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Trends in inpatient burden from pressure injuries in the United States: Cross-sectional study National Inpatient Sample 2009–2019

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Abstract

Pressure injuries are a significant comorbidity and lead to increased overall healthcare costs. Several European and global studies have assessed the burden of pressure injuries; however, no comprehensive analysis has been completed in the United States. In this study, we investigated the trends in the burden of pressure injuries among hospitalised adults in the United States from 2009 to 2019, stratified by sociodemographic subgroups. The length of admission, total cost of hospitalisation, and sociodemographic data was extracted from the National Inpatient Sample provided by the Healthcare Cost and Utilisation Project, Agency for Healthcare Research and Quality. Overall, the annual prevalence of pressure injuries and annual mean hospitalisation cost increased ($69,499.29 to $102,939.14), while annual mean length of stay decreased (11.14–9.90 days). Among all races, minority groups had higher average cost and length of hospitalisation. Our findings suggest that while the length of hospitalisation is decreasing, hospital costs and prevalence are rising. In addition, differing trends among racial groups exist with decreasing prevalence in White patients. Further studies and targeted interventions are needed to address these differences, as well as discrepancies in racial groups.

KEYWORDS
decubitis ulcer, epidemiology, pressure injuries

1 | INTRODUCTION

Pressure injuries (PIs) are a significant burden in hospitals and affect up to 3 million people per year in the United States.[1,2] PIs are the result of tissue ischemia, injury, and necrosis after sustained pressure over a bony prominence. According to the 2019 international guidelines from the National Pressure Injury Advisory Panel (NPIAP), prevalence rates in medical facilities across the globe have a great variance between 0% and 72.5% with the average global point prevalence for acute hospitals accruing at 14.8%, and the innovations in technology

Abbreviations: AAPC, Average Annual Percent Change; APC, Annual Percentage Change; CI, Confidence Interval; EU, European Union; HACRP, Hospital-Acquired Condition Reduction Program; HCUP, Healthcare Cost and Utilization Project; HMO, Health Maintenance Organization; ICD9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; ICD10-CM, International Classification of Diseases, Tenth Revision, Clinical Modification; NIS, National Inpatient Sample; NPIAP, National Pressure Injury Advisory Panel; PI, Pressure Injury; SE, Standard Errors.

and medical devices possibly contributing to an increased prevalence due to pressure shearing[3] PI can occur at any site with prolonged pressure, shearing of the skin and underlying bones moving in opposite directions, friction from a drag of the skin on surfaces, and/or moisture from sweating or wound drainage leading to skin susceptible to injury. These injuries typically affect the sacrum, ischial tuberosity or greater trochanter. The remainder areas include lower extremities like the heel or lateral malleolus, and less frequently the nose, ear, elbow, chest and back.[4] Risk factors for PI include prolonged immobility and bed rest, spinal cord injuries, malnutrition, diabetes mellitus, smoking, and patients 65 and older.[5]

PIs are common and a significant risk in hospitalised patients. While several European and global studies have assessed the burden of PI,[2,3,6,7] no comprehensive analysis has been completed in the United States. The NPIAP estimates the cost of PI treatment approaching $11.6 billion from 2000 to 2012, with increasing trends. In this study, we examine the overall trends in PI inpatient burden, prevalence, length of stay, mean hospital cost and sociodemographic data across the United States between 2009 and 2019.

2 | METHODS

We utilised discharge data from the National Inpatient Sample (NIS) provided by the Healthcare Cost and Utilisation Project (HCUP), Agency for Healthcare Research and Quality. The National Inpatient Sample (NIS), as part of the Healthcare Cost and Utilisation Project (HCUP), is a comprehensive database representing a sample of approximately 20% of all inpatient admissions in the United States. It encompasses a wide range of data including patient demographics, diagnoses, procedures, and charges across various hospital types. We used the International Classification of Diseases, Ninth Revision, and Clinical Modification Codes (ICD9-CM) for the survey years from 2009 to 2015 and the International Classification of Diseases, Tenth Revision, and Clinical Modification Codes (ICD10-CM) for the survey years from 2016 to 2019 to define the disease codes. The transition from ICD-9-CM to ICD-10-CM coding in 2015 may have impacted the capture and classification of pressure injuries due to an increased specificity in coding. This change could have affected the trends observed in our study, potentially leading to a decreased apparent prevalence observed and reduction in misclassification.

We included men and women aged 18 years or older who were admitted from 2009 to 2019 with the primary and secondary diagnosis of PI (ICD9-CM: 707.0 and 707.2; ICD10-CM: L89). More details about all the ICD9-CM and ICD10-CM codes are summarised in Tables A1 and A2. We defined the burden of the PI using the length (days) and the total cost ($) of hospital stay. We stratified age (18–29; 30–39; 40–49; 50–59; 60–69; 70–79; 80–89; 90 or more years), gender (male or female), race (White, Black, Hispanic, and other), mean household income (<$39,000, $39000–47,999, $48000–62,999, $63,000 or more), and insurance type (Medicare, Medicaid, Private or HMO, Self-Pay, and Other) as sociodemographic variables.

3 | STATISTICAL ANALYSIS

We described the sample characteristics of the hospitalised patients with PI using unweighted counts, survey-weighted national estimates, and percentages for categorical variables. The NIS includes survey weights in the database to produce national or regional estimates. We utilised the complex samples module of the IBM SPSS® Statistics 25.0 (IBM, Chicago, Illinois, United States), accounting for the complex sample design of the NIS. We used sample strata accounting for hospital characteristics and year of the NIS data, clusters, and discharge weights to calculate the national level estimates. We calculated the survey-weighted annual mean length of stay, annual mean total cost of hospitalisation, and standard errors (SE) from 2009 to 2019 in the overall sample of inpatients with PI and stratified by sociodemographic subgroups.

We used the Joinpoint regression program (National Cancer Institute) to estimate piecewise log-linear trends in the survey-weighted mean length of stay and mean total hospital stay cost in the overall and stratified samples. Turning points in trends (joinpoints) were identified using Monte Carlo permutation-based tests, and the annual percentage change (APC) with a 95% confidence interval (CI) was estimated for each trend segment, and the average APC (AAPC) was calculated for the entire period (2009–2019). We reported trend models for the overall sample of inpatients with PI and stratified them by subgroups of sociodemographic variables. Disparities in Average Annual Percent Changes (AAPCs) were assessed using parallel pairwise comparisons across different subgroups, allowing for the evaluation of trends between any two distinct subgroups within our study population. The two-sided p-value <0.05 was considered significant.

4 | RESULTS

4.1 | Summary statistics

There were 80,761,162 (weighted: 402,665,763) hospital admissions from 2009 to 2019, and 60,068,227 (weighted: 299,613,779) adults had complete data. Among those, 1,252,729 (weighted: 6,252,083) had PI. Table 1 shows pooled descriptive statistics of the hospitalised patients with PI. The mean age was 70.88 years (SE = 0.06), and there were slightly more women (50.5%). The majority of the patients were White (67.4%), those who had income <$39,000 (32.4%), and had Medicare (77%) as the primary insurance.

