Hospital-Acquired Pressure Injuries in Critical and Progressive Care: Avoidable Versus Unavoidable

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Background Despite prevention strategies, hospital-acquired pressure injuries (HAPIs) continue to occur, especially in critical care, raising the question whether some pressure injuries are unavoidable.
Objectives To determine the proportion of HAPIs among patients in critical and progressive care units that are unavoidable, and to identify risk factors that differentiate avoidable from unavoidable HAPIs.
Methods This study used a descriptive retrospective design. Data collected included demographic information, Braden Scale scores, clinical risk factors, and preventive interventions. The Pressure Ulcer Prevention Inventory was used to categorize HAPIs as avoidable or unavoidable.
Results A total of 165 patients participated in the study. Sixty-seven HAPIs (41%) were unavoidable. Participants who had congestive heart failure (odds ratio [OR], 0.22; 95% CI, 0.06-0.76; *P*=.02), were chemically sedated (OR, 0.38; 95% CI, 0.20-0.72; *P*=.003), had systolic blood pressure below 90 mm Hg (OR, 0.52; 95% CI, 0.27-0.99; *P*=.047), and received at least 1 vasopressor (OR, 0.44; 95% CI, 0.23-0.86; *P*=.01) were less likely to have an unavoidable HAPI. Those with bowel management devices were more likely to have an unavoidable HAPI (OR, 2.19; 95% CI, 1.02-4.71; *P*=.04). When length of stay was incorporated into the regression model, for each 1-day increase in stay, the odds of an unavoidable pressure injury developing increased by 4% (OR, 1.04; 95% CI, 1.002-1.08; *P*=.04). Participants who had a previous pressure injury were 5 times more likely to have an unavoidable HAPI (OR, 5.27; 95% CI, 1.20-23.15; *P*=.03).
Conclusions Unavoidable HAPIs do occur; moreover, when preventive interventions are not documented and implemented appropriately, avoidable HAPIs occur. (*American Journal of Critical Care.* 2019;28:338-350)

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Health care organizations strive to minimize harm and provide safe environments for patients they serve. Despite a vast array of prevention strategies, hospital-acquired pressure injuries (HAPIs) continue to occur, especially in critical care. Rates of such injuries have been reported to range from 2.8% to 53.4% in critical care units, compared with 2.0% to 8.3% in medical-surgical units.[1]

Regulatory and quality organizations consider HAPI rates to be a measure of the quality of nursing care provided and assess financial penalties when they occur. However, organizations of experts such as the Centers for Medicare and Medicaid Services, the National Pressure Ulcer Advisory Panel (NPUAP), and the Wound, Ostomy, and Continence Nurses Society have acknowledged that some HAPIs may be unavoidable.[2-4] The NPUAP defined "unavoidable" pressure injuries as those that develop even when the provider (1) evaluated the individual's clinical condition and pressure injury risk factors; (2) defined and implemented interventions that were consistent with individual needs, goals, and recognized standards of practice; (3) monitored and evaluated the impact of the interventions; and (4) revised the approaches as appropriate.[3]

Risk factors have been associated with the development of HAPIs, yet those that best predict the development of HAPIs are not completely understood.[1,5] Nonmodifiable risk factors such as age[5] and history of pressure injuries[6] may tip the scale toward pressure injury development despite the best preventive interventions. Unavoidable pressure injuries may occur when the magnitude and severity of the risk factors are extremely high and preventive measures are either contraindicated or inadequate given the risk.[2] Although new technology is available to provide quantitative assessment of turning and patient mobility, currently this technology is not widespread or integrated into most acute care settings.

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Until recently, research on unavoidable HAPIs has been limited because of the lack of valid and reliable tools for measuring and evaluating the provision of appropriate preventive interventions. The Pressure Ulcer Prevention Inventory (PUPI)[7] was designed using the NPUAP definition of unavoidable pressure injury[3] and Braden and Bergstrom's conceptual model of the etiology of pressure injuries.[8] The PUPI operationalized the 4 key concepts that are thought to capture the construct of unavoidable HAPIs and demonstrated acceptable validity (content validity index = 0.99) and reliability ($\kappa = 1.0$, $P = .02$; rater agreement 93%).[1,2,7]

> Despite prevention strategies, hospital-acquired pressure injuries continue to occur, especially in critical care.

The aims of this study were (1) to determine the proportion of HAPIs among patients in critical and progressive care units that are unavoidable, and (2) to identify the risk factors (or characteristics) of patients in critical and progressive care units that differentiate avoidable from unavoidable HAPIs.

Methods

Design

This study used a descriptive, retrospective, comparative design to examine rates of avoidable and unavoidable HAPIs in adult critical and progressive care patients in 6 acute care hospitals within a large academic health care system in the midwestern United States. The critical care areas included surgical, trauma, cardiovascular surgical, cardiac, neurologic, and medical intensive care and corresponding progressive care units. The study was approved by the Indiana University institutional review board before the start of data collection.

