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Pressure Injury Prevalence in Acute Care Hospitals With Unit-Specific Analysis

Results From the International Pressure Ulcer Prevalence (IPUP) Survey Database

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ABSTRACT

PURPOSE: The purpose of this study was to determine overall pressure injury (PI) prevalence and hospital-acquired pressure injury (HAPI) prevalence in US acute care hospitals. Additionally, analysis of patient characteristics associated with HAPIs will be presented.

DESIGN: Observational, cross-sectional cohort study.

SUBJECTS AND SETTING: An in-depth analysis of data was performed from the International Pressure Ulcer Prevalence™ (IPUP) Survey database for years 2018-2019 that included 296,014 patients. There were 914 participating US acute care facilities in 2018 and 887 in 2019. Overall PI prevalence and HAPI prevalence over time were also examined for 2006-2019 acute care data from 2703 unique facilities (1,179,108 patients).

METHODS: Overall PI prevalence and HAPI prevalence were analyzed from the 2006-2019 IPUP survey database. Recent data for 2018-2019 PI prevalence are reported separately for medical-surgical, step-down, and critical care unit types. PI stages, anatomic locations, Braden score associated with HAPIs, and body mass index were analyzed.

RESULTS: Overall PI prevalence and HAPI prevalence data declined between 2006 and 2019; however, the prevalence plateaued in the years 2015-2019. Data from 2018 to 2019 (N = 296,014) showed that 26,562 patients (8.97%) had at least one PI and 7631 (2.58%) had at least one HAPI. Patients cared for in medical-surgical inpatient care units had the lowest overall PI prevalence (7.78%) and HAPI prevalence (1.87%), while critical care patients had the highest overall PI prevalence (14.32%) and HAPI prevalence (5.85%). Critical care patients developed more severe PIs (stage 3,4, unstageable, and deep-tissue pressure injuries [DTPIs]), which were proportionally higher than those in the step-down or medical-surgical units. The sacrum/coccyx anatomic location had the highest overall PI prevalence and HAPI prevalence, except for DTPIs, which most common occurred on the heel.

CONCLUSIONS: Overall and HAPI prevalence has plateaued 2015-2019. Prevalence of HAPIs, especially in critical care units, remain high. While medical advancements have improved survival rates among critically ill patients, survival may come with unintended consequences, including PI development.

KEY WORDS: pressure injuries, pressure ulcers, Prevalence, hospital acquired prevalence, cost of pressure ulcers/injuries, body mass index, Braden Score and pressure injuries, critical care complications.

INTRODUCTION

A focused effort aimed to reduce the number and severity of pressure injuries (PIs) has been present for many years. Organizations such as the Institute of Healthcare Improvement (IHI), the Agency for Healthcare Research and Quality (AHRQ), the American Nurses Association (ANA), The Joint Commission, the Wound Ostomy Continence Nursing (WOCN) Society, the National Pressure Injury Advisory Panel (NPIAP), the European Pressure Ulcer Advisory Panel (EPUAP), the Pan Pacific Pressure Injury Allegiance (PPPIA), the World Council of Enterostomal Therapists (WCET), and others have all been a part of this effort.

Several studies have found reductions in PI occurrences.[1,2] He and colleagues[1] analyzed the National Database of Nursing Quality Indicators (NDNQI) US acute care data on PI prevalence (2004-2007 and 2008-2011 data groupings) and found that unit-level hospital-acquired pressure injury (HAPI) rates decreased (odds ratio [OR] = 0.91; 95% confidence interval [CI], 0.90-0.91) between the years 2004 and 2007, with an even more significant reduction during 2008-2011 data (OR = 0.84; 95% CI, 0.83-0.85). Similarly, VanGilder and colleagues[2] reported data from the 2006-2015 International Pressure Ulcer Prevalence™ (IPUP) Survey. Study findings demonstrated a reduction in HAPI prevalence (all PI stages) from 6.4% in 2006 to 2.9% in 2015. Kayser and associates[3] later segmented the 2011-2016 IPUP data and found that the HAPI reductions were primarily associated with superficial PIs (HAPI prevalence 3.6% in 2011 to ~2.0% in 2015); however,

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more severe PIs (stage 3,4, unstageable, and deep-tissue pressure injuries [DTPIs]) remained stable at about 1% throughout the study time period. Conversely, Padula and colleagues[4] recently reported an increase of 29.4% for stage 3 and stage 4 PIs between the years of 2013 and 2016 in 306 academic hospital reports on Patient Safety Indicator Data (PSI90). Moreover, the AHRQ reports that more than 2.5 million people in the United States develop HAPIs annually[5]. Considered collectively, findings from these studies indicate that our prevention efforts have not eliminated PIs in the United States.

In acute care settings, unit-specific PI prevalence data are limited; nevertheless, they are essential to a complete understanding of the epidemiology of PIs among US hospitals. He and colleagues[1] reported 2004-2011 HAPI rates of 14% in critical care and 8.4% in step-down unit, with other unit type rates between 5.8% and 7.6%. VanGilder and colleagues[7] reported a 2009 HAPI prevalence in critical care ranging from 8.8% to 10.4%, step-down units at 6.0%, and general medical-surgical, neurology, and orthopedic units between 3.0% and 5.4%. The International PI Prevention and Treatment guidelines also report a relatively high burden of PIs in critical care environments and consider intensive care unit (ICU) patients a special high-risk population.[6] If we better understand where in the acute care settings the majority of PIs are occurring, and the populations that are acquiring PIs, intensified PI prevention focus can be designed and applied to these populations, which may achieve our overall goal of reducing PIs in acute care facilities.

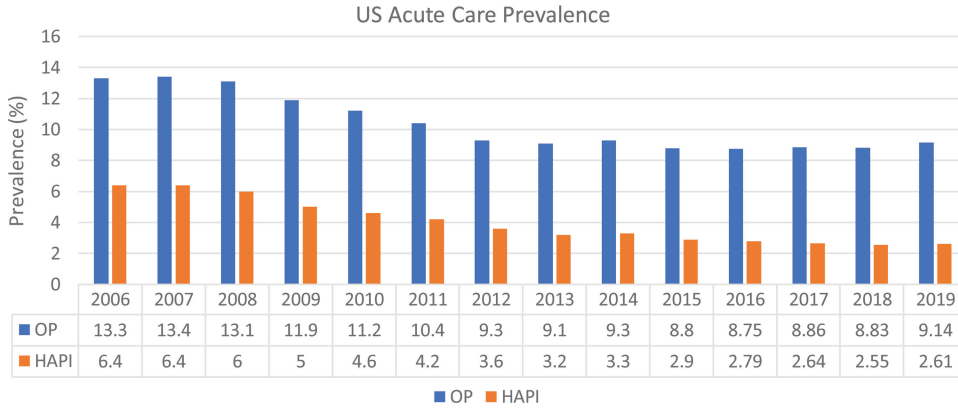
Given these unsolved challenges, more granularity in reporting is needed to define where HAPIs are most likely to occur. This knowledge will allow targeted prevention complementing current preventive efforts. This observational, cross-sectional cohort study derived from the IPUP database aims to present US data for acute care overall PI prevalence and HAPI prevalence for 2006-2019 and to use recent data from 2018 to 2019 to report (1) unit-specific acute care PI prevalence; (2) PI demographic data; (3) PI stages overall distribution by unit type; (4) PI anatomic location by unit type; (5) mean Braden Pressure Injury Risk Score by HAPI stage; and (6) PI prevalence by body mass index (BMI). The following research questions guided this analysis: (1) What is the current PI prevalence in US acute care hospitals and how does it compare to previous data? (2) What is the prevalence of HAPIs by hospital setting/unit type? (3) What is the anatomic distribution of PIs of patients in the acute care setting? and (4) What patient characteristics are associated with patients who develop PIs?

