 to ICD-10 occurred partway through 2015, discharges in the first quarter of 2015 and before were assessed with ICD-9 codes, and those afterward with ICD-10 codes. The volume of patients captured in the first quarter and second quarter of 2015 were statistically compared to ensure appropriate continuity for trend analysis, in accordance with HCUP guidelines. Years before 2012 were assessed using updated Trend Weights.

### Outcomes

The primary outcomes of interest were the volume of hospital discharges associated with a pressure ulcer diagnosis, and the frequency of ulcer-related surgical procedures among this cohort. Ulcer-related procedures were defined by ICD-9 and ICD-10 procedure codes, and included debridement, graft or flap coverage. Secondary outcomes included hospital charges, patient demographics, patient comorbidities, mortality, length of stay and ulcer characteristics (severity and location). Location coding was performed using ICD-9/10 codes, with four location categories identified: back/sacrum, lower extremity, multiple locations and other/unknown. The back/sacrum location included upper back, lower back, buttock and sacral codes. The lower extremity location included lower extremity and foot. The other/unknown category included all other locations including elbow and head. Severity 3 and 4 ulcers were identified with ICD-9/10 codes and considered "severe" for the purposes of this analysis. Patients admitted during the 2008 calendar year were excluded from analysis of severe ulcer trends, as the ICD-9 coding scheme for ulcer severity was not introduced until October 2008.[11] To assess comorbidities, 31 chronic medical conditions were identified using the enhanced-Elixhauser algorithm.

### Statistical Analysis

After isolating discharges with a diagnosis of pressure ulcer for each year, data sets were appended to facilitate analysis of trends over time. The number of hospital discharges, associated charges, patient characteristics, and hospital outcomes were determined for each year 2008-2019. Trends were then analyzed for patient sex, payer type, race, ulcer location, ulcer severity procedure occurrence, mortality, age, length of stay, and total inpatient charges.

For each categorical patient characteristic, a series of binary variables was generated to represent each strata (eg for each patient with potential insurance type of Medicare, Medicaid, Private, or Other, four binary variables were created, each representing "yes" or "no" for each payer). The prevalence of each patient characteristic over time was subsequently assessed using multiple logistic regression. Additional model covariates were included to control for confounding factors related to patient demographics (eg age, sex, race, etc.) and hospital characteristics (eg bed size, geographic location, teaching status, etc.). Continuous variables were assessed by multiple linear regression over time, with similar additional covariates used to control for patient demographics and hospital characteristics.

All analysis was performed StataMP 17 (StataCorp, College Station, TX). Significance was set at $P < .05$.

## Results

### Trends in Ulcer Volume and Mortality

From 2008-2019, 7,788,105 discharges with a diagnosis code of pressure ulcer were identified, representing an average of 1787 pressure ulcer diagnoses per 100,000 discharges per year. The proportion of all discharges with an ulcer diagnosis did not change during the time period (Figure 1), starting at 1.8% in 2008, and ending at 1.9% in 2019 ($P = .479$). Yearly patient volumes are presented by ulcer location in Table 1. 62.4% of all ulcers during the time period were located in the sacral or back area, followed by multiple locations and lower extremity location. The odds of a patient having a back/sacrum ulcer decreased during the time period ($P < .001$) as did the odds of a lower extremity location ($P < .001$) while the odds of multiple locations or other/unknown increased ($P < .001$).

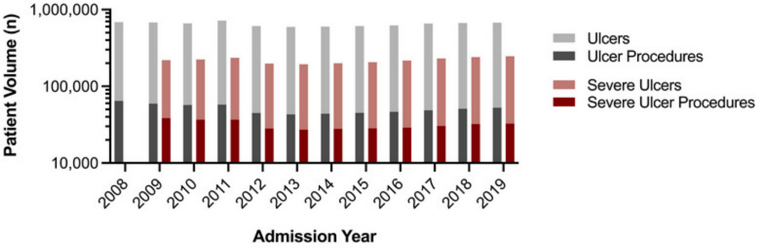

**Figure 1**. Annual patient and procedure volume for severe and non-severe pressure ulcers 2008-2019, on a logarithmic scale.