An investigator-developed conceptual framework for differentiating unavoidable from avoidable pressure ulcers (Figure 1) was used to guide this study. The aspects of this model that are new and unique incorporate (1) new epidemiological evidence on pressure injury risk factors,[9,10] (2) risk-based prevention strategies consistent with the 2014 Pressure Ulcer International Guideline,[11] and (3) guidance for determining whether the pressure injury was avoidable or

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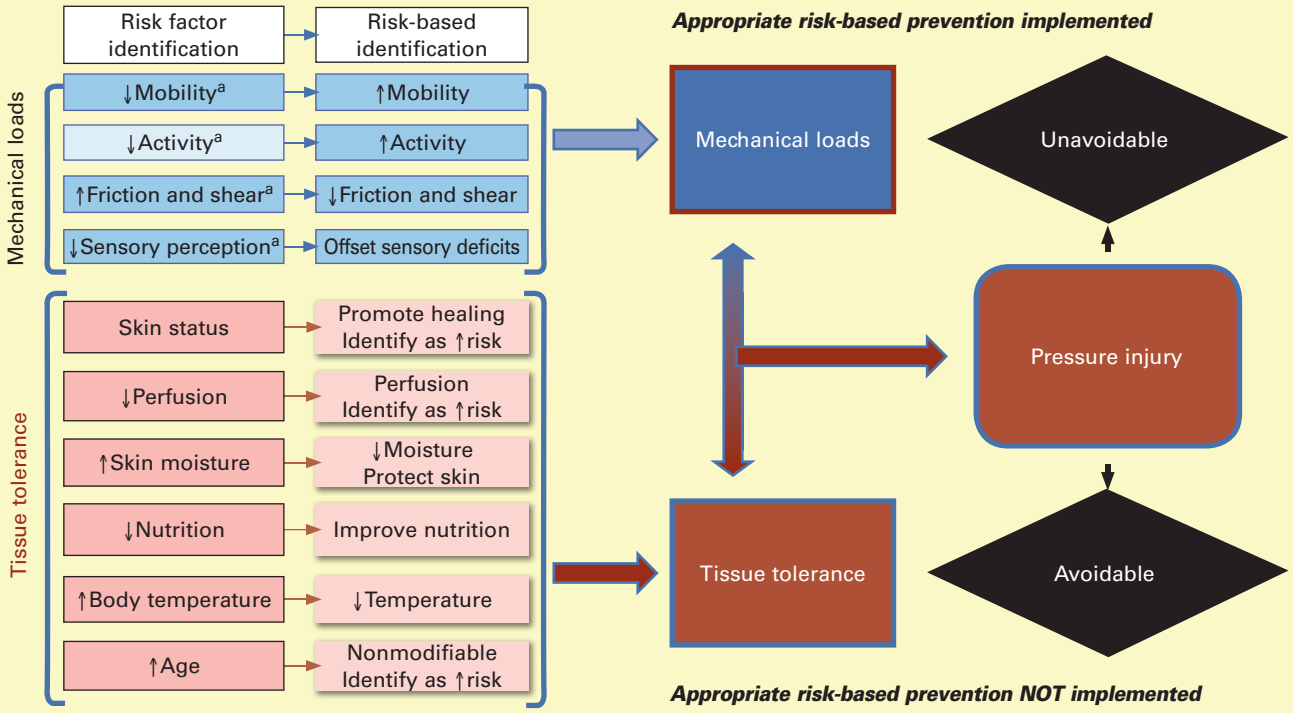

Figure 1 Conceptual framework for differentiating unavoidable from avoidable pressure ulcers.

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[a] Risk factors measured with Braden Scale subscales.

unavoidable based on the implementation of appropriate risk-based interventions.[7]

Sample/Setting

The sample consisted of patients who (1) had a HAPI develop while in critical and progressive care (NPUAP stage 2, 3, or 4, unstageable, or deep tissue pressure injury,[12] including pressure injuries from medical devices and on mucous membranes), (2) were hospitalized between 2012 and 2015, and (3) were aged 18 years or older. Patients were excluded if the HAPI developed outside the critical or progressive care unit. We used the National Database of Nursing Quality Indicators methods for identifying unit-acquired pressure injuries.[13] On the basis of a previous pilot study,[7] we determined potential sample size by estimating the number of HAPIs occurring during a 12-month period and the proportion of those estimated as unavoidable. Approximately 160 patients with a HAPI were estimated to provide an adequate sample to detect meaningful information.

Identification of Unavoidable HAPIs

To achieve the first study aim, eligible patients were identified by using monthly pressure injury prevalence surveys, medical record reporting mechanisms, medical coding procedures, and/or quality reporting processes. Patients were divided into 2 groups (avoidable and unavoidable) using the PUPI tool.

The PUPI contains 13 items (Figure 2). If all items in the PUPI are answered "yes" (all interventions were appropriately performed and documented), the HAPI was identified as unavoidable.[7]

The Braden Inventory Worksheet, an investigator-developed data collection tool specific to our electronic medical record (EMR) documentation, was used to collect Braden Scale subscale and total scores[14] for the 3 days before the first documentation of the HAPI and the interventions documented that correspond to each Braden Scale subscale (Figure 3). These data were then used to complete the PUPI.