4.2 | Overall trends in pressure injury prevalence, mean length of stay and mean hospital cost

PI prevalence was 2.03% in 2009 and 2.22% in 2019, and Joinpoint identified an increasing trend in the prevalence from 2013 to 2019 (APC = 3.2%; 95% CI 2.0%–4.4%) (Figure 1). The annual mean length of stay decreased overall from 2009 to 2019 (11.14–

TABLE 1 Descriptive statistics – National Inpatient Sample 2009–2019 (pooled sample).

Demographic characteristics	National estimate (weighted %)	Unweighted count
Pressure injury (yes)	6,252,083 (100.0%)	1,252,729
Age categories		
18–29 years	124,071 (2.0)	24,869
30–39 years	188,955 (3.0)	37,836
40–49 years	336,112 (5.4)	67,377
50–59 years	728,239 (11.6)	145,924
60–69 years	1,178,956 (18.9)	236,241
70–79 years	1,455,526 (23.3)	291,605
80–89 years	1,593,346 (25.5)	319,331
90 years or more	646,877 (10.3)	129,546
Sex		
Male	3,097,453 (49.5)	620,579
Female	3,154,630 (50.5)	632,150
Race		
White	4,215,004 (67.4)	844,949
Black	1,225,500 (19.6)	245,077
Hispanic	493,207 (7.9)	98,844
Other	318,371 (5.1)	63,859
Income		
<$39,000	2,025,388 (32.4)	405,037
$39,000–$47,999	1,558,325 (24.9)	312,389
$48,000–$62,999	1,427,304 (22.8)	286,545
$63,000 or more	1,241,067 (19.9)	248,758
Insurance type		
Medicare	4,815,745 (77.0)	965,024
Medicaid	629,205 (10.1)	126,040
Private or HMO	620,207 (9.9)	124,198
Self-pay	73,354 (1.2)	14,721
Other	113,572 (1.8)	22,746

Abbreviation: HMO, health maintenance organization.

9.90 days), and Joinpoint identified a significant decreasing trend from 2009 to 2012 (APC = −4.9%; 95% CI −8.0% to −1.7%), after which the mean length of stay was stable. However, the annual mean total hospital stay cost increased overall from 2009 to 2019 ($69,499.29 to $102,939.14), and Joinpoint identified a significant increasing trend from 2012 to 2019 (APC = 4.7%; 95% CI 4.3%–5.2%) (Figure 1).

5 | TRENDS OF HOSPITAL STAY LENGTHS STRATIFIED BY AGE, GENDER, RACE AND PRIMARY PAYER (PEP OR INSURANCE)

Table 2 and Figure 2 show the trends in the length of hospital stay among inpatients with PI stratified by sociodemographic subgroups.

5.1 | Age-related disparities

Among all age groups except for those aged 18–39 there were significant decreasing trends in length of hospital stay. In the 60–69, 70–79 and 80–89 age groups, the annual mean length of stay was significantly down-trending among both men and women from 2009 to −2012 but was stable after 2012 or in the case of patients aged 40–49 years stabilised after 2013. Comparatively, 50–59 and 90 or older age groups demonstrated significantly decreasing trends for the entire period. Furthermore, the trend in 18–29 years age groups was significantly different from the trends in 40–49 (AAPC difference: 1.1% [95% CI −0.2% to 2.5%]; $P = 0.03$), 70–79 (AAPC difference: 1.5% [95% CI 0.4%–2.6%]; $P = 0.03$), 80–89 (AAPC difference: 1.5% [95% CI 0.5%–2.6%]; $P = 0.02$), and 90 or more (AAPC difference: 1.4% [95% CI 0.4%–2.4%]; $P = 0.01$) groups.

5.2 | Gender-related disparities

For annual mean length of stay, there were significant decreasing trends among both men and women from 2009 to 2012 which stabilised thereafter from 2012 to 2019.

5.3 | Racial disparities

Among all races, only White adults had a significant decreasing trend in length of hospital stay. (AAPC%: −1.5% [95% CI −2.1% to −0.9%]), All other race subgroups (i.e., Black, Hispanic, Other) did not have significant decreasing trends in length of hospital stay.

5.4 | Income-related disparities

There was a significant decreasing trend in the length of hospital stay among those making $63,000 or more for the entire study period (2009–2019), while a significant decreasing trend was observed in the lower income categories only from 2009 to 2012 or 2013. After 2012/2013, those making under $63,000 annually did not have decreasing trends in length of hospital stay.

5.5 | Insurance or PEP-related disparities

Out of all insurance type (PEP) or Insurance groups (i.e., Medicare, Medicaid, Private or HMO, Self-Pay or Other), only Medicare and Other had significant decreasing trends in annual mean length of stay. Medicare patients (2009–2012) had a significant decreasing trend in hospital stay length from 2009 to 2012 only and stabilised thereafter, while patients in the 'Other' subgroup had a significant decreasing trend from 2009 to 2019 (the entire study period). Furthermore, the decreasing trend in the insurance type category Medicaid was significantly lower from the trends in insurance type categories Medicare