**Table 1**. Ulcer Volume and Mortality by Year and Location.

| | | Admission Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** |
| Ulcer volume | Total patients | 685,641 (1.8) | 678,209 (1.8) | 661,735 (1.8) | 718,336 (1.9) | 611,770 (1.7) | 593,965 (1.7) | 599,630 (1.7) | 611,785 (1.7) | 622,779 (1.7) | 657,760 (1.8) |
| | Back/ Sacrum | 427,856 (62.4) | 417,642 (61.6) | 408,553 (61.7) | 452,989 (63.1) | 393,125 (64.3) | 382,620 (64.4) | 383,385 (63.9) | 385,810 (63.1) | 385,095 (61.8) | 406,635 (61.8) |
| | Lower extremity | 78,012 (11.4) | 69,094 (10.2) | 64,096 (9.7) | 70,865 (9.9) | 56,540 (9.2) | 53,025 (8.9) | 53,870 (9.0) | 52,755 (8.6) | 51,265 (8.2) | 52,870 (8.0) |
| | Multiple locations | 108,018 (15.8) | 109,636 (16.2) | 108,845 (16.4) | 118,306 (16.5) | 100,110 (16.4) | 98,875 (16.6) | 99,970 (16.7) | 111,965 (18.3) | 138,935 (22.3) | 147,755 (22.5) |
| | Other/ Unknown | 71,755 (10.5) | 81,838 (12.1) | 80,242 (12.1) | 76,176 (10.6) | 61,995 (10.1) | 59,445 (10.0) | 62,405 (10.4) | 61,255 (10.0) | 47,485 (7.6) | 50,500 (7.7) |
| | Total patients | 68,917 (10.1) | 63,648 (9.4) | 59,467 (9.0) | 62,126 (8.7) | 50,770 (8.3) | 49,330 (8.3) | 49,250 (8.3) | 50,275 (8.2) | 50,150 (8.1) | 53,115 (8.1) |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mortality | Back/ Sacrum | 44,077 (10.3) | 39,788 (9.5) | 37,633 (9.2) | 40,384 (8.9) | 33,660 (8.6) | 33,400 (8.7) | 32,615 (8.5) | 33,530 (8.7) | 33,215 (8.6) | 35,290 (8.7) |
| | Lower extremity | 5,152 (6.6) | 3,901 (5.6) | 3,412 (5.3) | 3,782 (5.3) | 2,750 (4.9) | 2,435 (4.6) | 2,520 (4.7) | 2,625 (5.0) | 2,355 (4.6) | 2,485 (4.7) |
| | Multiple locations | 11,947 (11.1) | 11,279 (10.3) | 10,265 (9.4) | 10,393 (8.8) | 8,355 (8.3) | 8,365 (8.5) | 8,220 (8.2) | 8,960 (8.0) | 11,205 (8.1) | 12,145 (8.2) |
| | Other/ Unknown | 7,741 (10.1) | 8,680 (9.4) | 8,157 (9.0) | 7,567 (8.6) | 6,005 (8.3) | 5,130 (8.3) | 5,895 (8.2) | 5,160 (8.2) | 3,375 (8.1) | 3,195 (8.1) |

[a]represents $\beta_1$ of simple linear regression, showing % change per year.

The mortality rate of patients with an ulcer diagnosis decreased from 10.1% in 2008 to 7.6% in 2019 ($P < .001$). This decrease in mortality rate was observed for each ulcer location (Table 1).

### Trends in Patient Demographics

Multiple regression models were used to test for changes in patient-specific factors over time, including age, race, gender, and payer, reported in Table 2. Each of these patient-level factors changed significantly over time. The average age of the population decreased during the time period ($P < .001$) from 71.9 years in 2008 to 70.0 years in 2019. The proportion of the population identified as white increased ($P < .001$), while the percentage identified as Black/African American did not change. The percentage identified as "other race" significantly decreased, from 20.8% in 2008 to 5.7% in 2019. The proportion of the population identified as male increased during the time period (OR 1.01, $P < .001$) while the proportion female patients decreased (OR .99, $P < .001$). The percentage of the population insured by Medicaid or Medicare increased during the time period ($P < .001$) while the percentage insured by private insurance decreased ($P < .001$).