Identification of Risk Factors Differentiating Avoidable From Unavoidable HAPIs

Data were collected from the EMR upon admission and 3 days before first documentation of the HAPI, including (1) demographic and clinical information, (2) Braden Scale subscale and total scores, (3) additional risk factors identified as significant in epidemiological studies (eg, poor perfusion, body temperature), and (4) pressure injury prevention interventions. The types and number of comorbidities were determined. For a variable to be marked yes, it had to be documented on any of the 4 days. For example, if "chemically sedated (IV drip)" was marked no on the HAPI date, yes on 1 day before, yes on 2 days before, and yes on 3 days before, then it was counted as yes (Figure 4).

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Pressure Ulcer Prevention Inventory

Subject ID: _____ HAPU Acquisition Date: ___/___/___

HAPU Location: 1=Sacrum/Coccyx 2=Ischium 3=Trochanter 4=Heel 5=Occipital 6=Ear 7=Other _____
HAPU Laterality: 1=Right 2=Left 3=Midline
HAPU Stage: 1=sDTI 2=2 3=3 4=4 5=Unstageable 6=Indeterminate

Audit Date: _____ Auditor: _____

Review medical record 3 days prior to the documented development of the HAPU

Assign the appropriate score for each item:

1=NO, not appropriate 2=YES, appropriate

1. Clinical Condition Evaluation	**SCORE** ▼
History and physical completed upon admission	
Braden pressure ulcer assessment upon admission	
Braden pressure ulcer assessment per policy (daily or every shift)	
Skin assessment (nursing) completed upon admission	

Review medical record 3 days prior to the documented development of the HAPU

Assign the appropriate score for each item:

1=NO, not appropriate 2=YES, appropriate

2. Defined and Implemented Intervention(s) Consistent With Patient's Needs					
	HAPU DAY 0 Date____	**1 day prior to HAPU Date____**	**2 days prior to HAPU Date____**	**3 days prior to HAPU Date____**	
2.1 Sensory Perception Interventions Appropriate?					
2.2 Moisture Interventions Appropriate?					
2.3 Activity Interventions Appropriate?					
2.4 Mobility Interventions Appropriate?					
2.5 Nutritional Interventions Appropriate?					
2.6 Friction and Shear Interventions Appropriate?					
3. Monitored/Evaluated Impact of Interventions					
Skin assessment completed every shift					
4. Revised Interventions as Appropriate					

Summary/Conclusion

5. Pressure Ulcer Avoidable	

Figure 2 Pressure Ulcer Prevention Inventory.

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Abbreviations: HAPU, hospital-acquired pressure ulcer; sDTI, suspected deep tissue injury. (The Pressure Ulcer Prevention Inventory was developed before the National Pressure Ulcer Advisory Panel changed the staging terminology in 2016.)

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BRADEN INVENTORY WORKSHEET

HAPU Acquisition Date: _____

2.0 Braden Scale															
Days Prior to HAPU	Date	Sensory Perception		Moisture		Activity		Mobility		Nutrition		Friction and Shear		Total Daily Braden Score	
		DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT
-1PUDAY															
-2PUDAY															
-3PUDAY															

Review documentation. Based on the lowest score for each Braden category, check all types of interventions found in documentation.

2.1 Sensory Perception Interventions	-1PU DAY	-2PU DAY	-3PU DAY
Elevate Heels Off Surface			
Reposition Frequently			
Pressure Redistribution			
Bony Prominence Protection			
Total			

2.2 Moisture Management Interventions	-1PU DAY	-2PU DAY	-3PU DAY
Breathable Pads			
Diapers			
Barrier Creams			
Scheduled Voiding			
Urinary Device			
IO Catheter			
Fecal Device			
Extra Linen Change			
Total			

2.3 Activity Interventions	-1PU DAY	-2PU DAY	-3PU DAY
Elevate Heels Off Surface			
Reposition Frequently			
Pressure Redistribution			
Bony Prominence Protection			
Mobility Promotion (PT, OT, ROM)			
Total			

2.4 Mobility Interventions	-1PU DAY	-2PU DAY	-3PU DAY
Elevate Heels Off Surface			
Reposition Frequently			
Pressure Redistribution			
Mobility Promotion (PT, OT, ROM)			
Rotoprone, Rotorest			
Exception Documented			
Total			

2.5 Nutrition Interventions	-1PU DAY	-2PU DAY	-3PU DAY
Enteral Nutrition			
Parenteral Nutrition			
PO Diet			
Supplements			
Contraindications Documented			
Dietary Consult			
Total			

2.6 Friction and Shear Interventions	-1PU DAY	-2PU DAY	-3PU DAY
Elevate Heels Off Surface			
Reposition Frequently			
Pressure Redistribution			
Mobility Promotion (PT, OT, ROM)			
Drawsheet/Lift Sheet			
HOB ≤30 degrees			
Bony Prominence Protection			
Other			
Total			

Figure 3 Braden Inventory Worksheet.

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Abbreviations: HAPU, hospital-acquired pressure ulcer/injury; HOB, head of bed; IO, in and out; OT, occupational therapy; PO, by mouth; PT, physical therapy; ROM, range of motion.