METHODS

The IPUP database is an observational, cross-sectional cohort database that allows measurement of the presence and severity of PIs and correlation analysis of nonprotected health data. The IPUP Survey, facilitated by Hill-Rom, Inc (Batesville, Indiana), has been assisting facilities to measure and benchmark their PI prevalence to similar facilities or units since 1989. Data collection methods for the IPUP Survey have been previously published.[2,7-10] Briefly, hospitals choose to participate by signing up on the Hillrom Web site (https://surveys.hillrom.com/). Participation is available to all facilities regardless of whether they purchase or rent Hillrom products. A staff member from the hospital who is self-designated as the hospital's coordinator receives survey materials. Survey data are directly collected by hospital clinical teams who assess patients admitted to the hospital over a specific preselected 24-hour period within a 2- to 3-day window. The coordinator designates internal survey teams that assess the skin of patients with a 100% participation goal (all admitted patients).

We report point prevalence in this study. Point prevalence was operationally defined as the number of individuals with a PI at a specific point in time. It was calculated as the [Number of patients with a PI]/[Total number of patients surveyed] × 100 and reported as a percentage.[6] Hospital-acquired pressure injury prevalence or facility-acquired pressure injury prevalence is a subset of the total or overall PI prevalence, including only the patients who developed a PI during the course of a single hospital admission. [Number of patients with an HAPI]/[Number of patients surveyed] × 100.[6] To clarify, overall PI prevalence includes both preexisting PIs and PIs acquired during admission. The prevalence of HAPIs includes only those patients who had PIs that developed during admission or PIs that were not documented as present on admission.

Unit specific analysis involved a grouping of Critical Care units, general hospital units under medical/surgical, and step-down unit bundling. Units identified as "other" that were not evaluated on a unit-specific basis (Figure 3) include obstetrics, adult rehabilitation, general psych/mental health units, geriatric psychiatric units, observation units, labor and delivery, emergency departments, long-term acute care (LTAC), bone marrow units, long-term care, skilled nursing units, spinal cord injury units, hospice, all pediatric units, and postanesthesia care units. Study methods were reviewed and was determined to be exempt by Rutgers University (exempt determination: approval #2019001057).



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
OP	13.3	13.4	13.1	11.9	11.2	10.4	9.3	9.1	9.3	8.8	8.75	8.86	8.83	9.14
HAPI	6.4	6.4	6	5	4.6	4.2	3.6	3.2	3.3	2.9	2.79	2.64	2.55	2.61

Figure 1. Acute care prevalence in the United States during 2006-2019. OP indicates overall prevalence; HAPI, hospital-acquired pressure injury.

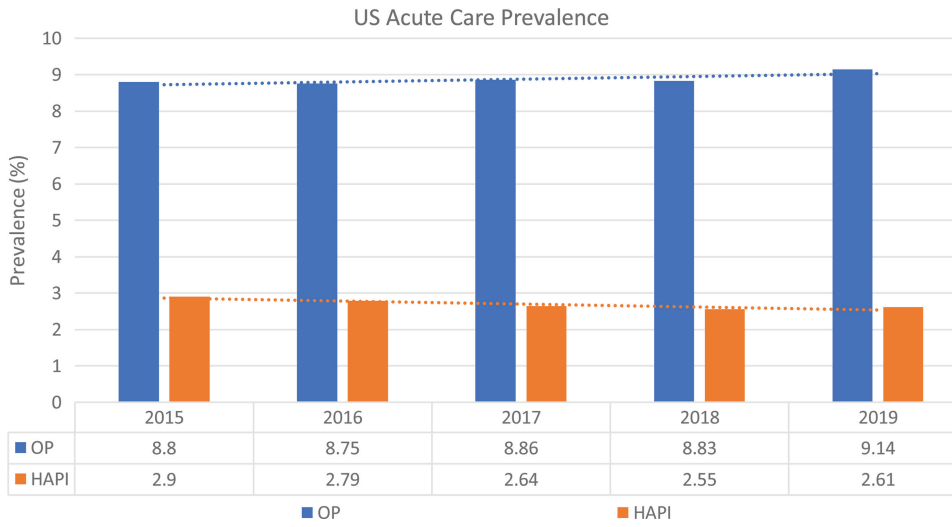


Figure 2. Acute care prevalence in the United States over the last 5 years (2015-2019).

RESULTS

Annual IPUP data from 2006 to 2019 in acute care facilities within the United States showed a significant reduction in both overall PI and HAPI occurrences since 2008 (Figure 1). The annual average number of adult participants (≥18 years of age) in an acute care setting in the IPUP data set was 134,405 subjects for years 2006-2019 (Figure 1). Overall PI prevalence declined from around 13% to approximately 9%, while HAPI prevalence was reduced by more than half (from ~6.6% to ~3%), with a subsequent decline to a current prevalence of 2.6%. However, analysis also indicates that overall PI prevalence and HAPI prevalence have plateaued over the last 5 years (Figure 2). Overall PI prevalence exhibits a linear trend where for every increase in year, the prevalence is expected to increase by 0.1 percentage points and HAPI prevalence is expected to decrease by only 0.04 percentage points for each new year (Figures 1 and 2).

Unit-Specific Data Analysis

Our sample comprised 914 participating US acute care facilities in 2018 and 887 in 2019, comprising 296,014 patients. Of these, 26,562 patients had at least one PI (8.97%) and 7631 had at least one HAPI (2.58%). Analysis of demographic data showed that 49.4% were male and 50.0% were female (0.6% were not recorded); their average height was 168.5 cm (66.3 in or 5.5 ft tall), their average weight was 83.8 kg (184.8 lb), and their mean BMI (n = 170,006) was 29.4 kg/m^2. The average age of the entire sample was 64.6 years; PI subjects were older at 69.91 years (SD = 15.45) than those without PIs (age 63.74 years; SD = 17.2).