**Table 2**. Ulcer Patient Demographics by Year.

| | | | | | | | | | Admission Ye |
|---|---|---|---|---|---|---|---|---|---|
| | | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** |
| | Male | 321,273 (46.9) | 324,292 (47.8) | 322,471 (48.7) | 346,483 (48.2) | 297,665 (48.7) | 291,545 (49.1) | 297,315 (49.6) | 305,715 (50.0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sex | Female | 364, 097 (53.1) | 353, 612 (52.1) | 339, 087 (51.2) | 371, 582 (51.7) | 311, 430 (50.9) | 299, 595 (50.4) | 299, 360 (49.9) | 303, 040 (49.5 |
| | Other/ Unknown | 271 (.0) | 306 (.1) | 177 (.0) | 271 (.0) | 2, 675 (.4) | 2, 825 (.5) | 2, 955 (.5) | 3, 03 (.5) |
| Race | White | 386, 626 (56.4) | 400, 298 (59.0) | 395, 878 (59.8) | 443, 027 (61.7) | 392, 570 (64.2) | 381, 620 (64.3) | 386, 950 (64.5) | 390, 570 (63.8 |
| | Black | 102, 159 (14.9) | 109, 166 (16.1) | 133, 030 (20.1) | 135, 360 (18.8) | 112, 225 (18.3) | 107, 485 (18.1) | 108, 955 (18.2) | 116, 865 (19.1 |
| | Hispanic | 42, 342 (6.2) | 49, 207 (7.3) | 45, 573 (6.9) | 55, 693 (7.8) | 46, 315 (7.6) | 46, 135 (7.8) | 45, 915 (7.7) | 45, 70 (7.5) |
| | Asian | 11, 731 (1.7) | 12, 091 (1.8) | 12, 273 (1.9) | 10, 467 (1.5) | 11, 375 (1.9) | 11, 085 (1.9) | 11, 470 (1.9) | 12, 24 (2.0) |
| | Other | 142, 783 (20.8) | 107, 447 (15.8) | 74, 981 (11.3) | 73, 788 (10.3) | 49, 285 (8.1) | 47, 640 (8.0) | 46, 340 (7.7) | 46, 41 (7.6) |
| Insurance provider | Medicare | 525, 813 (76.7) | 511, 310 (75.4) | 496, 276 (75.0) | 552, 281 (76.9) | 467, 690 (76.4) | 453, 460 (76.3) | 455, 155 (75.9) | 464, 310 (75.9 |
| | Medicaid | 58, 673 (8.6) | 65, 792 (9.7) | 71, 240 (10.8) | 67, 102 (9.3) | 61, 060 (10.0) | 59, 680 (10.0) | 63, 300 (10.6) | 64, 37 (10.5 |
| | Private | 78, 798 (11.5) | 78, 992 (11.6) | 72, 271 (10.9) | 76, 767 (10.7) | 59, 630 (9.7) | 57, 515 (9.7) | 60, 265 (10.1) | 61, 80 (10.1 |
| | Other | 22, 357 (3.3) | 22, 115 (3.3) | 21, 948 (3.3) | 22, 185 (3.1) | 23, 390 (3.8) | 23, 310 (3.9) | 20, 910 (3.5) | 21, 30 (3.5) |
| Characteristic | Age (years) | 71.9 (±16.5) | 71.2 (±16.8) | 70.7 (±17.1) | 71.3 (±16.7) | 70.3 (±17.2) | 70.1 (±17.3) | 69.8 (±17.2) | 69.8 (±17. |
| | LOS (days) | 12.0 (±16.0) | 11.2 (±14.8) | 11.5 (±15.8) | 10.8 (±14.7) | 9.8 (±13.5) | 9.8 (±13.3) | 10.0 (±13.9) | 10.1 (±13. |
| | Total charges ($ thousands) | 67.8 (±108.2) | 68.7 (±109.7) | 72.5 (±113.8) | 76.2 (±138.5) | 75.0 (±140.0) | 79.6 (±146.9) | 84.0 (± 54.0) | 87.4 (±158. |

[a]ln transformed.