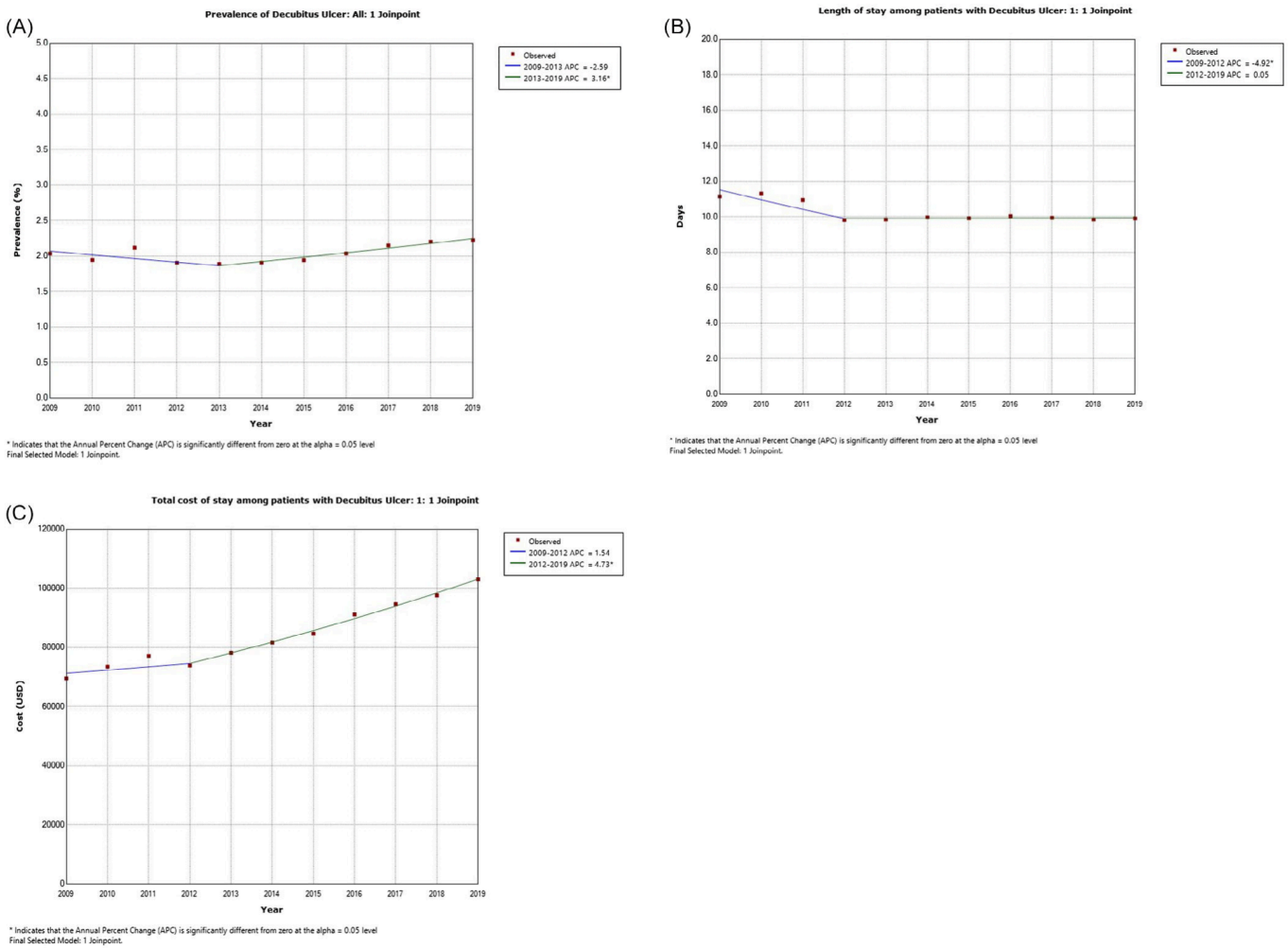

FIGURE 1 (A) Prevalence of pressure injury (PI). (B) Length of stay among patients with PI. (C) Total cost of stay among patients with PI.

(AAPC difference, −1.3% [95% CI, −2.2% to −0.3%]; $P = 0.01$), Private or HMO (AAPC difference, −0.1% [95% CI, −0.9% to 0.7%]; $P = 0.03$), and Other (AAPC difference, 0.9% [95% CI, 0.1%–1.7%]; $P = 0.01$).

6 | TRENDS OF TOTAL HOSPITAL COSTS STRATIFIED BY AGE, GENDER, RACE AND INSURANCE TYPE (PEP OR INSURANCE)

6.1 | Overall

Table 3 and Figure 3 show the trends in the total hospital stay cost among hospitalised patients with PI stratified by sociodemographic subgroups. All the sociodemographic subgroups had increasing trends in the total cost of hospital stay.

6.2 | Age-related disparities

All age categories had significant increasing trends in the total hospital cost for the entire period. Those in the 18–29 years age group had the highest average annual percentage increase (Average Annual Percentage Change, 5.2% [95% CI, 4.6%–5.9%]) at +5.2% annually. Furthermore, the uptrend in the 18–29 years age group was significantly higher than 50–59 (AAPC difference: +1.5% [95% CI 0.8%–2.3%]; P = 0.02), 70–79 (AAPC difference: +1.9% [95% CI 0.9%–3.0%]; $P = 0.03$), 80–89 (AAPC difference: +1.9% [95% CI 0.8%–3.0%]; $P = 0.02$) and 90 or more (AAPC difference: +1.3% [95% CI 0.6%–2.1%]; $P = 0.03$) age groups.

6.3 | Gender-related disparities

There was a significant increasing trend in the total cost of hospital stay among men for the entire study period (2009–2019), while a significant increasing trend was observed in women only from 2012 to 2019.

6.4 | Racial disparities

All race categories had significant increasing trends in the total hospital cost for the entire period. Those of Black race had the highest average annual percentage increase (average annual percentage

TABLE 2 Trends in length of hospital stay in pressure injury inpatients in the United States by sociodemographic subgroups – National Inpatient Sample 2009–2019.

Demographic characteristics	Length of stay (days) 2009 Mean (SE)	2019 Mean (SE)	AAPC, % (95% CI) 2009–2019	Segment 1[a]	APC % (95% CI)	Segment 2[a]	APC % (95% CI)
Total sample	11.14 (0.23)	9.90 (0.09)	**−1.5** (−2.3 to −0.7)	2009–2012	**−4.9** (−8.0 to −1.7)	2012–2019	0.0 (−0.3 to 0.4)
Age categories							
18–29 years	13.86 (0.58)	13.59 (0.51)	−0.3 (−1.1 to 0.5)	2009–2019	−0.3 (−1.1 to 0.5)	—	—
30–39 years	13.32 (0.42)	12.09 (0.37)	−0.9 (−2.2 to 0.4)	2009–2019	−0.9 (−2.2 to 0.4)	—	—
40–49 years	13.77 (0.39)	12.08 (0.24)	**−1.5** (−2.6 to −0.3)	2009–2013	**−3.9** (−6.8 to −0.9)	2013–2019	0.1 (−1.2 to 1.5)
50–59 years	13.21 (0.32)	11.82 (0.18)	**−0.8** (−1.6 to −0.0)	2009–2019	**−0.8** (−1.6 to −0.0)	—	—
60–69 years	12.57 (0.28)	11.04 (0.14)	**−1.5** (−2.1 to −1.0)	2009–2012	**−5.0** (−7.2 to −2.8)	2012–2019	−0.0 (−0.3 to 0.3)
70–79 years	11.34 (0.27)	9.75 (0.10)	**−1.9** (−2.7 to −1.0)	2009–2012	**−6.3** (−9.6 to −2.8)	2012–2019	0.1 (−0.3 to 0.5)
80–89 years	9.61 (0.23)	8.32 (0.08)	**−1.9** (−2.7 to −1.1)	2009–2012	**−5.4** (−8.4 to −2.3)	2012–2019	−0.3 (−0.7 to 0.0)
90 years or more	8.05 (0.20)	6.93 (0.11)	**−1.8** (−2.5 to −1.1)	2009–2012	**−4.5** (−7.1 to −1.8)	2012–2019	**−0.6** (−1.0 to −0.1)
Sex							
Male	11.79 (0.24)	10.37 (0.10)	**−1.5** (−2.4 to −0.6)	2009–2012	**−4.7** (−8.1 to −1.1)	2012–2019	−0.2 (−0.6 to 0.3)
Female	10.56 (0.23)	9.40 (0.10)	**−1.5** (−2.2 to −0.8)	2009–2012	**−5.2** (−8.0 to −2.4)	2012–2019	0.1 (−0.2 to 0.5)
Race							
White	10.46 (0.21)	9.29 (0.08)	**−1.5** (−2.1 to −0.9)	2009–2012	**−4.6** (−6.9 to −2.3)	2012–2019	−0.1 (−0.4 to 0.1)
Black	12.11 (0.34)	11.14 (0.16)	−1.1 (−2.3 to 0.1)	2009–2012	−4.6 (−9.2 to 0.1)	2012–2019	0.4 (−0.3 to 1.2)
Hispanic	13.08 (0.55)	10.72 (0.21)	−2.0 (−4.0 to 0.0)	2009–2012	−5.7 (−13.2 to 2.4)	2012–2019	−0.4 (−1.4 to 0.6)
Other	13.31 (0.72)	11.73 (0.39)	−0.9 (−1.8 to 0.0)	2009–2019	−0.9 (−1.8 to 0.0)	—	—
Income							
<$39,000	11.43 (0.29)	10.07 (0.11)	**−1.5** (−2.8 to −0.3)	2009–2012	**−5.7** (−10.3 to −0.9)	2012–2019	0.3 (−0.3 to 0.9)
$39,000–$47,999	11.06 (0.28)	9.90 (0.14)	**−1.3** (−2.2 to −0.4)	2009–2013	**−3.8** (−6.3 to −1.3)	2013–2019	0.4 (−0.5 to 1.3)
$48,000–$62,999	10.99 (0.26)	9.80 (0.12)	**−1.5** (−2.0 to −1.0)	2009–2012	**−5.3** (−7.1 to −3.4)	2012–2019	0.2 (−0.1 to 0.5)
$63,000 or more	10.99 (0.35)	9.72 (0.16)	**−0.8** (−1.4 to −0.2)	2009–2019	**−0.8** (−1.4 to −0.2)	—	—
Insurance type							
Medicare	10.42 (0.23)	9.06 (0.08)	−1.8 (−2.6 to −0.9)	2009–2012	**−6.0** (−9.3 to −2.5)	2012–2019	0.1 (−0.2 to 0.5)
Medicaid	14.33 (0.44)	13.45 (0.30)	−0.5 (−1.0 to 0.0)	2009–2019	−0.5 (−1.0 to 0.0)	—	—
Private or HMO	12.72 (0.37)	11.98 (0.21)	−0.4 (−1.2 to 0.4)	2009–2019	−0.4 (−1.2 to 0.4)	—	—
Self-pay	16.15 (0.93)	14.27 (0.64)	−0.6 (−1.7 to 0.5)	2009–2019	−0.6 (−1.7 to 0.5)	—	—
Other	12.03 (0.71)	10.58 (0.37)	**−1.4** (−2.1 to −0.7)	2009–2019	**−1.4** (−2.1 to −0.7)	—	—