We also analyzed prevalence based on care unit using the 2018-2019 recent data. Unit types were grouped into medical surgical units (n = 195403; 66%), ICUs (n = 41,866; 14%), and step-down care units (n = 23,979; 8%). Medical-surgical units had the lowest overall PI prevalence and HAPI prevalence at 7.78% and 1.87% respectively, followed by step-down (10.15% and 3.35%, respectively). Critical care had the highest overall PI prevalence and HAPI prevalence at 14.32% and 5.85%, respectively (Tables 1 and 2). The proportion of all hospitalized patients by unit type is shown in Figure 3A, PI patients by unit type in Figure 3B, and HAPI patients by unit type in Figure 3C. Although critical care represents only 14% of the study sample, this group represented 23% of all PIs and 32% of all HAPIs (shown in Figures 3B and 3C, respectively).

Prevalence by Stage

The prevalence of PIs based on stage is usually conceptualized by one of 2 frameworks. The first approach measures all PIs on all patients, where the number of PIs is higher, as many PI patients have more than one PI. The second approach evaluates "worst stage" data; this approach reports the highest stage PI for each patient. The latter approach requires definition of which stage is considered the worst stage. In the context of this study, we defined a hierarchy of "worst" (from worst to mildest) as stage 4, unstageable, DTPI, stage 3, stage 2, and stage 1. In order to assess which units had more severe PIs (stage 3,4, unstageable, and DTPIs) and which units had more superficial PIs (stages 1 and 2), we evaluated "worst stage" PI data where each patient is counted once. Overall

TABLE 1.
2018-2019 Acute Care PI and HAPI Prevalence Data

Care Setting	Patients	Overall PI Count	PI Prevalence	Overall HAPI Count	HAPI Prevalence
All AC patients	296,014	45,672	26,562 (9.0%)	10,894	7,631 (2.6%)
MedSurg	195,403	26,066	15,194 (7.8%)	5,039	3,647 (1.9%)
Step-down	23,979	4,135	2,434 (10.2%)	1,180	803 (3.4%)
CC	41,866	10,481	5,995 (14%)	3,642	2,451 (5.9%)

Abbreviations: AC, acute care; CC, critical care; HAPI, hospital-acquired pressure injury; MedSurg, medical-surgical; PI, pressure injury.

TABLE 2.
United States–Specific Prevalence 2018-2019[a]

	2018			2019		
Unit Type	**N**	**PI Prevalence**	**HAPI Prevalence**	**N**	**PI Prevalence**	**HAPI Prevalence**
Critical care	**21,840**	**14%**	**5.8%**	**20,026**	**14%**	**5.9%**
Burn ICU	5	40%	0.0%	138	20%	13%
Cardiac ICU	2,663	11%	5.4%	2,722	13%	6.5%
General CCU	2,561	12%	4.9%	2,297	12%	4.9%
General ICU	7,374	16%	6.4%	6,448	16%	6.6%
Medical ICU	4,760	17%	5.8%	4,073	17%	5.9%
Neuro ICU	1,556	8.6%	4.4%	1,527	9.2%	2.6%
Surgical ICU	2,904	13%	6.3%	2,463	13%	6.2%
Trauma ICU	17	29%	12%	358	12%	5.0%
MedSurg	**104,657**	**7.7%**	**1.9%**	**90,746**	**7.6%**	**1.9%**
Burn	584	10.6%	6.0%	458	7.6%	1.3%
MedSurg	34,303	8.0%	1.8%	29,806	7.2%	1.8%
Medical	12,857	8.7%	1.8%	10,463	9.0%	2.0%
Neurology	4,483	6.2%	1.9%	3,960	7.3%	2.1%
Oncology	7,524	7.3%	1.7%	6,659	8.2%	1.8%
Orthopedic	9,320	4.8%	1.5%	8,468	4.7%	1.4%
Renal/Urology	2,352	9.8%	1.9%	2,107	9.5%	2.3%
Surgical	9,478	5.6%	1.6%	8,711	5.9%	1.7%
Telemetry (cardiac, general, medical, surgical)	23,756	8.7%	2.2%	20,114	9.0%	2.2%
Step-down (cardiac, respiratory, surgical, me dical)	**12,258**	**9.9%**	**3.4%**	**11,721**	**10.4%**	**3.3%**

Abbreviations: CCU, critical care unit; HAPI, hospital-acquired pressure injury; ICU, intensive care unit; LTAC, long-term acute care; MedSurg, medical-surgical; PACU, postanesthesia care unit; PI, pressure injury.
[a]"Other unit types" that were not included in the analysis were cardiac-surgery, trauma ICU, obstetrics, rehab adult, general psych/mental health, Geri-Gero psychiatry, observation, labor and delivery, emergency departments, LTAC, bone marrow units, long-term care, skilled nursing units, spinal cord, hospice, all pediatric units, clinical decision units, telemetry, interventional, and PACU.

worst stage data are presented in Tables 3 and 4, where Table 4 highlights only HAPIs.

Based on "worst stage" data analysis, patients in ICUs had the most severe PIs (8.7%), followed by step-down units (5.12%) and medical-surgical units (4.19%). Patients with only superficial PIs were proportionally also more common in critical care units, with 5.29% as compared to 4.78% of step-down patients and 3.39% of medical-surgical patients.

Severe HAPIs were proportionally higher in critical care (3.23%), followed by step-down (1.53%) and medical-surgical (0.75%) units. Moreover, patients with only superficial HAPIs were more common in critical care units versus step-down units versus medical-surgical units (2.39% vs 1.76% vs 1.07%, respectively).

Anatomic Location and Unit Type

We then analyzed all PIs by stage, the alternative approach to stage analysis as described earlier (Tables 5 and 6). We found that the sacrum/coccyx had the highest percentage of overall PIs and HAPIs for all stages except for DTPIs. Deep-tissue

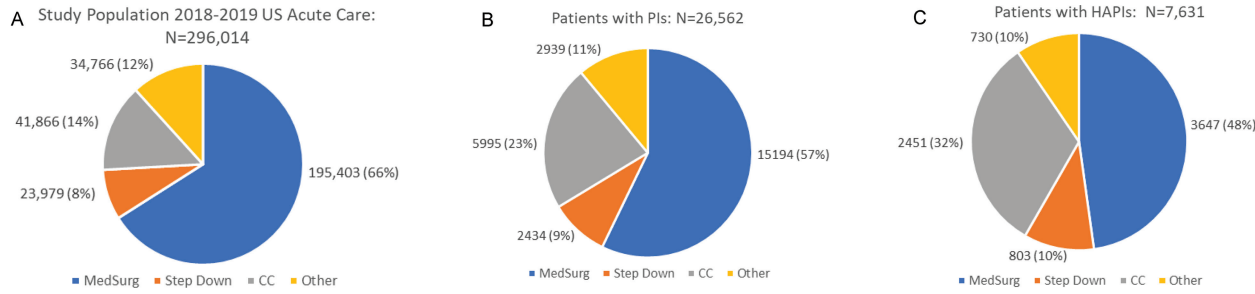


Figure 3. (A) Percentage of all patients in each unit "other unit types" that were not included in the analysis were cardiac surgery, trauma ICU, obstetrics, rehab adult, general psych/mental health, Geri-Gero psychiatry, observation, labor and delivery, emergency departments, LTAC, bone marrow units, long-term care, skilled nursing units, spinal cord, hospice, all pediatric units, clinical decision units, telemetry, interventional, and postanesthesia care units. (B) Percentage of patients with a PI in each unit. (C) Percentage of patients with an HAPI in each unit. ICU indicates intensive care unit; LTAC, long-term acute care; PI, pressure injury; HAPI, hospital-acquired pressure injury.