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BANNER BAR

1. Subject ID:
2. Age:
3. Gender: 1 = Male 2 = Female
4. Hospital: 1 2 3 4 5 6 7
5. LOS prior to HAPU (in days):
6. Mortality this admission: 1 = NO 2 = YES

FACE SHEET

7. Race: 1 = African American 2 = White 3 = Asian 4 = Native American
5 = Pacific Islander/Hawaiian 6 = Other

CLINICAL NOTES

8. Admitting diagnosis:		
9. Patient admitted from: 1 = Home 2 = OSH 3 = LTAC 4 = Nursing Home 5 = Other		
10. Any hospital admission within 30 days prior to HAPU: 1 = NO 2 = YES 3 = UNKNOWN		
11. Smoker: 1 = Never 2 = Past 3 = Current		
12. Comorbidities:		
1 = MI	6 = Chronic pulmonary disease	11 = Hemiplegia/paraplegia
2 = CHF	7 = Rheumatic disease	12 = Renal disease
3 = PVD	8 = PUD	13 = Malignancy
4 = Cerebrovascular disease	9 = Liver disease	14 = AIDS/HIV
5 = Dementia	10 = DM	15 = NONE
Total # of comorbidities:		
13. History of pressure ulcer: 1 = NO 2 = YES 3 = UNKNOWN		
14. Previous pressure ulcer location:		
1 = Sacrum/coccyx	4 = Heel	7 = Other
2 = Ischium	5 = Occipital	8 = NA
3 = Trochanter	6 = Ear	
15. Previous PU laterality: 1 = Left 2 = Right 3 = Midline 4 = NA		
16. Previous Pressure Ulcer Stage:		
0 = Unknown	3 = Stage 3	6 = Indeterminate
1 = sDTI	4 = Stage 4	7 = NA
2 = Stage 2	5 = Unstageable	
17. Previous PU device related? 1 = NO 2 = YES 3 = NA		

FORMS

18. Unintentional weight loss of 10 or more pounds in 1 month? 1 = NO 2 = YES 3 = UNKNOWN

RESULTS REVIEW

19. Height (cm):			
20. Admission weight (kg):			
21. Pressure ulcer location:			
1 = Sacrum/coccyx	3 = Trochanter	5 = Occipital	7 = Other
2 = Ischium	4 = Heel	6 = Ear	
22. Pressure ulcer laterality: 1 = Left 2 = Right 3 = Midline			
23. Pressure ulcer stage:			
1 = sDTI	3 = Stage 3	5 = Unstageable	
2 = Stage 2	4 = Stage 4	6 = Indeterminate	
24. Pressure ulcer device related? 1 = NO 2 = YES			

Continued

Figure 4 Data collected from electronic medical record.

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	PU Date _____	-1 Day _____	-2 Days _____	-3 Days _____
RESULTS REVIEW				
25. Daily weight:				
26. BMI:				
27. Mechanical ventilation: 1=NO 2=YES				
28. MAP <60: 1=NO 2=YES				
29. SBP<90: 1=NO 2=YES				
30. FIO2 (highest):				
31. O2 saturation (lowest):				
32. Temperature (highest):				
33. Temperature (lowest):				
34. Glucose (highest):				
35. Glucose (lowest):				
36. Hemoglobin (lowest):				
37. Blood pH (lowest):				
38. ScVO2/SVO2:				
39. Any stage I PU present? 1=NO 2=YES				
EXPLORER MENU				
40. Unit/location: 1=CC 2=PCU 3=M/S 4=ED 5=OR				
MAR SUMMARY				
41. Chemically sedated (IV drip): 1=NO 2=YES				
42. Paralytic agent >2 hrs: 1=NO 2=YES				
43. Vasopressors (concurrently): 0=NONE 1=1 2=2 3=3 or more				
44. Steroids: 1=NO 2=YES				
CLINICAL NOTES				
45. Perioperative/procedure time >4 hrs: 1=NO 2=YES				
46. Any type of dialysis: 1=NO 2=YES				
I/O FLOW SHEET				
47. Nutrition: 1=NPO 2=Tube feed 3=TPN 4=Oral 5=Multiple				
48. Bed type: 1=Standard for unit 2=Specialty				
49. Specialty bed type: 1=Bariatric 2=Rotoprone 3=Rotorest 4=Clinitron				
50. Waffle mattress: 1=NO 2=YES				
51. Moisture: 0=None 1=Urinary incontinence 2=Fecal incontinence 3=Both 4=Other				
52. Bowel management system? 1=NO 2=YES				
53. Lowest daily Braden score:				
54. Capillary refill >3 seconds? 1=NO 2=YES				

55. APACHE score within 24 hrs of ICU admit:	
56. APACHE score 3 days prior to PU:	

Figure 4 *Continued*

Abbreviations: APACHE, Acute Physiology and Chronic Health Evaluation; BMI, body mass index; CC, critical care unit; CHF, congestive heart failure; DM, diabetes mellitus; ED, emergency department; FIO2, fraction of inspired oxygen; HAPU, hospital-acquired pressure injury/ulcer; ICU, intensive care unit; ID, identification; I/O, Inspection/Observation; IV, intravenous; LOS, length of stay; LTAC, long-term acute care hospital; MAP, mean arterial pressure; MAR, medication administration record; MI, mycardial infarction; M/S, medical/surgical unit; NA, not applicable; NPO, nothing by mouth; O2, oxygen; OR, operating room; OSH, outside hospital; PCU, progressive care unit; PU, pressure ulcer; PUD, peptic ulcer disease; PVD, peripheral vascular disease; SBP, systolic blood pressure; ScVO2, central venous oxygen saturation; sDTI, stage deep tissue injury; SvO2, mixed venous oxygen saturation; TPN, total parenteral nutrition.