Note: Bold results are statically significant.

Abbreviations: AAPC, average annual percentage change; APC, annual percentage change; CI: confidence interval; HMO, health maintenance organization; SE, standard error.

[a]Segments were chosen by Joinpoint regression.

change, 4.6% [95% CI, 3.9%–5.3%]) at +4.6% annually. Those of 'Other' race who were not Black, Hispanic, or White (e.g., multiracial, Asian, AI/AN, etc.) had the second highest average annual percentage increase (Average Annual Percentage Change, 4.3% [95% CI, 3.9%–5.3%]) at +4.3% annually. Furthermore, the trend in the Hispanic race was significantly different from the trend in the 'Other' race (AAPC difference: −0.7% [95% CI −1.8% to 0.3%]; $P = 0.03$).

6.5 | Income-related disparities

There were significant increasing trends in total hospital stay costs among all income categories. Those making an income below $39,000 had the highest average annual percentage increase (average annual percentage change, 5.0% [95% CI, 4.2%–5.8%]) at +5% annually.

6.6 | Insurance or PEP-related disparities

Inpatients with Medicare had an increasing trend in the total hospital stay cost only from 2012 to 2019, while all other insurance type categories had increasing trends for the entire period (2009–2019). Furthermore, the increasing trend in total hospital costs for Medicare patients was significantly lower compared to 'Private and HMO' (AAPC difference: −0.8% [95% CI −1.6% to 0.0%]; $P = 0.02$) and 'Self-pay' (AAPC difference: −0.4% [95% CI −1.4% to 0.6%]; $P = 0.04$) categories.

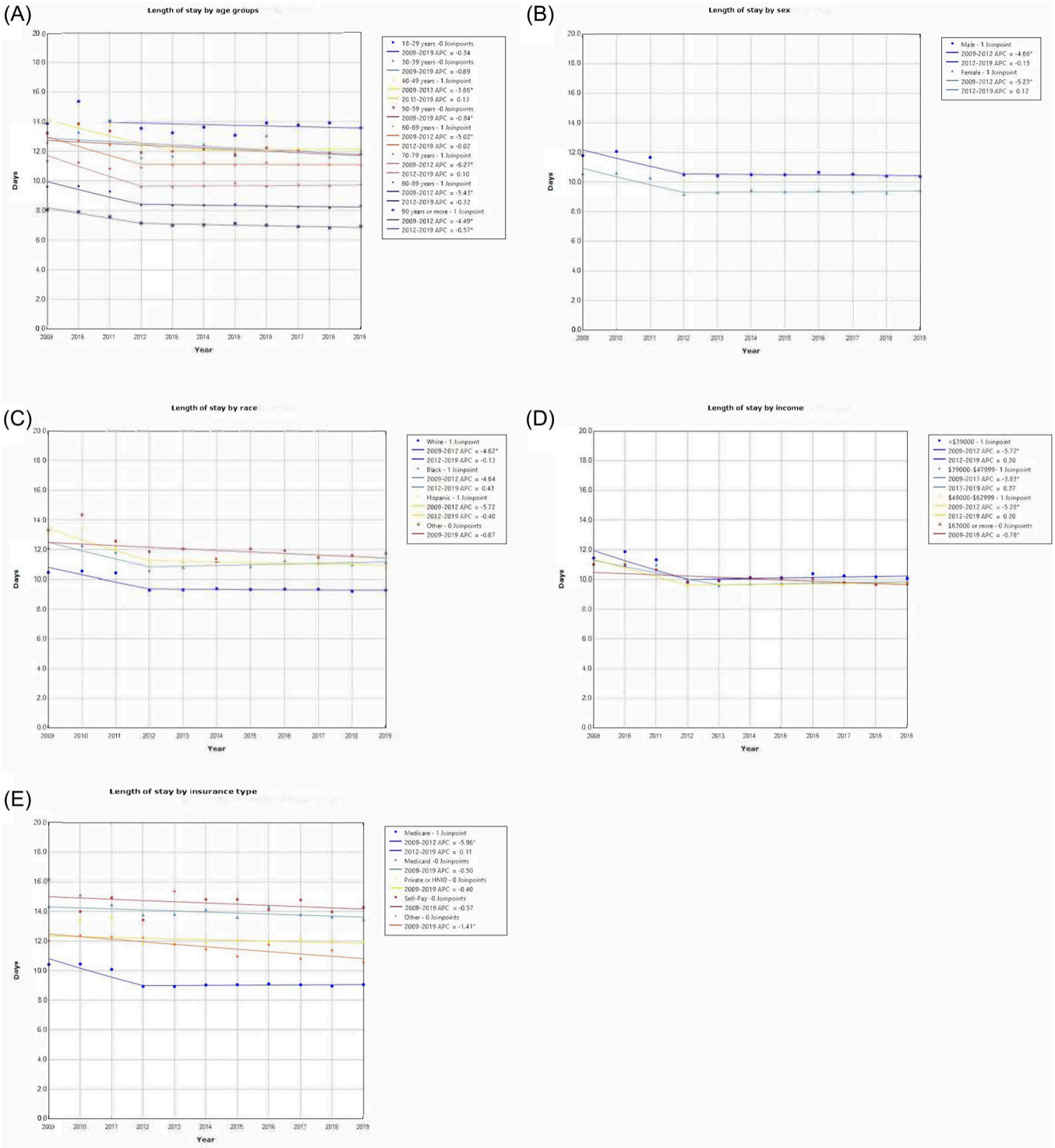

FIGURE 2 (A) Length of stay by age groups. (B) Length of stay by sex. (C) Length of stay by race. (D) Length of stay by income. (E) Length of stay by insurance type.