TABLE 3.
All PI Patients by Unit Type and Severity (Worst Stage Data)

Unit Type	All Patients, N	Patients w/ PI, n	%	Patients w/Worst Stage 3, 4, Unstageable, or DTPI, n	%	Patients w/Worst Stage 1, 2, n	%
Critical care	**41,866**	**5,995**	**14%**	**3,630**	**8.7%**	**2,213**	**5.3%**
Burn ICU	143	30	21%	24	17%	6	4.2%
Cardiac ICU	5,385	651	12%	385	7.2%	245	4.6%
General CCU	4,858	587	12%	321	6.6%	251	5.2%
General ICU	13,822	2,167	16%	1,246	9.0%	883	6.4%
Medical ICU	8,833	1,536	17%	987	11%	506	5.7%
Neuro ICU	3,083	275	9.0%	170	5.5%	85	2.8%
Surgical ICU	5,367	702	13%	467	8.7%	221	4.1%
Trauma ICU	375	47	13%	30	8.0%	16	4.3%
MedSurg	**195,403**	**14,924**	**7.6%**	**8,183**	**4.2%**	**6,629**	**3.4%**
Burn	1,042	97	9.3%	67	6.4%	24	2.3%
MedSurg	64,109	4,887	7.6%	2,799	4.4%	2,231	3.5%
Medical	23,320	2,069	8.9%	1,187	5.1%	831	3.6%
Neurology	8,443	568	6.7%	298	3.5%	257	3.0%
Oncology	14,183	1,095	7.7%	541	3.8%	527	3.7%
Orthopedic	17,788	849	4.8%	452	2.6%	377	2.1%
Renal/Urology	4,459	432	9.7%	230	5.2%	179	4.0%
Surgical	18,189	1,046	5.8%	591	3.3%	430	2.4%
Telemetry (cardiac, general, medical, surgical)	43,870	3,881	8.9%	2,018	4.6%	1,773	4.0%
Step-down (cardiac, respiratory, surgical, medical)	**23,979**	**2,434**	**10.2%**	**1,228**	**5.1%**	**1,146**	**4.8%**

Abbreviations: CCU, critical care unit; DTPI, deep-tissue pressure injury; ICU, intensive care unit; MedSurg, medical-surgical; PI, pressure injury.

pressure injuries were most common at the heel, followed by sacrum/coccyx for all PIs and HAPIs. The buttocks were the second most common location for PIs and HAPIs in stage 2, stage 3, and stage 4 and the third most common location for DTPIs. The heel was the third most common location for stage 1 and unstageable PIs.

We subsequently analyzed PI occurrences based on anatomic location and unit type; the proportion of overall PIs and HAPIs was highest at the sacrum/coccyx in all unit types; refer to Tables 7 for overall PI analysis based on location and unit type and Table 8 for HAPIs. The buttocks were the most common PI location in step-down units; this finding differs from medical-surgical units where the heel was the second most common location, followed by the buttocks as third most common location.

Braden Scale Score and BMI

The average Braden Scale Risk Score (defined as "last Braden Scale score" on the survey form) for patients without HAPIs (n = 285,683) was 18.42 (SD = 3.48), which was higher than the scores of patients with a superficial HAPI at 15.83 (SD = 3.76) (n = 4578) and still higher than those having a severe HAPI at 15.04 (SD = 4.10). Significant differences in Braden Scale scores were found between these groups (P = .000).

Overall PI prevalence and HAPI prevalence were highest among patients with a BMI of less than 18.5 kg/m^2 (18.9% and 5.5%, respectively; Figure 4A), followed by patients with a BMI of 18.5 to 24.9 kg/m^2. Patients with a lower BMI had more stage 1 and 3 PIs. Figure 4B, Stage 4 PIs were most common in patients with a BMI of 30 to 40 kg/m^2, followed by patients with a reported BMI of less than 18.5 kg/m^2. Stage 2 PIs were the most common in all BMI groupings, and patients with BMI 25 and above DTPIs were 2nd most common.

DISCUSSION

Results of this study provide some important insights with regard to the plateau in pressure injury prevalence rates in recent years, the potential for unavoidability in pressure injury occurrence in the acute care population as well as highlights the economic impacts associated with pressure injuries. Between the years 2006 and 2013, the overall PI prevalence in US hospitals ranged from 8.8% to 13.8% (Figure 1). Analysis of PI prevalence from 2006 to 2016 revealed a consistent downward trend (from 13.5% to 8.8%). In contrast, data from the years 2015-2019 demonstrated minimal fluctuation in PI prevalence, ranging from 8.8% and 9.1%, respectively. Analysis of HAPI rates within the entire time period (2006-2019) reveals a distinct downward trend from the years 2006-2013 (from 6.6% to 3.3%). In contrast, analysis of data from the years 2015-2019, the HAPI rates showed little variability, ranging from a low of 2.6% to a high of 3.0%.