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Analysis

Descriptive statistics were used to summarize avoidable and unavoidable HAPIs. Risk factors were compared between the 2 groups (avoidable and unavoidable). Continuous variables were reported by using mean and SD and were compared between patient groups by using the Student *t* test. Categorical variables were reported as number (percentage) and compared between patient groups using the χ^2 test. Logistic regression analyses were used to describe factors associated with unavoidable HAPIs. A *P* value of .05 was considered to represent statistical significance.

Results

A total of 165 participants were included in this study. Participants' mean (SD) age was 59.9 (16.4) years. The mortality rate was 27% (n = 45), and the mean (SD) length of stay (LOS) in the hospital before development of the HAPI was 15.1 (13.7) days (Table 1).

Almost 60% (n = 98) of the HAPIs were determined to be avoidable and 41% (n = 67) were determined to be unavoidable (Table 1). Most HAPIs were deep tissue pressure injuries (n = 102, 63%), followed by stage 2 (n = 34, 21%) and unstageable (n = 25, 15%). Approximately 36% (n = 60) of the HAPIs were related to medical devices. Most of the HAPIs were on the sacrum (n = 70, 42%) or heel (n = 23, 14%). Almost 79% (n = 130) of the participants with HAPIs were receiving mechanical ventilation, 56% (n = 92) were chemically sedated, 64% (n = 106) had systolic blood pressure (SBP) less than 90 mm Hg, 61% (n = 100) had mean arterial pressure less than 60 mm Hg, 41% (n = 68) were receiving 1 or more vasopressors, 55% (n = 91) were incontinent, and 21% (n = 34) had a bowel management system used at least once in the 3 days before and the day when the HAPI was first documented (Table 1).

In this study, the PUPI demonstrated fair interrater reliability ($\kappa = 0.40$), and raters were in total agreement 92.5% of the time (310 of 335) for the 13 PUPI items.

In comparison of clinical risk factors between groups, participants who had a comorbid disease of congestive heart failure (CHF) were less likely to have an unavoidable HAPI (odds ratio [OR], 0.22; 95% CI, 0.06-0.76; *P* = .02). Similar results were found for those who were chemically sedated (OR, 0.38; 95% CI, 0.20-0.72; *P* = .003), had SBP less than 90 mm Hg (OR, 0.52; 95% CI, 0.27-0.99; *P* = .047), and received at least 1 vasopressor (OR, 0.44; 95% CI, 0.23-0.86; *P* = .01). However, those who had a bowel management system were more likely to have an unavoidable HAPI than those who did not (OR, 2.19; 95% CI, 1.02-4.71; *P* = .04). Similarly, those who had a previous pressure injury were more likely to have an unavoidable HAPI, although this difference was not statistically significant (OR, 2.32; 95% CI, 0.84-6.44; *P* = .10).

The LOS before pressure injury identification was longer in the unavoidable HAPI group (17.6 vs 13.4 days). A 1-day increase in LOS before pressure injury identification was associated with an almost 2% increase in the odds of being an unavoidable HAPI. Participants in the unavoidable group consistently had higher daily Braden Scale total scores as well as individual subscale scores (mobility, activity, sensory perception, and nutrition), although the difference was statistically significant only for nutrition (*P* = .01). A 1-unit increase in nutrition score was associated with a 182% increase in the odds of being an unavoidable HAPI, a statistically significant difference (*P* = .01). When the number of preventive interventions was analyzed, patients with avoidable HAPIs had fewer preventive interventions implemented than did patients with unavoidable HAPIs. For all of the Braden Scale subscales except moisture, 1 more intervention was associated with a significant increase in the odds of being an unavoidable HAPI (mobility: OR, 4.02; 95% CI, 2.17-7.43; activity: OR, 4.12; 95% CI, 2.24-7.58; sensory perception: OR, 2.96; 95% CI, 1.55-5.64; nutrition: OR, 3.09; 95% CI, 1.75-5.47; friction and shear: OR, 1.70; 95% CI, 1.22-2.36; all *P* values < .01; Table 2).

> This study provides important information and new knowledge related to hospital-acquired pressure injuries and highlights the importance of documenting interventions to prevent pressure injuries.