The average length of stay of patients with an ulcer diagnosis decreased during the time period (P < .001) from 12.0 days in 2008 to 10.1 days in 2019. And the average total charges, logarithmically transformed, increased from $67,800 in 2008 to $105,900 in 2019 (*P* < .001).

### Trends in Procedure Volume

Ulcer-related procedures were defined by ICD-9/10 procedure codes. Over the 2008-2019 time period, the percentage of ulcer patients undergoing an ulcer-related procedure during admission decreased, from 9.4% in 2008 to 7.8% in 2018 (*P* < .001). This decrease in procedures was seen across every ulcer location (Table 3).

**Table 3**. Ulcer-Related Procedure Volume by Year and Location.

| | | Admission Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| Procedure volume | Total patients | 64,630 (9.4) | 59,606 (8.8) | 57,066 (8.6) | 57,665 (8.0) | 44,790 (7.3) | 43,185 (7.3) | 44,080 (7.4) | 45,195 (7.4) | 46,605 (7.4) | 48,725 (7.4) |
| | Back/Sacrum | 32,239 (7.5) | 28,469 (6.8) | 27,517 (6.7) | 28,355 (6.3) | 23,155 (5.9) | 21,875 (5.7) | 22,720 (5.9) | 22,080 (5.7) | 22,345 (5.8) | 23,325 (5.7) |
| | Lower extremity | 9,523 (12.2) | 7,686 (11.1) | 7,331 (11.4) | 7,578 (10.7) | 5,645 (10.0) | 5,555 (10.5) | 5,460 (10.1) | 5,610 (10.6) | 5,315 (10.4) | 5,515 (10.4) |
| | Multiple locations | 16,595 (15.4) | 15,328 (14.0) | 14,223 (13.1) | 14,170 (12.0) | 11,190 (11.2) | 11,235 (11.4) | 11,310 (11.3) | 12,995 (11.6) | 15,320 (11.0) | 16,220 (11.0) |
| | Other/Unknown | 6,273 (8.7) | 8,123 (9.9) | 7,994 (10.0) | 7,563 (9.9) | 4,800 (7.7) | 4,520 (7.6) | 4,590 (7.4) | 4,510 (7.4) | 3,625 (7.6) | 3,665 (7.3) |

### Severe Ulcer Subgroup Analysis

The percent of patients with a severe ulcer, defined as a severity 3 or 4, increased during the time period from 32.4% in 2009 to 36.6% in 2019 (Table 4, *P* < .001). The mortality rate among patients with a severe ulcer decreased from 9.9% in 2009 to 7.4% in 2019 (*P* < .001). The rate of ulcer-related procedures among patients with a severe ulcer decreased from 17.5% in 2009 to 13.2% in 2019 ($P < .001$).