The downward trends in the prevalence data we observed during earlier years may reflect implementation of several national initiatives aimed at reducing PIs. In 2008, the Centers for Medicare & Medicaid Services deemed stage 3 and stage 4 PIs as "never events," sparking a nationwide interest in efforts to eliminate or reduce their occurrence.[12] Pressure injury

TABLE 4.
Prevalence of HAPIs by Unit Type and Severity (Worst Stage Data)

Unit Type	All Patients, N	Patients w/ HAPI, n	%	Patients w/HAPI Worst Stage 3, 4, Unstageable, or DTPI, n	%	Patients w/HAPI Worst Stage 1, 2, n	%
Critical care	**41,866**	**4,048**	**9.7%**	**1,351**	**3.2%**	**1,001**	**2.4%**
Burn ICU	143	46	32%	14	9.8%	4	2.8%
Cardiac ICU	5,385	523	9.7%	184	3.4%	124	2.3%
General CCU	4,858	383	7.9%	132	2.7%	97	2.0%
General ICU	13,822	1,446	10.5%	452	3.3%	413	3.0%
Medical ICU	8,833	947	10.7%	294	3.3%	209	2.4%
Neuro ICU	3,083	180	5.8%	51	1.7%	40	1.3%
Surgical ICU	5,367	463	8.6%	209	3.9%	110	2.1%
Trauma ICU	375	60	16%	15	4.0%	4	1.1%
MedSurg	**195,403**	**8,592**	**4.4%**	**1,466**	**0.75%**	**2,083**	**1.1%**
Burn	1,042	41	3.9%	25	2.4%	15	1.4%
MedSurg	64,109	2,688	4.2%	446	0.70%	692	1.1%
Medical	23,320	1,150	4.9%	185	0.79%	239	1.0%
Neurology	8,443	374	4.4%	63	0.75%	99	1.2%
Oncology	14,183	665	4.7%	98	0.69%	140	0.99%
Orthopedic	17,788	518	2.9%	101	0.57%	150	0.84%
Renal/Urology	4,459	249	5.6%	34	0.76%	54	1.2%
Surgical	18,189	659	3.6%	132	0.73%	156	0.86%
Telemetry (cardiac, general, medical, surgical)	43,870	2,248	5.1%	382	0.87%	538	1.2%
Step-down (cardiac, respiratory, surgical, medical)	**23,979**	**1,608**	**6.7%**	**366**	**1.5%**	**421**	**1.8%**

Abbreviations: CCU, critical care unit; DTPI, deep-tissue pressure injury; HAPI, hospital-acquired pressure injury; ICU, intensive care unit; MedSurg, medical-surgical.

prevention practice bundles available through such organizations as the AHRQ and the IHI provided facilities with concrete strategies and prevention programs in which to reduce their PI prevalence and standardize PI care practices.[13,14] Moreover, in 2009[14], the first edition of an international clinical practice guideline was published, providing evidence-based PI prevention practices for clinicians in the United States and abroad.[15] Updated versions of the clinical practice guideline, published in 2014[16] and 2019,[6] continue to provide evidence-based practice strategies to assist healthcare providers in their endeavors to improve both PI prevention practices and PI rates.

Despite the dissemination of updated clinical practice guidelines in both 2014 and 2019, and the establishment of hospital-based PI prevention programs, study findings indicated that PI rates have varied only slightly during this time period. Moreover, we have not been successful in eliminating all HAPIs in acute care settings, despite their designation as "never events." In fact, in the most vulnerable patient populations such as the critically ill, HAPIs continue to be a healthcare concern. Critically ill patients represent the sickest patients in our healthcare system. While advanced medical technologies have improved survival rates over the past 2 decades in this population, survival may come with unintended consequences including PI development. The results of this study suggest that this population suffers from the highest overall PI prevalence as well as the highest HAPI rates at 14.3% and 5.8%, respectively. Severe PIs and HAPIs were more common in critical care patients (8.7% and 3.23%, respectively) than in step-down and medical-surgical patients. Patients with only superficial PIs and HAPIs were also proportionately more common in critical care with 2.39% as compared to 1.76% of step-down and 1.07% in medical-surgical patients.

In some cases, PI development may be unavoidable owing to illness burden that is compounded by the need for competing lifesaving treatment priorities that may supersede PI prevention practices. In 2014, the NPIAP identified potential nonmodifiable risk factors that could influence PI development and may render a PI unavoidable.[17] These include such clinical conditions as respiratory instability, arterial insufficiency, malnutrition or cachexia, vasopressor use, impaired cardiopulmonary status, and hypotension, all clinical situations found among the critically ill population.[17] According to the NPIAP, an unavoidable PI is defined as a PI that develops even though the provider evaluated the individual's clinical condition and PI risk factors; defined and implemented interventions consistent with individual needs, goals, and recognized standards of practice; monitored and evaluated the impact of the interventions; and revised the approaches as appropriate.[18] There is a strong potential that some PIs occur within acute care patients, and especially in the critically ill, that surpass the prevention capabilities of caregivers and as such may be deemed unavoidable. To date, however, there exists no regulatory support for unavoidable PIs in the acute care setting as is present in long-term care setting.[19] Efforts to improve the evidence base is therefore a clear imperative to substantiate its existence

TABLE 5.
Anatomic Location by Stage of All PIs: Anatomic Location of All PIs (Patients Can Have Multiple PIs)[a]

	All PIs											
	Stage 1		Stage 2		Stage 3		Stage 4		Unstageable		DTPI	
Location	n	%	n	%	n	%	n	%	n	%	n	%
Total	6,846		12,689		4,370		3,520		8,715		7,993	
Ankle	132	1.9%	234	1.8%	184	4.2%	53	1.5%	381	4.4%	249	3.1%
Arm	29	0.4%	34	0.3%	4	0.1%	0	0.0%	24	0.3%	20	0.3%
Back	149	2.2%	246	1.9%	74	1.7%	30	0.9%	169	1.9%	184	2.3%
Buttocks	**1,155**	**17%**	**3,538**	**28%**	**814**	**19%**	**318**	**9.0%**	**782**	**9.0%**	**1,012**	**13%**
Cheekbone	18	0.3%	26	0.2%	4	0.1%	0	0.0%	30	0.3%	19	0.2%
Chin	4	0.1%	8	0.1%	2	0.0%	0	0.0%	17	0.2%	7	0.1%
Ear	259	3.8%	254	2.0%	51	1.2%	18	0.5%	136	1.6%	129	1.6%
Elbow	168	2.5%	136	1.1%	31	0.7%	16	0.5%	87	1.0%	63	0.8%
Foot	154	2.2%	220	1.7%	95	2.2%	59	1.7%	545	6.3%	486	6.1%
Forehead	6	0.1%	7	0.1%	0	0.0%	1	0.0%	13	0.1%	19	0.2%
Hand	18	0.3%	6	0.0%	3	0.1%	3	0.1%	16	0.2%	20	0.3%
Heel	**1,287**	**19%**	**838**	**6.6%**	**416**	**9.5%**	**171**	**4.9%**	**2,200**	**25%**	**2,478**	**31%**
Ischium	104	1.5%	378	3.0%	316	7.2%	622	18%	367	4.2%	204	2.6%
Knee/Peri-knee	33	0.5%	113	0.9%	50	1.1%	16	0.5%	137	1.6%	89	1.1%
Lower leg	79	1.2%	195	1.5%	106	2.4%	56	1.6%	278	3.2%	149	1.9%
Neck	14	0.2%	46	0.4%	25	0.6%	2	0.1%	38	0.4%	16	0.2%
Nose	57	0.8%	84	0.7%	9	0.2%	0	0.0%	74	0.8%	70	0.9%
Not collected	8	0.1%	14	0.1%	5	0.1%	8	0.2%	9	0.1%	4	0.1%
Occiput	5	0.1%	24	0.2%	14	0.3%	4	0.1%	62	0.7%	33	0.4%
Other	100	1.5%	270	2.1%	94	2.2%	36	1.0%	196	2.2%	176	2.2%
Sacrum/Coccyx	**2,750**	**40.2%**	**5,285**	**42%**	**1,749**	**40.0%**	**1,808**	**51%**	**2,311**	**27%**	**2,047**	**26%**
Scapula	22	0.3%	48	0.4%	18	0.4%	10	0.3%	36	0.4%	33	0.4%
Scrotum	57	0.8%	130	1.0%	29	0.7%	8	0.2%	53	0.6%	24	0.3%
Thigh	68	1.0%	265	2.1%	82	1.9%	23	0.7%	128	1.5%	115	1.4%
Toes	79	1.2%	100	0.8%	36	0.8%	19	0.5%	304	3.5%	198	2.5%
Trochanter	91	1.3%	190	1.5%	159	3.6%	239	6.8%	322	3.7%	149	1.9%