Using multivariate logistic regression analysis controlling for clinical risk factors (LOS before pressure injury identification, comorbidities, daily Braden Scale total score, history of pressure injury, chemically sedated, CHF, SBP < 90 mm Hg, vasopressors, bowel management system, and smoking), participants who had CHF (OR, 0.028; 95% CI, 0.002-0.36; *P* = .006) were less likely to have an unavoidable HAPI, whereas those who had longer LOS before pressure injury development (OR, 1.04; 95% CI, 1.002-1.08; *P* = .04) or a history of pressure injury (OR, 5.27; 95% CI, 1.20-23.15; *P* = .03) were more likely to have an unavoidable HAPI. Specifically, for every additional day before pressure injury identification, there was a 4% increase in the likelihood

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Table 1
Participants' demographic and clinical data

Variable	No. (%) of participants[a] Total (N = 165)	Avoidable (n = 98)	Unavoidable (n = 67)	*P*
Age, mean (SD), y	59.9 (16.4)	61.5 (16.1)	57.7 (16.6)	.14
Acute Physiology and Chronic Health Evaluation (APACHE) score within 24 hours of ICU admission, mean (SD)	23.8 (8.7)	23.6 (8.2)	24.0 (9.4)	.72
Total No. of comorbid conditions, mean (SD)	1.5 (1.2)	1.7 (1.3)	1.3 (1.1)	.08
Days in hospital before HAPI was documented, mean (SD)	15.1 (13.7)	13.4 (12.7)	17.6 (14.8)	.06
Female sex	67 (41)	43 (44)	24 (36)	.30
Race				.43
White	132 (83)	81 (87)	51 (77)	
Nonwhite	26 (16)	12 (13)	14 (21)	
Multiracial	1 (1)	0 (0)	1 (2)	
Ethnicity				.43
Hispanic or Latinx	1 (1)	0 (0)	1 (3)	
Not Hispanic or Latinx	90 (99)	52 (100)	38 (97)	
Smoker				.05
Never	68 (45)	35 (39)	33 (55)	
Current/past	82 (55)	55 (61)	27 (45)	
Congestive heart failure				.01
No	142 (87)	80 (82)	62 (95)	
Yes	21 (13)	18 (18)	3 (5)	
Unintentional weight loss of ≥10 lb (4.5 kg) in 1 month				.91
No	121 (86)	71 (86)	50 (86)	
Yes	20 (14)	12 (14)	8 (14)	
History of pressure injury				.10
No	114 (86)	68 (91)	46 (81)	
Yes	18 (14)	7 (9)	11 (19)	
Pressure injury stage				.07
Deep tissue pressure injury	102 (63)	67 (70)	35 (52)	
2	34 (21)	17 (18)	17 (25)	
3	1 (1)	0 (0)	1 (1)	
4	1 (1)	1 (1)	0 (0)	
Unstageable	25 (15)	11 (11)	14 (21)	
Medical device–related pressure injury				.27
No	105 (64)	59 (60)	46 (69)	
Yes	60 (36)	39 (40)	21 (31)	
Pressure injury location				.78
Sacrum/coccyx	70 (42)	41 (42)	29 (43)	
Ischium	4 (2)	1 (1)	3 (4)	
Heel	23 (14)	14 (14)	9 (13)	
Occipital	3 (2)	2 (2)	1 (1)	
Ear	13 (8)	7 (7)	6 (9)	
Other	52 (32)	33 (34)	19 (28)	
Mortality				.24
Yes	45 (27)	30 (31)	15 (22)	
Mechanical ventilation				.49
No	35 (21)	19 (19)	16 (24)	
Documented at least once in the 3 days before HAPI and day when HAPI was first documented	130 (79)	79 (81)	51 (76)	
Chemically sedated (intravenous infusion)				.003
No	73 (44)	34 (35)	39 (58)	
Documented at least once in the 3 days before and the day when HAPI was first documented	92 (56)	64 (65)	28 (42)	
Systolic blood pressure <90 mm Hg				.046
No	59 (36)	29 (30)	30 (45)	
Documented at least once in the 3 days before and the day when HAPI was first documented	106 (64)	69 (70)	37 (55)	

Continued

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Table 1
Continued

Variable	No. (%) of participants[a] Total (N = 165)	Avoidable (n = 98)	Unavoidable (n = 67)	*P*
Mean arterial pressure < 60 mm Hg				.07
No	65 (39)	33 (34)	32 (48)	
Documented at least once in the 3 days before and the day when HAPI was first documented	100 (61)	65 (66)	35 (52)	
Vasopressors (concurrently)				.01
No	97 (59)	50 (51)	47 (70)	
Documented at least once in the 3 days before and the day when HAPI was first documented	68 (41)	48 (49)	20 (30)	
Incontinence				.76
No	74 (45)	43 (44)	31 (46)	
Documented at least once in the 3 days before and the day when HAPI was first documented	91 (55)	55 (56)	36 (54)	
Bowel management system				.04
No	131 (79)	83 (85)	48 (72)	
Documented at least once in the 3 days before and the day when HAPI was first documented	34 (21)	15 (15)	19 (28)	

Abbreviations: HAPI, hospital-acquired pressure injury; ICU, intensive care unit.
[a] Values are mean (SD) in the first 4 rows; all remaining entries are No. (%) of participants. Some percentages do not total 100 because of rounding.