**Table 4**. Severe Ulcer (Severity 3 or 4) Volume, Procedure Volume, and Mortality by Year and Location.

| | | Admission Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| Ulcer volume | Total patients | 219, 832 (32.4) | 223, 929 (33.8) | 235, 379 (32.8) | 197, 640 (32.3) | 194, 480 (32.7) | 199, 970 (33.3) | 206, 475 (33.7) | 216, 615 (34.8) | 230, 810 (35.1) | 240, 230 (35.8) |
| | Back/ Sacrum | 114, 730 (52.2) | 116, 901 (52.2) | 128, 372 (54.5) | 113, 730 (57.5) | 113, 460 (58.3) | 116, 260 (58.1) | 118, 185 (57.2) | 121, 850 (56.3) | 128, 420 (55.6) | 134, 030 (55.8) |
| | Lower extremity | 16, 761 (7.6) | 16, 103 (7.2) | 16, 991 (7.2) | 13, 530 (6.8) | 12, 035 (6.2) | 12, 345 (6.2) | 12, 365 (6.0) | 12, 400 (5.7) | 13, 200 (5.7) | 13, 470 (5.6) |
| | Multiple locations | 53, 203 (24.2) | 53, 410 (23.9) | 58, 546 (24.9) | 49, 080 (24.8) | 49, 600 (25.5) | 51, 745 (25.9) | 59, 200 (28.7) | 72, 860 (33.6) | 79, 995 (34.7) | 83, 100 (34.6) |
| | Other/ Unknown | 35, 138 (16.0) | 37, 515 (16.8) | 31, 469 (13.4) | 21, 300 (10.8) | 19, 385 (10.0) | 19, 620 (9.8) | 16, 725 (8.1) | 9, 505 (4.4) | 9, 195 (4.0) | 9, 630 (4.0) |
| Procedure volume | Total patients | 38, 554 (17.5) | 36, 839 (16.5) | 36, 868 (15.7) | 28, 245 (14.3) | 27, 240 (14.0) | 27, 905 (14.0) | 28, 390 (13.7) | 28, 975 (13.4) | 30, 475 (13.2) | 32, 225 (13.4) |
| | Back/ Sacrum | 18, 522 (16.1) | 17, 463 (14.9) | 17, 779 (13.8) | 14, 755 (13.0) | 13, 895 (12.2) | 14, 560 (12.5) | 13, 970 (11.8) | 13, 580 (11.1) | 14, 135 (11.0) | 14, 575 (10.9) |
| | Lower extremity | 3, 190 (19.0) | 3, 114 (19.3) | 3, 230 (19.0) | 2, 295 (17.0) | 2, 075 (17.2) | 2, 000 (16.2) | 2, 150 (17.4) | 2, 035 (16.4) | 2, 285 (17.3) | 2, 450 (18.2) |
| | Multiple locations | 11, 662 (21.9) | 10, 864 (20.3) | 10, 782 (18.4) | 8, 570 (17.5) | 8, 750 (17.6) | 8, 865 (17.1) | 10, 320 (17.4) | 11, 965 (16.4) | 12, 715 (15.9) | 13, 740 (16.5) |
| | Other/ Unknown | 5, 179 (14.7) | 5, 399 (14.4) | 5, 076 (16.1) | 2, 625 (12.3) | 2, 520 (13.0) | 2, 480 (12.6)) | 1, 950 (11.7) | 1, 395 (14.7) | 1, 340 (14.6) | 1, 460 (15.2) |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mortality | Total patients | 21, 725 (9.9) | 21, 101 (9.4) | 20, 791 (8.8) | 16, 665 (8.4) | 16, 055 (8.3) | 15, 920 (8.0) | 16, 375 (79) | 16, 715 (7.7) | 18, 035 (7.8) | 18, 405 (7.7) |
| | Back/ Sacrum | 10, 786 (9.4) | 10, 535 (9.0) | 10, 865 (8.5) | 9, 130 (8.0) | 9, 335 (8.2) | 9, 025 (7.8) | 9, 520 (8.1) | 10, 305 (8.5) | 10, 950 (8.5) | 11, 055 (8.2) |
| | Lower extremity | 966 (5.8) | 771 (4.8) | 878 (5.2) | 705 (5.2) | 465 (3.9) | 575 (4.7) | 610 (4.9) | 570 (4.6) | 620 (4.7) | 595 (4.4) |
| | Multiple locations | 5, 059 (9.5) | 4, 556 (8.5) | 4, 747 (8.1) | 3, 720 (7.6) | 3, 670 (7.4) | 3, 465 (6.7) | 4, 165 (7.0) | 5, 255 (7.2) | 5, 945 (7.4) | 6, 125 (7.4) |
| | Other/ Unknown | 4, 914 (14.0) | 5, 239 (14.0) | 4, 300 (13.7) | 3, 110 (14.6) | 2, 585 (13.3) | 2, 855 (14.6) | 2, 080 (12.4) | 585 (6.2) | 520 (5.7) | 630 (6.5) |

## Discussion

Large-volume data from the NIS facilitates broad, longitudinal evaluation of changes in healthcare diagnosis, procedure and population dynamics. This type of analysis improves understanding of factors and changes in pervasive diseases, such as pressure ulcer. In this study, analysis of nearly eight million pressure ulcer patients over a twelve-year time period shows that the volume of pressure ulcer diagnoses remained stable from 2008 to 2019. Moreover, in this time period, the volume of ulcer-related procedures decreased despite an increase in the proportion of severe ulcers.