Abbreviations: DTPI, deep-tissue pressure injury; PI, pressure injury.
[a]Most common anatomic locations are shown in bold text.

in the acute care setting and have been undertaken in recent years. In an attempt to distinguish unavoidable PIs and acute skin failure as distinct concepts, researchers have attempted to discern risk factors associated with each concept. For example, Pittman and colleagues[20] examined HAPIs in a sample of 475 critical care and progressive care patients and found the factors respiratory failure, renal failure, anemia, cardiac failure, moisture, and sepsis as significant predictors of HAPIs, while Delmore and colleagues[21] reported similar predictors including respiratory failure, renal failure, arterial disease, impaired nutrition, sepsis, septic shock, mechanical ventilation, vascular surgery, orthopedic surgery, peripheral necrosis, and general surgery to be related to the concept defined as acute skin failure At this time, a paucity of research exists examining the concept of acute skin failure and no diagnostic criteria are currently available to differentiate this concept clinically from PIs. Additional research is needed to identify characteristics of unavoidable PIs and acute skin failure in order to guide clinical practice.

The sacral/coccyx, buttocks, and heels were the most frequent anatomic locations for PIs; these findings are consistent with prior research.[9] When comparing anatomic location with stage, DTPIs were the only stage (category) that differed in anatomic location, as the heels were most common over the sacral/coccyx area.

While a statistically significant difference in Braden Scale scores was found between all groups, the clinical relevance of this statistical finding is less impactful. The mean Braden Scale score reported for patients with no PIs was 18.38, while the mean Braden Scale scores for superficial HAPIs and severe HAPIs were 15.69 and 14.89, respectively. When stratifying risk using the Braden Scale, all of these scores fall within the category indicating mild risk for PIs. Based on findings from our study, the Braden Scale scores reported did not adequately discriminate PI risk. It should be noted that the Braden Scale score used in this analysis was the patient's Braden Scale score on the day of the data collection. Therefore, this variable did

TABLE 6.
Anatomic Location by Stage of All HAPIs: Anatomic Location of All HAPIs (Patients Can Have Multiple HAPIs)[a]

	All HAPIs											
	Stage 1		Stage 2		Stage 3		Stage 4		Unstageable		DTPI	
Location	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Total	2,212		3,369		491		172		1,373		2,878	
Ankle	42	1.9%	35	1.0%	13	2.6%	0	0.0%	46	3.4%	75	2.6%
Arm	6	0.3%	6	0.2%	1	0.2%	0	0.0%	5	0.4%	11	0.4%
Back	53	2.4%	82	2.4%	8	1.6%	2	1.2%	28	2.0%	68	2.4%
Buttocks	**315**	**14%**	**845**	**25%**	**88**	**18%**	**17**	**9.9%**	**129**	**9.4%**	**377**	**13%**
Cheekbone	16	0.7%	20	0.6%	2	0.4%	0	0.0%	22	1.6%	13	0.5%
Chin	4	0.2%	6	0.2%	2	0.4%	0	0.0%	14	1.0%	6	0.2%
Ear	200	9.0%	165	4.9%	27	5.5%	7	4.1%	79	5.8%	86	3.0%
Elbow	85	3.8%	46	1.4%	4	0.8%	2	1.2%	19	1.4%	24	0.8%
Foot	45	2.0%	36	1.1%	7	1.4%	1	0.6%	59	4.3%	148	5.1%
Forehead	3	0.1%	5	0.1%	0	0.0%	1	0.6%	7	0.5%	15	0.5%
Hand	8	0.4%	1	0.0%	0	0.0%	0	0.0%	2	0.1%	14	0.5%
Heel	**461**	**21%**	**219**	**6.5%**	**23**	**4.7%**	**5**	**2.9%**	**202**	**15%**	**851**	**30%**
Ischium	18	0.8%	66	2.0%	17	3.5%	14	8.1%	24	1.7%	53	1.8%
Knee/Peri-knee	11	0.5%	20	0.6%	3	0.6%	0	0.0%	18	1.3%	21	0.7%
Lower leg	18	0.8%	34	1.0%	4	0.8%	0	0.0%	19	1.4%	67	2.3%
Neck	8	0.4%	39	1.2%	19	3.9%	2	1.2%	23	1.7%	9	0.3%
Nose	38	1.7%	64	1.9%	6	1.2%	0	0.0%	47	3.4%	57	2.0%
Not collected	1	0.0%	4	0.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Occiput	2	0.1%	14	0.4%	9	1.8%	0	0.0%	33	2.4%	19	0.7%
Other	34	1.5%	102	3.0%	8	1.6%	3	1.7%	58	4.2%	90	3.1%
Sacrum/Coccyx	**735**	**33%**	**1,399**	**42%**	**235**	**48%**	**107**	**62%**	**440**	**32%**	**723**	**25%**
Scapula	10	0.5%	17	0.5%	2	0.4%	1	0.6%	6	0.4%	10	0.3%
Scrotum	23	1.0%	37	1.1%	2	0.4%	0	0.0%	4	0.3%	6	0.2%
Thigh	27	1.2%	74	2.2%	3	0.6%	1	0.6%	22	1.6%	46	1.6%
Toes	27	1.2%	8	0.2%	1	0.2%	2	1.2%	41	3.0%	62	2.2%
Trochanter	22	1.0%	25	0.7%	7	1.4%	7	4.1%	26	1.9%	27	0.9%

Abbreviations: DTPI, deep-tissue pressure injury; HAPI, hospital-acquired pressure injury.
[a]Most common anatomic locations are shown in bold text.

not reflect a consistent point in time for all study participants during their hospitalizations, which may have influenced this finding. Additional analysis of Braden subscale scores should also be undertaken and may provide some important clinical information with regard to which subscale risk factors pose the greatest risk in acute care patients.