Table 2
Univariate models of factors associated with unavoidable hospital-acquired pressure injury (HAPI)

Variable	Mean (SD) Avoidable	Unavoidable	Odds ratio[a] (95% CI)	*P*
Days in hospital before HAPI occurred	13.4 (12.7)	17.6 (14.8)	1.02 (1.00-1.05)	.07
Total No. of comorbidities	1.7 (1.3)	1.3 (1.1)	0.79 (0.60-1.03)	.08
Daily Braden Inventory Worksheet (data reflect the mean of day and night Braden Scale scores totaled, then the mean across 3 days)				
Mobility	2.0 (0.7)	2.2 (0.8)	1.35 (0.88-2.07)	.18
Activity	1.3 (0.5)	1.4 (0.7)	1.56 (0.91-2.67)	.11
Sensory perception	2.7 (0.8)	2.8 (0.9)	1.14 (0.78-1.68)	.49
Moisture	3.2 (0.5)	3.2 (0.5)	0.90 (0.49-1.66)	.74
Nutrition	2.5 (0.5)	2.7 (0.4)	2.82 (1.27-6.24)	.01
Friction and shear	1.9 (0.5)	1.9 (0.5)	0.79 (0.43-1.44)	.44
Braden Scale total score	13.6 (2.5)	14.2 (2.7)	1.09 (0.97-1.23)	.16
No. of pressure ulcer preventive interventions				
Mobility	2.6 (0.7)	3.1 (0.6)	4.02 (2.17-7.43)	<.001
Activity	3.4 (0.7)	4.0 (0.7)	4.12 (2.24-7.58)	<.001
Sensory perception	3.4 (0.7)	3.8 (0.5)	2.96 (1.55-5.64)	.001
Moisture	2.8 (0.6)	2.9 (0.7)	1.34 (0.80-2.22)	.26
Nutrition	1.9 (0.7)	2.3 (0.5)	3.09 (1.75-5.47)	<.001
Friction and shear	4.7 (1.1)	5.3 (1.1)	1.70 (1.22-2.36)	.002

[a] Odds of being an unavoidable HAPI with continuous variable in first column controlled for.

of having an unavoidable HAPI, and participants with a history of pressure injury were 5 times more likely to have an unavoidable HAPI (Table 3).

Discussion

An important finding of this study was the identification of 41% (n = 67) of the HAPIs as being unavoidable. Using a valid and reliable instrument (PUPI) provided an objective measure to identify unavoidable HAPIs. No other similar studies using such a tool were found in the literature.

In addition, this study is unique in being the first of its kind with the aim of objectively quantifying pressure injury prevention interventions in use

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Table 3
Multivariate models of clinical factors associated with unavoidable hospital-acquired pressure injury (HAPI)

Risk factor	Odds ratio[a] (95% CI)	*P*
Days in hospital before HAPI	1.04 (1.002-1.08)	.04
Total No. of comorbidities	0.96 (0.65-1.43)	.85
Daily Braden Scale total score per unit increase	1.12 (0.92-1.36)	.27
History of pressure injury	5.27 (1.20-23.15)	.03
Chemically sedated (intravenous infusion)	0.49 (0.20-1.25)	.14
Congestive heart failure	0.028 (0.002-0.36)	.006
Systolic blood pressure < 90 mm Hg	0.82 (0.31-2.22)	.70
Vasopressors (concurrently)	0.45 (0.16-1.24)	.12
Bowel management system	1.49 (0.47-4.71)	.50
Smoker	0.92 (0.38-2.19)	.84

[a] Odds of being an unavoidable HAPI with clinical risk factor controlled for.

before pressure injury development. The only other study we found that examined appropriate pressure injury preventive care was that of Beeckman and colleagues,[15] a randomized controlled trial of 464 nursing home residents in 4 nursing homes in Belgium. In that study, the authors examined adherence to guideline-based pressure injury preventive care recommendations. Pressure injury preventive protocol was tailored to the resident and was described as skin observation, use of support surface, repositioning, and heel elevation. Preventive interventions were defined as either fully adequate, meaning that all were performed, or not. The results of the study were limited, as the researchers found that fully adequate preventive care was provided to the intervention group only when patients were seated; no improvements to preventive care were found while patients were in bed.[15] Preventive interventions were not described in as much detail as in the present study. The main factor distinguishing avoidable from unavoidable HAPIs in the present study was the number of interventions documented. The unavoidable HAPI group had more interventions documented than the avoidable HAPI group; this finding makes sense given that the documented nursing care was deemed appropriate to the patient condition in the unavoidable HAPI group.

This study provides an objective, though retrospective, means to identify unavoidable pressure injuries.

Another interesting finding of the present study was the high proportion (36%) of medical device–related HAPIs. This finding is most likely due to the nature of the study population and the large number of devices used in critical care areas. The finding is consistent with the results of Black and colleagues,[16] who reported a HAPI rate of 5.4% (113 of 2079), with 34.5% (39 of 113) being related to medical devices.

In this study, unavoidable HAPIs were defined as those that developed in spite of consistent documentation of evidence-based preventive interventions. Thus, the question arises: Why did a HAPI develop in these individuals? The literature includes discussion of the complexity of pressure injury etiology and the potential for acute skin failure in critically ill patients[4-6,17-20]; however, with our current level of evidence, the distinction between acute skin failure and unavoidable pressure injury remains obscure.