Although reimbursement changes instituted by CMS in 2008 and 2015 have made pressure ulcers a common focus of the medical community,[12] the impact of these policies on ulcer prevalence remains unclear. One investigation found no decrease in hospital-acquired pressure ulcers after the 2008 payment change.[13] Other work has supported this conclusion, and suggested that pressure injury rates have plateaued from 2015-2019.[14] In contrast, a study of acute care facilities revealed a decrease in overall and hospital-acquired pressure injury prevalence from 2006-2019.[15] Another investigation directly contradicted these findings, and suggested that hospital-acquired pressure injury rates rose 29.4% between the years of 2013-2016. Notably, this was the only hospital-acquired condition in the CMS Patient Safety Indicators 90 (PSI 90) that increased in this time, up to a rate of 4.8 cases per 10,000 hospital visits.[12] Our results show rates three times higher than this, likely explained by the fact that the ulcers in our analysis were not exclusively hospital-acquired.

Our results support findings of a plateau. Despite payment incentives ulcers remain prevalent. Reasons for a plateau may be related to the challenging nature of PI prevention. Some other hospital-acquired conditions may be “low hanging fruit” with simple prevention and higher weighting for payment incentives. More severe conditions are given a higher weight, so while pressure injury has a .06 weight, respiratory failure is given .30,[12] incentivizing prevention of respiratory failure over pressure injury. Pressure injury may be more difficult to prevent, leading hospitals to focus efforts on other conditions.

Management of pressure ulcers can be complex and multimodal. For severity 3 or 4 ulcers surgical management is indicated, particularly if wounds show little healing with conservative management. Advanced surgical management often includes an advancement or rotational flap.[16] In our analysis, we show that the frequency of ulcer-related procedures went down among the total ulcer population, as well as among those with severe ulcers. Notably, there was also a decrease in procedures among patients with a stage 3 or 4 ulcer, the population most likely to require surgical intervention.[17] Due to the admissions-based nature of the NIS data, no outpatient or ambulatory management is captured, so a possible explanation for this trend could be a transition toward more ambulatory ulcer-related procedures. However, another trend that could explain this change is a movement toward negative pressure wound therapy (NPWT) for the treatment of PIs. NPWT has been added to the reconstructive ladder since its development in the 1990s.[18] And breakthroughs in technology including NPWT with instillation and dwell (NPWTi-d) have proven promising for management of pressure wounds.[19]

Changes in population dynamics were assessed for this ulcer cohort. Results showed that the population became younger, and more male. As age is a well-established risk factor for PI, the decrease in age of the population may represent improved risk prediction and prevention in older patients, as new risk assessment tools are introduced. The proportion of patients with Medicaid increased, while the proportion with private insurance decreased, indicating a possible shift in the socioeconomic status of the cohort. Of note, about 75% of ulcer patients were insured under Medicare, with a slight increase over time, despite the small decrease in age over the time period. Race/ethnicity coding improved substantially during the time period, with 20.8% coded as missing or other in 2008, down to 5.7% in 2019.

In 2002, severity 3, 4, and unstageable ulcers acquired after admission were defined as never events, or serious reportable events, by the Agency for Healthcare Research and Quality National Quality Forum. Results from our analysis show an increase in the prevalence of severity 3 and 4 ulcers from 2008 to 2019. In support of our findings, Kayser et al. found that the 2011-2016 reduction in hospital-acquired pressure injuries previously reported[14] was due to a reduction in more superficial PIs rather than deeper, more severe PIs (stage 3, 4 or unstageable).[20] This finding was also supported by Padula et al who found the prevalence of severe pressure ulcers remained steady from 2009 to 2012.[7] Despite this finding, results also showed a decrease in mortality and length of stay. The increase in proportion of severe ulcers in our study was mostly seen from 2015-2019. These results may indicate that preventive efforts are not effective at targeting the most severe ulcers. However another interpretation, similar to changes in procedure volume, may be a movement toward more outpatient and ambulatory management of less severe pressure ulcers, which would increase the captured proportion of severe ulcers in an inpatient setting. Nevertheless, the relatively high prevalence of severe ulcers presented in the results raises the question of whether hospital-acquired ulcers should be measures of hospital quality, or are an unavoidable byproduct of multi-system disease. This question has implications for hospital quality measures and accordingly, payments from payers. Now that we've shown the prevalence of severe ulcers is not decreasing, this question should be explored in further work assessing the time of acquisition of these severe ulcers and the patients' preceding health status.