7 | DISCUSSION

PIs are a significant concern among hospitalised adults, leading to increased morbidity, prolonged hospital stays and substantial healthcare costs.[4] Understanding the trends in the burden of PI is crucial for informing healthcare policies, resource allocation, and interventions aimed at prevention and management. This study investigates the trends in the burden of PI among hospitalised adults in the United States from 2009 to 2019, with a specific focus on sociodemographic subgroups.

Using discharge data from the National Inpatient Sample, representing 20% of US hospitalizations, this study examined factors

TABLE 3 Trends in the total cost of hospital stay in pressure injury inpatients in the United States by sociodemographic subgroups – National Inpatient Sample 2009–2019.

	Total cost ($)						
Demographic characteristics	**2009 Mean (SE)**	**2019 Mean (SE)**	**AAPC, % (95% CI) 2009–2019**	**Segment 1[a]**	**APC % (95% CI)**	**Segment 2[a]**	**APC % (95% CI)**
Total sample	69499.29 (2115.81)	102939.14 (1828.25)	**3.8** (2.9 to 4.6)	2009–2012	1.5 (−1.6 to 4.7)	2012–2019	**4.7** (4.3 to 5.2)
Age categories							
18–29 years	94944.41 (5184.42)	153672.98 (7456.25)	**5.2** (4.6 to 5.9)	2009–2019	**5.2** (4.6 to 5.9)	—	—
30–39 years	87737.18 (4149.22)	138898.55 (6036.46)	**4.7** (3.4 to 6.1)	2009–2019	**4.7** (3.4 to 6.1)	—	—
40–49 years	91398.77 (3827.57)	130726.81 (4102.42)	**3.8** (2.5 to 5.2)	2009–2013	1.8 (−1.6 to 5.3)	2013–2019	**5.2** (3.7 to 6.7)
50–59 years	88793.95 (3056.26)	127117.21 (2894.75)	**3.7** (3.1 to 4.3)	2009–2019	**3.7** (3.1 to 4.3)	—	—
60–69 years	82955.26 (2550.49)	120344.22 (2501.74)	**4.0** (3.3 to 4.7)	2009–2019	**4.0** (3.3 to 4.7)	—	—
70–79 years	70666.41 (2289.96)	100679.19 (1990.47)	**3.3** (2.4 to 4.2)	2009–2012	0.3 (−3.0 to 3.8)	2012–2019	**4.6** (4.1 to 5.2)
80–89 years	55730.64 (1931.17)	80231.34 (1493.26)	**3.4** (2.5 to 4.3)	2009–2013	1.4 (−1.0 to 4.0)	2013–2019	**4.7** (3.8 to 5.7)
90 years or more	42348.55 (1591.87)	63373.14 (1798.12)	**3.9** (3.3 to 4.5)	2009–2019	**3.9** (3.3 to 4.5)	—	—
Sex							
Male	75893.76 (2337.60)	110404.39 (1985.26)	**4.1** (3.5 to 4.7)	2009–2019	**4.1** (3.5 to 4.7)	—	—
Female	63694.46 (1983.70)	95107.94 (1840.69)	**3.7** (3.2 to 4.3)	2009–2012	1.2 (−0.9 to 3.3)	2012–2019	**4.9** (4.5 to 5.2)
Race							
White	62161.87 (1828.93)	93367.54 (1681.92)	**4.1** (3.5 to 4.7)	2009–2019	**4.1** (3.5 to 4.7)	—	
Black	75134.42 (4003.76)	109805.51 (2729.73)	**4.6** (3.9 to 5.3)	2009–2019	**4.6** (3.9 to 5.3)	—	
Hispanic	100047.60 (4948.60)	141832.46 (4356.33)	**3.6** (2.9 to 4.4)	2009–2019	**3.6** (2.9 to 4.4)	—	
Other	94415.17 (4458.91)	142099.74 (5926.76)	**4.3** (3.4 to 5.3)	2009–2019	**4.3** (3.4 to 5.3)	—	
Income							
<$39,000	64983.92 (3018.70)	101312.00 (2153.97)	**5.0** (4.2 to 5.8)	2009–2019	**5.0** (4.2 to 5.8)	—	—
$39,000–$47,999	66995.32 (2341.58)	99324.86 (2221.40)	**3.8** (2.8 to 4.8)	2009–2013	1.7 (−0.9 to 4.3)	2013–2019	**5.2** (4.2 to 6.3)
$48,000–$62,999	72917.99 (2707.41)	102545.91 (2028.80)	**3.7** (2.8 to 4.5)	2009–2012	**3.7** (2.8 to 4.5)	—	—
$63,000 or more	74623.84 (3646.45)	110662.00 (3426.06)	**4.0** (3.7 to 4.3)	2009–2019	**4.0** (3.7 to 4.3)	—	—
Insurance type							
Medicare	62880.26 (2002.85)	92379.77 (1625.26)	**3.6** (2.9 to 4.3)	2009–2012	0.9 (−1.6 to 3.5)	2012–2019	**4.8** (4.4 to 5.1)
Medicaid	98130.74 (4372.73)	142044.27 (3438.82)	**4.3** (3.7 to 4.9)	2009–2019	**4.3** (3.7 to 4.9)	—	—
Private or HMO	87145.14 (3344.36)	137216.92 (4201.15)	**4.4** (3.8 to 5.0)	2009–2019	**4.4** (3.8 to 5.0)	—	—
Self-pay	92502.87 (7379.69)	138113.08 (7956.75)	**4.0** (3.1 to 4.9)	2009–2019	**4.0** (3.1 to 4.9)	—	—
Other	76618.63 (6534.62)	113685.77 (6403.64)	**3.6** (2.6 to 4.5)	2009–2019	**3.6** (2.6 to 4.5)	—	—

Note: Bold results are statically significant.

Abbreviations: AAPC, average annual percentage change; APC, annual percentage change; CI: confidence interval; HMO, health maintenance organization; SE, standard error.

[a]Segments were chosen by Joinpoint regression.