The NPUAP hosted a multidisciplinary conference in 2014 to explore the issue of pressure injury unavoidability using an organ system framework.[5] Participants achieved consensus that unavoidable pressure injuries do indeed occur and that risk factors such as multiorgan dysfunction syndrome, shock or sepsis, hemodynamic instability and impaired tissue oxygenation, cardiac dysfunction, CHF, and skin failure are associated with pressure injury development and increase the likelihood of unavoidable pressure injury development.[5] These factors have also been described as part of the concept of acute skin failure.[18-21]

Langemo and Brown conducted a systematic review and defined skin failure as "an event in which skin and underlying tissues die due to hypoperfusion concurrent with severe dysfunction or failure of other organ systems."[18(p208)] They reported that the term *skin failure* appeared in the literature as early as 1993 and was described as the damage that occurs in skin and underlying tissue at the end of life and in the intensive care setting.[18] Langemo and Brown stated that the distinguishing factor between skin failure and a pressure injury is the coexistence of a significant disease process or organ failure. Their definition of acute skin failure is consistent with the overall characteristics of the patients in our study.

In a study of 552 critical care patients, Delmore and colleagues[19] developed a predictive risk model for development of acute skin failure versus pressure injury in patients admitted to critical care units. Specifically, they identified 5 predictors of acute skin failure: peripheral artery disease, mechanical ventilation lasting more than 72 hours, respiratory failure, liver failure, and severe sepsis or septic shock.[19] In a retrospective correlational study of 347 critical care patients, Cox[20] identified norepinephrine as a predictive risk factor for pressure injuries. Our study results are consistent with these findings, as almost

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79% (n = 130) of the participants with HAPIs in our study were receiving mechanical ventilation, 56% (n = 92) were chemically sedated, 64% (n = 106) had SBP below 90 mm Hg, 61% (n = 100) had mean arterial pressure below 60 mm Hg, and 41% (n = 68) were receiving 1 or more vasopressors.

Advances in medicine have enabled critically ill patients to survive situations that in the past led to death. Now, increasing numbers of patients with multiorgan failure are surviving but remain highly susceptible to adverse events involving skin integrity, specifically skin failure. In a prospective descriptive study of 29 critical care patients with acute skin failure, Curry and colleagues[21] reported that 5 patients had 2 organ failures at the time that skin failure was noted, 15 patients had either 3 organ failures or 2 organ failures plus sepsis, and 9 patients experienced 4 or more organ system failures and/or sepsis. All patients in that study had a diagnosis of nonskin organ failure and low albumin levels. Although the study of Curry et al[21] provides additional information, it lacks an objective definition of acute skin failure and does not differentiate between pressure injuries and acute skin failure. The present study provides an objective, although retrospective, means to identify pressure injuries that are unavoidable. The results may suggest a process more aligned with acute skin failure than with pressure injury.

The present study's findings regarding risk factors and avoidable HAPIs are difficult to explain, but they may be due to nurses' perceptions of patients' hemodynamic instability and thus their inability to implement preventive interventions, primarily repositioning. Patients with CHF, chemical sedation, SBP less than 90 mm Hg, or vasopressor use were more likely to lack sufficient preventive measures. These findings support current discussions in the literature on the challenges of repositioning critical care patients. Brindle and colleagues[22] reported on the development of consensus recommendations by a group of experts related to safe repositioning of patients. They noted that the critical care unit's culture and clinicians' perceptions about hemodynamic instability may lead to staff members' not repositioning patients. Krapfl and colleagues,[23] in a review of the literature, noted that the complexity and instability of the patient's condition often limit repositioning by the nurse. However, best practice continues to suggest that slow, gradual turning allows sufficient time for stabilization of blood pressure and oxygen saturation and should be considered.[11]

Limitations

Several limitations of this study are evident. The study had a retrospective design and relied on the accuracy of documentation, which did not allow confirmation of findings through observation. All participants in the study had pressure injuries, and no case-control group was used for comparison, thus limiting the ability to compare risk factors across groups. The study was conducted at a large health care system with high patient acuity, and the findings may not be generalizable to other populations and settings. Data retrieval to complete the PUPI relied on the accuracy of the documentation in the EMR. The complexity of the EMR was evident during data collection, even though the EMR software is commonly used and provided by an international EMR software company. Another limitation was the inclusion of progressive care patients, which may have diluted the acuity of the sample. Finally, the PUPI is based on the Braden Scale subscales and was not originally intended for use with medical device–related pressure injuries, thus limiting its application to this type of HAPI.

Implications for Nursing

The findings of this study provide important information and new knowledge for critical care nurses and other health care providers and highlight the importance of pressure injury prevention documentation. Attention to standard nursing care (preventive interventions) and accuracy of documentation is essential in the complex critical care setting. In addition, this study objectively identified the occurrence of unavoidable pressure injuries, suggesting a possible etiology of acute skin failure rather than a lack of preventive nursing care. Further research—particularly rigorous, controlled studies—is needed to investigate the occurrence of unavoidable HAPIs and acute skin failure in critically ill patients.

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SEE ALSO
For more about pressure injuries, visit the *Critical Care Nurse* website, **www.ccnonline.org**, and read the article by McGee et al, "Pressure Injuries at Intensive Care Unit Admission as a Prognostic Indicator of Patient Outcomes" (June 2019).

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