Moreover, while the Braden Scale addresses global PI risk factors, in certain populations such as critical care patients, the patients are exposed to a myriad of factors not accounted for in formal PI risk assessment and may be of greater clinical significance in this population. Risk factors including age, length of an ICU admission, and comorbid conditions such as diabetes mellitus, cardiovascular disease, use of vasopressor agents, hypotension, sedation, and mechanical ventilation have all been cited in the critical care literature as risk factors that need stronger consideration in PI risk quantification.[22-25] Evaluating available alternative PI risk assessment tools is one strategy in which to improve the predictive validity of current formal PI risk assessment. For example, Sullivan and colleagues[26] reported outcomes of a quality improvement project that examined the validity of a modified Norton Scale and found acceptable validity and reliability for the tool. Delawder and colleagues[27] compared the predictive validity of the Cubbin-Jackson tool to the Braden Scale in a sample of 4137 critical care patients and found the predictive validity to be similar, while Higgins and associates[28] found the predictive validity of this tool to be superior to the Braden Scale in a sample of critical care trauma patients. We recommend harnessing the power of the extensive data available in electronic medical records in order to create additional opportunities for researchers and clinicians to improve PI risk assessment.

Our findings also indicate that the likelihood of PIs is greater among underweight patients. We found that nearly one in 5 patients with a BMI of less than 18.5 kg/m^2 had a PI and one in 20 patients developed an HAPI. Patients with a BMI between 18.5 and 24.9 kg/m^2 had the second highest rate of

TABLE 7.
Proportions of PIs by Unit Type (Patients Can Have More Than One PI)[a]

	All PIs					
	Critical Care		MedSurg		Step-down	
Location	n	%	n	%	n	%
Total	10,481		26,066		4,135	
Ankle	262	2.5%	736	2.8%	109	2.6%
Arm	48	0.46%	62	0.24%	13	0.31%
Back	234	2.2%	478	1.8%	90	2.2%
Buttocks	**1,690**	**16%**	**4,529**	**17%**	**740**	**18%**
Cheekbone	57	0.54%	29	0.11%	5	0.12%
Chin	19	0.18%	13	0.05%	3	0.07%
Ear	263	2.5%	430	1.6%	103	2.5%
Elbow	147	1.4%	288	1.1%	35	0.85%
Foot	328	3.1%	981	3.7%	152	3.7%
Forehead	32	0.31%	8	0.03%	2	0.05%
Hand	30	0.29%	29	0.11%	5	0.12%
Heel	**1,526**	**15%**	**4,662**	**18%**	**662**	**16%**
Ischium	395	3.8%	1,204	4.6%	155	3.8%
Knee/Peri-knee	99	0.94%	267	1.0%	44	1.1%
Lower leg	216	2.1%	536	2.1%	69	1.7%
Neck	65	0.62%	50	0.19%	16	0.39%
Nose	194	1.9%	90	0.35%	29	0.70%
Not collected	8	0.08%	22	0.08%	18	0.44%
Occiput	67	0.64%	45	0.17%	11	0.27%
Other	382	3.6%	498	1.9%	62	1.5%
Sacrum/Coccyx	**3,745**	**36%**	**9,220**	**35%**	**1,519**	**37%**
Scapula	51	0.49%	91	0.35%	18	0.44%
Scrotum	76	0.73%	180	0.69%	43	1.0%
Thigh	175	1.7%	422	1.6%	57	1.4%
Toes	178	1.7%	451	1.7%	75	1.8%
Trochanter	194	1.9%	745	2.9%	100	2.4%

Abbreviations: MedSurg, medical-surgical; PI, pressure injury.
[a]Most common anatomic locations are shown in bold text.

PIs. It is well established in the International PI Prevention and Treatment guidelines (chapter 7, Nutrition), that malnutrition increases the likelihood of PI development and delays healing.[6] When examining patients with a higher BMI in our study, all patients with a BMI of more than 40 kg/m^2 were analyzed as a single group, identified by the Centers for Disease Control and Prevention as class 3 obesity or severe obesity. In a previous investigation by Kayser and colleagues,[3] patients with a BMI of 60 kg/m^2 and greater demonstrated a higher PI prevalence. It is important to note that the number of patients at these very high BMIs (60+ kg/m^2) is low in both our investigation and the study by Kayser and colleagues.[3] Therefore, when examining the prevalence in obese patient populations, it may be prudent to differentiate the BMI of patients in higher BMI groupings in order to more accurately discern differences in PI prevalence.

Lastly, PIs come at a significant economic cost to the US healthcare system. In an effort to estimate the likely annual cost of severe PIs given the current study data, the authors present the following: Definitive Healthcare[29] reports a total of 5462 acute care hospitals operating in 2020 in the United States (including short-term acute care, critical access hospitals, and Veterans Administration hospitals). United States census data indicate that as of July 1, 2020, there were 268,308,190 adults,[30] 18 years or older, living in the United States. Hospitalization rates range from 5.8% to 15%, with persons 65 years and older experiencing the highest rates, yielding approximately 22,225,385 (Table 9) patients admitted to US acute care hospitals annually.[31] We found that 3524 patients (1.2%) developed a severe HAPI in the participating hospitals in 2018/2019. Estimating the number of severe HAPIs in US acute care using the 1.2% of the admitted population, 266,705 patients (1.2% of 22,225,385) could develop a severe HAPI annually. Costs associated with each severe PI (stages 3, 4, unstageable) have been reported at US $6209.53.[32] Based

TABLE 8.
Proportions of HAPIs by Unit Type (Patients Can Have More Than One HAPI)

	HAPIs Only					
	Critical Care		MedSurg		Step-down	
Location	n	%	n	%	n	%
Total	3,642		5,039		1,180	
Ankle	57	1.6%	99	2.0%	24	2.0%
Arm	18	0.49%	10	0.20%	3	0.25%
Back	95	2.6%	110	2.2%	25	2.1%
Buttocks	**540**	**15%**	**904**	**18%**	**207**	**18%**
Cheekbone	50	1.4%	11	0.22%	5	0.42%
Chin	16	0.44%	10	0.20%	3	0.25%
Ear	192	5.3%	276	5.5%	67	5.7%
Elbow	63	1.7%	101	2.0%	11	0.93%
Foot	90	2.5%	145	2.9%	42	3.6%
Forehead	22	0.60%	3	0.06%	2	0.17%
Hand	16	0.44%	5	0.10%	0	0.00%
Heel	**459**	**13%**	**962**	**19%**	**188**	**16%**
Ischium	52	1.4%	100	2.0%	30	2.5%
Knee/Peri-knee	22	0.60%	28	0.56%	12	1.0%
Lower leg	67	1.8%	50	0.99%	14	1.2%
Neck	52	1.4%	29	0.58%	14	1.2%
Nose	163	4.5%	49	0.97%	20	1.7%
Not collected	1	0.03%	1	0.02%	5	0.42%
Occiput	43	1.2%	20	0.40%	5	0.42%
Other	231	6.3%	125	2.5%	22	1.9%
Sacrum/Coccyx	**1,208**	**33%**	**1,748**	**35%**	**413**	**35%**
Scapula	19	0.52%	20	0.40%	5	0.42%
Scrotum	26	0.71%	26	0.52%	19	1.6%
Thigh	69	1.9%	80	1.6%	11	0.93%
Toes	43	1.2%	62	1.2%	21	1.8%
Trochanter	28	0.77%	65	1.3%	12	1.0%

Abbreviations: HAPI, hospital-acquired pressure injury; MedSurg, medical-surgical.

on our study results, the economic burden to the healthcare system for severe PIs among hospitalized patients is estimated at $1,656,110,368 annually, representing a significant financial impact that cannot be ignored.