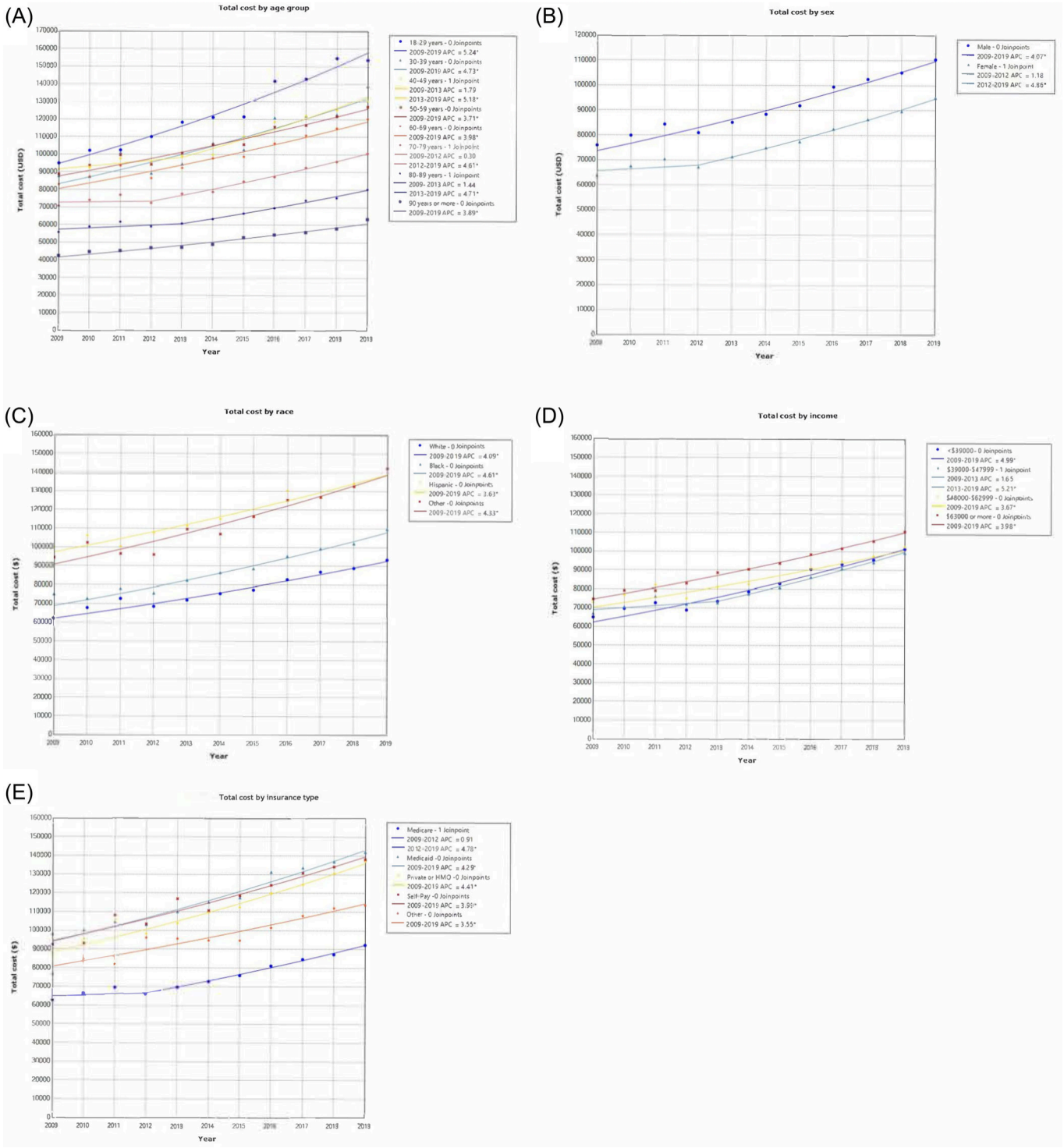

FIGURE 3 (A) Total cost by age group. (B) Total cost by sex. (C) Total cost by race. (D) Total cost by income. (E) Total cost by insurance type.

including age, gender, race, income, and insurance to analyse trends with the Joinpoint regression program. We found significant trends in PI prevalence, length of hospitalisation, and associated costs. Admissions for PI increased while the average length of hospital stays decreased. Despite the decrease in duration of stay, there was a substantial increase in total hospital costs associated with PI. The increased prevalence of PI observed in this study aligns with recent research demonstrating a higher incidence of this condition in most European Union (EU) countries.[6,7] and globally.[2,3] The underlying factors contributing to the rise of PIs are likely associated with an increased prevalence of chronic health conditions, predisposing patients to immobility, reduced sensation, incontinence, and poor nutrition, all of which are well-established risk factors for PI.[4,6,8]

Despite the growing awareness of this issue, there remains limited data on the epidemiology of PI specifically within the United States as most recent studies have focused on assessing

the global impact. Previous studies and systematic reviews have reported a broad range in the prevalence of PI among hospitalised patients in the United States, varying from 3.1% to 30.0%, with differences in study populations, sample sizes, and significant heterogeneity between studies.[9–14] In a recent systematic analysis of the 2019 Lancet's Global Burden of Disease study, it was reported that the United States has witnessed a notable rise in the incidence of pressure injuries, with 23% of global cases reported in the United States alone in 2019.[15,16] Our own analysis also supports this trend, indicating an increase in the prevalence of pressure injuries among United States hospitalised patients from 2.03% to 2.22% between 2009 and 2019.

Additionally, the rising costs associated with PIs are a significant concern in healthcare. Estimated costs of hospital-acquired PI in the United States are projected to exceed $26.8 billion.[17] A considerable portion (approximately 59%) of these costs can be attributed to a small number of Stage 3 and 4 full-thickness wounds, which require significant clinician time and consume valuable hospital resources.[17] In 2008, Medicare and Medicaid discontinued payment for hospital-acquired PI, placing a substantial financial burden on hospitals and incentivising cost reduction and preventive strategies.[1] Despite this, our analysis reveals increasing cost trends across all sociodemographic subgroups, rising from $69,499.29 in 2009 to $102,939.14 in 2019. Regarding possible drivers of increased hospital cost despite stay length not increasing and only a marginal increase in PI prevalence, factors such as the escalating price of medical care, administrative costs, advanced technology costs, inflationary pressures and policies regarding reimbursements are all possible contributors. The breakpoint between 2012 and 2013 where trends of healthcare costs associated with pressure injuries increased could be due to changes in health policy in the United States. While the Hospital-Acquired Condition Reduction Program (HACRP) began officially in 2014, inpatient facilities began to prepare earlier at risk of being penalised for having the highest rate of hospital acquired conditions, including pressure injuries, particularly in the Medicare population with a higher risk of PI development. This could have led hospitals to implement and expand more resources toward prevention and treatment of pressure injuries around 2013, possibly impacting both healthcare cost and stay. Similarly, the observed stability in hospital stay lengths across Medicaid, private insurance, and HMOs might be indicative of the standardised implementation of care protocols and hospital practices to combat pressure injuries consistently across facilities irrespective of the patient's insurance type.

Studies have hinted that there have been an increased association of pressure injuries in patients with darker skin tones compared to lighter skinned cohorts, and a study done within patients admitted to nursing home found that Black patients had a 1.7 times higher prevalence of PI compared to White cohorts.[18,19] Our study contributes to this important but understudied literature by examining that only White adults had a significantly decreasing trend in length of hospital stay associated with PI and that Black patients had the highest average annual percentage increase of PI associated hospital stays at +4.6% annually. Factors that can contribute to this discrepancy can be the under-detection of PI at early stages as darker toned skin types typically present with signs of damage that are not considered the 'classic' presentation, including inflammation and redness that is more readily detectable in White skin phenotypes.