Certain limitations must be acknowledged in this study. Primarily, the NIS is a discharge-based, administrative database. While this type of database facilitated this large analysis, certain constraints exist. Each discharge was analyzed as a unique instance, with no continuity between discharges. Some of the discharges may have represented multiple admissions for a single patient. Additionally, no data could be obtained on whether pressure ulcers were obtained in the hospital stay or were present on admission.

Additionally, the results show pressure ulcers are largely a disease of advanced age. As trends in the entire population of advanced-age patients were not assessed, trends in ulcer prevalence and rates of procedures may be driven by overall trends in this population. Finally, the change in ICD coding during the time period limited granularity of diagnosis-related analyses, although we were able to confirm that the new set of codes did not capture significantly more or less patients. Finally, this analysis measures prevalence of pressure ulcers rather than incidence, which precludes analysis of hospital-acquired ulcers.

In conclusion, it was found that the overall prevalence of pressure ulcers in hospital admissions did not change from 2008-2019 in a nationally-representative sample of US hospital discharges. However during this time period the severity of ulcers increased, which may indicate success in prevention of less severe ulcers, but challenges in preventing more severe ulcers. Further work in identifying risk factors and effective preventative strategies for severe pressure ulcers is warranted. Also during this time period the volume of ulcer-related procedures performed went down, which may indicate a shift toward outpatient and less-invasive management, such as negative pressure wound therapy.

## Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

## ORCID iD

Phoebe B. McAuliffe

## References

1. Duncan KD. Preventing pressure ulcers: The goal is zero. *Joint Comm J Qual Patient Saf.* 2007;33(10):605-610.

Crossref | PubMed | Google Scholar

2. Padula WV, Delarmente BA. The national cost of hospital-acquired pressure injuries in the United States. *Int Wound J.* 2019;16(3):634-640.

Crossref | PubMed | Web of Science | Google Scholar

3. van den Bos J, Rustagi K, Gray T, Halford M, Ziemkiewicz E, Shreve J. The $17.1 billion problem: The annual cost of measurable medical errors. *Health Aff.* 2011;30(4):596-603.

Crossref | PubMed | Web of Science | Google Scholar

4. Lyder CH. Pressure ulcer prevention and management. *Am Med Assoc.* 2003;289(2):223-226.

Crossref | PubMed | Web of Science | Google Scholar

5. Cox J, Edsberg LE, Koloms K, VanGilder CA. Pressure Injuries in Critical Care Patients in US Hospitals: Results of the International Pressure Ulcer Prevalence Survey. *J Wound, Ostomy Cont Nurs*. 2022;49(1):21-28.

Crossref | PubMed | Web of Science | Google Scholar

---

6. Centers for Medicare and Medicaid Services (CMS), HHS. Medicare program: changes to the hospital inpatient prospective payment systems and fiscal year 2009 rates; payments for graduate medical education in certain emergency situations; changes to disclosure of physician ownership in hospitals and physician self-referral rules; updates to the long-term care prospective payment system; updates to certain IPPS-excluded hospitals; and collection of information regarding financial relationships between hospitals. *Fed Regist*. 2008;73(161):48433-49084.

PubMed | Google Scholar

---

7. Padula WV, Makic MBF, Wald HL, et al. Hospital-acquired pressure ulcers at academic medical centers in the United States, 2008-2012: Tracking changes since the CMS nonpayment policy. *Joint Comm J Qual Patient Saf*. 2015;41(6):257-263.