STRENGTHS AND LIMITATION

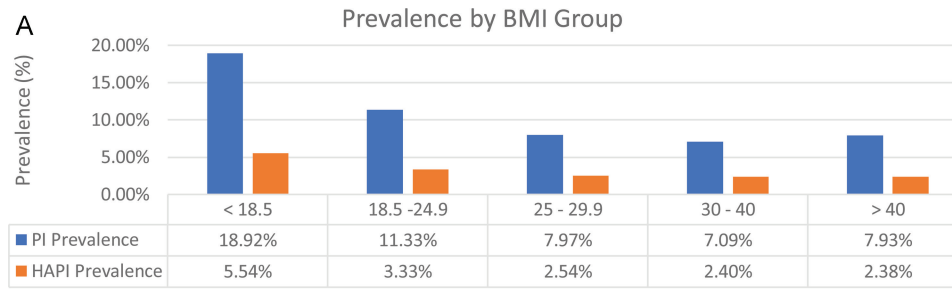
We analyzed data from a large database of approximately 16% of all US acute care facilities and an annual average of 134,405 adult patients for years 2006-2019. The database fields analyzed in this study have remained fairly consistent over the years, with updates performed on staging and other factors in keeping with US healthcare educational materials. The study began in 1989, thus allowing measurement over a period of decades.

In addition to these strengths, our observational, cross-sectional cohort study has several limitations. Facilities self-report their patient data; therefore, errors in data reporting and response bias can occur. Facilities commonly may not be able to perform the survey on 100% of their patients especially those in short stay/23 hour admit units. This, however, does not affect unit-specific analyses, as they would be included in the "other" units.

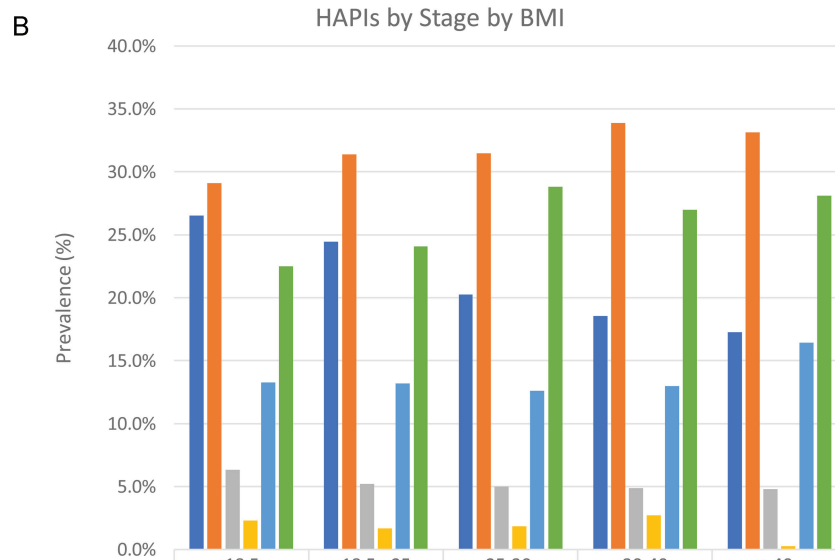
The unit type where the HAPI patient is currently admitted may not be the unit type that the patient developed a PI as root cause analysis was not part of the data collected. For example, patients who may develop PIs from emergency department stays, long operative procedures, and other such risk exposure will be included in the data analysis of their admitted unit on the day of the survey. More detailed data as to the exact location that is likely the cause of the PI are desirable but difficult to acquire. Additionally, some patient groups may have been underrepresented in our sample, such as burn or trauma ICU patients, reducing the generalizability of findings in these important subgroups.

CONCLUSIONS

Pressure injuries pose a significant healthcare burden to patients as well as an estimated US $1.6 billion cost to the US healthcare



	< 18.5	18.5 -24.9	25 - 29.9	30 - 40	> 40
PI Prevalence	18.92%	11.33%	7.97%	7.09%	7.93%
HAPI Prevalence	5.54%	3.33%	2.54%	2.40%	2.38%



	<18.5	18.5 - 25	25-30	30-40	>40
Stage 1	26.5%	24.4%	20.3%	18.5%	17.2%
Stage 2	29.1%	31.4%	31.5%	33.9%	33.2%
Stage 3	6.3%	5.2%	5.0%	4.9%	4.8%
Stage 4	2.3%	1.7%	1.8%	2.7%	0.3%
Unstageable	13.3%	13.2%	12.6%	13.0%	16.4%
DTPI	22.5%	24.1%	28.8%	27.0%	28.1%

Figure 4. (A) Prevalence by BMI. (B) Prevalence by BMI and stage. BMI indicates body mass index.

TABLE 9.
Estimate of the Number of Acute Care Hospitalized Patients by Age Grouping

Age, y	US 2020 Population by Age Grouping[a]	Rate of Hospitalization by Age	Total Hospitalized Adult Patients Annually
18-24	43,351,778	5.8%	2,514,403
25-54	128,863,172	6.8%	8,762,696
55-64	42,179,856	7.8%	3,290,029
65+	51,055,052	15%	7,658,258
All	326,625,791		22,225,385

[a]US census data by age grouping[30] is shown above. To calculate the number of hospitalized adult patients, (Population by age grouping)[30] × (Rate of hospitalization by age)[31] = Total hospitalized adult patients annually. This value is used in the below cost calculations.

system. Data from this study suggest that significant declines in HAPI rates have not been realized over the past 5 years despite adoption of national initiatives aimed at PI prevention in acute care settings. Our findings confirm that the highest risk for HAPI occurrence is in the critical care population. Nevertheless, study findings show that both medical-surgical and step-down inpatient care units are at risk for HAPIs. Gaining a clearer understanding of the subsets of hospitalized patients who are at a greatest risk for PI development will aid in our ability to both sharpen and target our focus on PI prevention strategies in an effort to improve clinical outcomes for these populations.

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