The potential limitations of the study include a focus on hospital cost and length of stay as measures of the burden of PI, which may not provide a complete picture of their impact. Further comparators of hospitalisation trends across control cohorts without PI injury should be performed to further analyse the impact specific to PI rather than increasing costs attributed to other factors, such as inflation. A limitation for sociodemographic analysis includes being unable to do an analysis across ethnicity cohorts as 'Hispanic' was coded in the NIS as a race rather than an ethnicity. Factors such as patient quality of life and effective functioning should be evaluated in the future to gain a comprehensive understanding of patients' experiences and their interactions with the healthcare system. Future studies should investigate the burden, impact, and discrepancies for PI trends across racial cohorts to determine both causes and possible solutions to healthcare disparities. Additionally, future studies could benefit from including other related costs, such as outpatient care, rehabilitation, and long-term care expenses, in the cost analysis to provide a more comprehensive economic assessment.

8 | CONCLUSION

Despite improvements in the average length of hospital stay, the rising prevalence and total hospital costs associated with PI necessitate attention and comprehensive preventive strategies. The trends hint toward a need to improve the prevention, early detection, and treatment of PI to reduce both the potential burden on hospital costs associated with the condition and to improve quality of life in patients overall. The disparities observed among different sociodemographic groups highlight the need for targeted interventions to ensure equitable healthcare outcomes for all individuals. Further research is crucial to investigate the underlying factors contributing to these trends and to develop effective interventions that address the specific needs of vulnerable populations. By identifying the sociodemographic variations in the trends, healthcare providers and policymakers can tailor their efforts to mitigate the burden of PI and improve patient outcomes.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data supporting this study are available from HCUP Databases: www.hcup-us.ahrq.gov/databases.jsp. HCUP Data Use Agreement (DUA) training and a signed DUA are required to purchase and/or use the HCUP databases. HCUP is a voluntary partnership between the Federal government and State data organizations (HCUP Partners). The HCUP databases are consistent with the definition of limited data sets

under the HIPAA Privacy Rule and contain no direct patient identifiers.

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APPENDIX A

TABLE A1 ICD9-CM codes and description.

ICD9-CM code	Description
707.00	Decubitus ulcer site nos (begin 2004)
707.01	Decubitus ulcerelbow (begin 2004)
707.02	Decubitus ulcerup back (begin 2004)
707.03	Decubitus ulcerlow back (begin 2004)
707.04	Decubitus ulcerhip (begin 2004)
707.05	Decubitus ulcerbuttock (begin 2004)
707.06	Decubitus ulcerankle (begin 2004)
707.07	Decubitus ulcerheel (begin 2004)
707.09	Decubitus ulcersite nec (begin 2004)
707.20	Pressure ulcerstage nos (begin 2008)
707.21	Pressure ulcer stage i (begin 2008)
707.22	Pressure ulcer stage ii (begin 2008)
707.23	Pressure ulcer stage iii (begin 2008)
707.24	Pressure ulcer stage iv (begin 2008)
707.25	Pressure ulcer unstageable (begin 2008)

TABLE A2 ICD10-CM codes and description.

ICD10-CM code	Description
L89.000	Pressure ulcer of unspecified elbow, unstageable
L89.001	Pressure ulcer of unspecified elbow, stage 1
L89.002	Pressure ulcer of unspecified elbow, stage 2
L89.003	Pressure ulcer of unspecified elbow, stage 3
L89.004	Pressure ulcer of unspecified elbow, stage 4
L89.009	Pressure ulcer of unspecified elbow, unspecified stage
L89.010	Pressure ulcer of right elbow, unstageable
L89.011	Pressure ulcer of right elbow, stage 1
L89.012	Pressure ulcer of right elbow, stage 2
L89.013	Pressure ulcer of right elbow, stage 3
L89.014	Pressure ulcer of right elbow, stage 4
L89.016	Pressure-induced deep tissue damage of right elbow
L89.019	Pressure ulcer of right elbow, unspecified stage
L89.020	Pressure ulcer of left elbow, unstageable
L89.021	Pressure ulcer of left elbow, stage 1
L89.022	Pressure ulcer of left elbow, stage 2
L89.023	Pressure ulcer of left elbow, stage 3
L89.024	Pressure ulcer of left elbow, stage 4
L89.026	Pressure-induced deep tissue damage of left elbow
L89.029	Pressure ulcer of left elbow, unspecified stage
L89.100	Pressure ulcer of unspecified part of back, unstageable
L89.101	Pressure ulcer of unspecified part of back, stage 1
L89.102	Pressure ulcer of unspecified part of back, stage 2
L89.103	Pressure ulcer of unspecified part of back, stage 3
L89.104	Pressure ulcer of unspecified part of back, stage 4
L89.106	Pressure-induced deep tissue damage of unspecified part of back
L89.109	Pressure ulcer of unspecified part of back, unspecified stage
L89.110	Pressure ulcer of right upper back, unstageable
L89.111	Pressure ulcer of right upper back, stage 1
L89.112	Pressure ulcer of right upper back, stage 2
L89.113	Pressure ulcer of right upper back, stage 3
L89.114	Pressure ulcer of right upper back, stage 4
L89.116	Pressure-induced deep tissue damage of right upper back
L89.119	Pressure ulcer of right upper back, unspecified stage
L89.120	Pressure ulcer of left upper back, unstageable
L89.121	Pressure ulcer of left upper back, stage 1
L89.122	Pressure ulcer of left upper back, stage 2
L89.123	Pressure ulcer of left upper back, stage 3
L89.124	Pressure ulcer of left upper back, stage 4
L89.126	Pressure-induced deep tissue damage of left upper back
L89.129	Pressure ulcer of left upper back, unspecified stage
L89.130	Pressure ulcer of right lower back, unstageable
L89.131	Pressure ulcer of right lower back, stage 1
L89.132	Pressure ulcer of right lower back, stage 2
L89.133	Pressure ulcer of right lower back, stage 3
L89.134	Pressure ulcer of right lower back, stage 4
L89.136	Pressure-induced deep tissue damage of right lower back
L89.139	Pressure ulcer of right lower back, unspecified stage
L89.140	Pressure ulcer of left lower back, unstageable
L89.141	Pressure ulcer of left lower back, stage 1
L89.142	Pressure ulcer of left lower back, stage 2
L89.143	Pressure ulcer of left lower back, stage 3
L89.144	Pressure ulcer of left lower back, stage 4
L89.146	Pressure-induced deep tissue damage of left lower back
L89.149	Pressure ulcer of left lower back, unspecified stage
L89.150	Pressure ulcer of sacral region, unstageable
L89.151	Pressure ulcer of sacral region, stage 1
L89.152	Pressure ulcer of sacral region, stage 2
L89.153	Pressure ulcer of sacral region, stage 3
L89.154	Pressure ulcer of sacral region, stage 4
L89.156	Pressure-induced deep tissue damage of sacral region
L89.159	Pressure ulcer of sacral region, unspecified stage
L89.200	Pressure ulcer of unspecified hip, unstageable
L89.201	Pressure ulcer of unspecified hip, stage 1
L89.202	Pressure ulcer of unspecified hip, stage 2
L89.203	Pressure ulcer of unspecified hip, stage 3