Crossref | PubMed | Google Scholar

---

8. CMS Media Relations. CMS to improve quality of care during hospital inpatient stays. In: *Department of Health & Human Services*. Washington, DC: Centers for Medicare and Medicaid Services; 2014.

Google Scholar

---

9. Wassel CL, Delhougne G, Gayle JA, Dreyfus J, Larson B. Risk of readmissions, mortality, and hospital-acquired conditions across hospital-acquired pressure injury (HAPI) stages in a US National Hospital Discharge database. *Int Wound J*. 2020;17(6):1924-1934.

Crossref | PubMed | Web of Science | Google Scholar

---

10. HCUP Databases. *Healthcare Cost and Utlilization Project (HCUP)*. Rockville, MD: Agency for Healthcare Research and Quality; 2021. www.hcup-us.ahrq.gov/nisoverview.jsp

Google Scholar

---

11. Centers of Medicare & Medicaid Services. *CMS Manual System: Pub 100-04 Medicare Claims Processing*. Baltimore, MD: Centers for Medicare and Medicaid Services; 2008. https://www.cms.gov/Regulations-and-Guidance/Guidance/Transmittals/downloads/R115NCD.pdf

Google Scholar

---

12. Padula WV, Black JM, Davidson PM, Kang SY, Pronovost PJ. Adverse effects of the medicare PSI-90 hospital penalty system on revenue-neutral hospital-acquired conditions. *J Patient Saf*. 2020;16(2):E97-E102.

Crossref | PubMed | Web of Science | Google Scholar

---

13. Waters TM, Daniels MJ, Bazzoli GJ, Perencevich E, Dunton N, Staggs VS, et al. Effect of medicare's

nonpayment for hospital-acquired conditions lessons for future policy. *JAMA Intern Med*. 2015;175(3):347-354.

Crossref | PubMed | Web of Science | Google Scholar

14. VanGilder CA, Cox J, Edsberg LE, Koloms K. Pressure injury prevalence in acute care hospitals with unit-specific analysis: Results from the international pressure ulcer prevalence (IPUP) survey database. *J Wound, Ostomy Cont Nurs*. 2021;48(6):492-503.

Crossref | PubMed | Web of Science | Google Scholar

15. VanGilder C, Lachenbruch C, Algrim-Boyle C, Meyer S. The international pressure ulcer prevalence survey: 2006-2015: A 10-year pressure injury prevalence and demographic trend analysis by care setting. *J Wound, Ostomy Cont Nurs*. 2017;44(1):20-28.

Crossref | PubMed | Web of Science | Google Scholar

16. Cushing CA, Phillips LG. Evidence-based medicine: Pressure Sores. *Plast Reconstr Surg*. 2013;132(6):1720-1732. https://journals.lww.com/plasreconsurg/Fulltext/2013/12000/Evidence_Based_Medicine__Pressure_Sores.52.aspx

Crossref | PubMed | Web of Science | Google Scholar

17. Sørensen JL, Jørgensen B, Gottrup F. Surgical treatment of pressure ulcers. *Am J Surg*. 2004;188(suppl 1):42-51.

Crossref | PubMed | Web of Science | Google Scholar

18. Janis JE, Kwon RK, Attinger CE. The new reconstructive ladder: Modifications to the traditional model. *Plast Reconstr Surg*. 2011;127(suppl 1S):205-212S.

Crossref | Web of Science | Google Scholar

19. Arowojolu OA, Wirth GA. Sacral and ischial pressure ulcer management with negative-pressure wound therapy with instillation and dwell. *Plast Reconstr Surg*. 2021;147(1 1):61S-67S.

Crossref | PubMed | Web of Science | Google Scholar

20. Kayser SA, VanGilder CA, Lachenbruch C. Predictors of superficial and severe hospital-acquired pressure injuries: A cross-sectional study using the international pressure ulcer prevalence$^{TM}$ survey. *Int J Nurs Stud*. 2019;89(February 2018):46-52.

Crossref | PubMed | Web of Science | Google Scholar