(Continues)

TABLE A2 (Continued)

ICD10-CM code	Description
L89.204	Pressure ulcer of unspecified hip, stage 4
L89.206	Pressure-induced deep tissue damage of unspecified hip
L89.209	Pressure ulcer of unspecified hip, unspecified stage
L89.210	Pressure ulcer of right hip, unstageable
L89.211	Pressure ulcer of right hip, stage 1
L89.212	Pressure ulcer of right hip, stage 2
L89.213	Pressure ulcer of right hip, stage 3
L89.214	Pressure ulcer of right hip, stage 4
L89.216	Pressure-induced deep tissue damage of right hip
L89.219	Pressure ulcer of right hip, unspecified stage
L89.220	Pressure ulcer of left hip, unstageable
L89.221	Pressure ulcer of left hip, stage 1
L89.222	Pressure ulcer of left hip, stage 2
L89.223	Pressure ulcer of left hip, stage 3
L89.224	Pressure ulcer of left hip, stage 4
L89.226	Pressure-induced deep tissue damage of left hip
L89.229	Pressure ulcer of left hip, unspecified stage
L89.300	Pressure ulcer of unspecified buttock, unstageable
L89.301	Pressure ulcer of unspecified buttock, stage 1
L89.302	Pressure ulcer of unspecified buttock, stage 2
L89.303	Pressure ulcer of unspecified buttock, stage 3
L89.304	Pressure ulcer of unspecified buttock, stage 4
L89.306	Pressure-induced deep tissue damage of unspecified buttock
L89.309	Pressure ulcer of unspecified buttock, unspecified stage
L89.310	Pressure ulcer of right buttock, unstageable
L89.311	Pressure ulcer of right buttock, stage 1
L89.312	Pressure ulcer of right buttock, stage 2
L89.313	Pressure ulcer of right buttock, stage 3
L89.314	Pressure ulcer of right buttock, stage 4
L89.316	Pressure-induced deep tissue damage of right buttock
L89.319	Pressure ulcer of right buttock, unspecified stage
L89.320	Pressure ulcer of left buttock, unstageable
L89.321	Pressure ulcer of left buttock, stage 1
L89.322	Pressure ulcer of left buttock, stage 2
L89.323	Pressure ulcer of left buttock, stage 3
L89.324	Pressure ulcer of left buttock, stage 4
L89.326	Pressure-induced deep tissue damage of left buttock
L89.329	Pressure ulcer of left buttock, unspecified stage
L89.40	Pressure ulcer of contig site of back, buttock and hip, unspecified stage
L89.41	Pressure ulcer of contig site of back, buttock and hip, stage 1
L89.42	Pressure ulcer of contig site of back, buttock and hip, stage 2
L89.43	Pressure ulcer of contig site of back, buttock and hip, stage 3
L89.44	Pressure ulcer of contig site of back, buttock and hip, stage 4
L89.45	Pressure ulcer of contig site of back, buttock & hip, unstageable
L89.46	Pressure-induced dp tiss damage of contig site of back, butt and hp
L89.500	Pressure ulcer of unspecified ankle, unstageable
L89.501	Pressure ulcer of unspecified ankle, stage 1
L89.502	Pressure ulcer of unspecified ankle, stage 2
L89.503	Pressure ulcer of unspecified ankle, stage 3
L89.504	Pressure ulcer of unspecified ankle, stage 4
L89.509	Pressure ulcer of unspecified ankle, unspecified stage
L89.510	Pressure ulcer of right ankle, unstageable
L89.511	Pressure ulcer of right ankle, stage 1
L89.512	Pressure ulcer of right ankle, stage 2
L89.513	Pressure ulcer of right ankle, stage 3
L89.514	Pressure ulcer of right ankle, stage 4
L89.516	Pressure-induced deep tissue damage of right ankle
L89.519	Pressure ulcer of right ankle, unspecified stage
L89.520	Pressure ulcer of left ankle, unstageable
L89.521	Pressure ulcer of left ankle, stage 1
L89.522	Pressure ulcer of left ankle, stage 2
L89.523	Pressure ulcer of left ankle, stage 3
L89.524	Pressure ulcer of left ankle, stage 4
L89.526	Pressure-induced deep tissue damage of left ankle
L89.529	Pressure ulcer of left ankle, unspecified stage
L89.600	Pressure ulcer of unspecified heel, unstageable
L89.601	Pressure ulcer of unspecified heel, stage 1
L89.602	Pressure ulcer of unspecified heel, stage 2
L89.603	Pressure ulcer of unspecified heel, stage 3
L89.604	Pressure ulcer of unspecified heel, stage 4
L89.606	Pressure-induced deep tissue damage of unspecified heel
L89.609	Pressure ulcer of unspecified heel, unspecified stage
L89.610	Pressure ulcer of right heel, unstageable
L89.611	Pressure ulcer of right heel, stage 1
L89.612	Pressure ulcer of right heel, stage 2
L89.613	Pressure ulcer of right heel, stage 3
L89.614	Pressure ulcer of right heel, stage 4
L89.616	Pressure-induced deep tissue damage of right heel
L89.619	Pressure ulcer of right heel, unspecified stage
L89.620	Pressure ulcer of left heel, unstageable
L89.621	Pressure ulcer of left heel, stage 1
L89.622	Pressure ulcer of left heel, stage 2

(Continues)

TABLE A2 (Continued)

ICD10-CM code	Description
L89.623	Pressure ulcer of left heel, stage 3
L89.624	Pressure ulcer of left heel, stage 4
L89.626	Pressure-induced deep tissue damage of left heel
L89.629	Pressure ulcer of left heel, unspecified stage
L89.810	Pressure ulcer of head, unstageable
L89.811	Pressure ulcer of head, stage 1
L89.812	Pressure ulcer of head, stage 2
L89.813	Pressure ulcer of head, stage 3
L89.814	Pressure ulcer of head, stage 4
L89.816	Pressure-induced deep tissue damage of head
L89.819	Pressure ulcer of head, unspecified stage
L89.890	Pressure ulcer of other site, unstageable
L89.891	Pressure ulcer of other site, stage 1
L89.892	Pressure ulcer of other site, stage 2
L89.893	Pressure ulcer of other site, stage 3
L89.894	Pressure ulcer of other site, stage 4
L89.896	Pressure-induced deep tissue damage of other site
L89.899	Pressure ulcer of other site, unspecified stage
L89.90	Pressure ulcer of unspecified site, unspecified stage
L89.91	Pressure ulcer of unspecified site, stage 1
L89.92	Pressure ulcer of unspecified site, stage 2
L89.93	Pressure ulcer of unspecified site, stage 3
L89.94	Pressure ulcer of unspecified site, stage 4
L89.95	Pressure ulcer of unspecified site, unstageable
L89.96	Pressure-induced deep tissue damage of unspecified site