Published in final edited form as:

Am J Crit Care. 2014 November ; 23(6): 494–501. doi:10.4037/ajcc2014535.

Body Mass Index and Pressure Ulcers: Improved Predictability of Pressure Ulcers in Intensive Care Patients

Sookyung Hyun, RN, PhD [assistant professor],

College of Nursing, Department of Biomedical Informatics, Ohio State University, Columbus, Ohio

Xiaobai Li, PhD [assistant professor],

Center for Biostatistics, Wexner Medical Center, Ohio State University

Brenda Vermillion, RN, DNP, ACNS-BC,

is director of health system nursing education, Wexner Medical Center, Ohio State University

Cheryl Newton, RN, MSN [clinical nurse specialist],

Department of Critical Care Nursing, Wexner Medical Center, Ohio State University

Monica Fall, MS, RD, LD, CNSC [staff dietitian],

Department of Nutrition Services, Wexner Medical Center, Ohio State University

Pacharmon Kaewprag, MEng [PhD candidate],

Department of Computer Science and Engineering, Ohio State University, Columbus, Ohio

Susan Moffatt-Bruce, MD, PhD [chief quality and patient safety officer, associate dean of clinical affairs for quality and patient safety, and associate professor], and

Department of Surgery, Wexner Medical Center, Ohio State University

Elizabeth R. Lenz, RN, PhD [professor emeritus]

College of Nursing, Ohio State University, Columbus, Ohio

Abstract

Background—Obesity contributes to immobility and subsequent pressure on skin surfaces. Knowledge of the relationship between obesity and development of pressure ulcers in intensive care patients will provide better understanding of which patients are at high risk for pressure ulcers and allow more efficient prevention.

Objectives—To examine the incidence of pressure ulcers in patients who differ in body mass index and to determine whether inclusion of body mass index enhanced use of the Braden scale in the prediction of pressure ulcers.

Methods—In this retrospective cohort study, data were collected from the medical records of 4 groups of patients with different body mass index values: underweight, normal weight, obese, and extremely obese. Data included patients' demographics, body weight, score on the Braden scale, and occurrence of pressure ulcers.

Results—The incidence of pressure ulcers in the underweight, normal weight, obese, and extremely obese groups was 8.6%, 5.5%, 2.8%, and 9.9%, respectively. When both the score on the Braden scale and the body mass index were predictive of pressure ulcers, extremely obese patients were about 2 times more likely to experience an ulcer than were normal weight patients. In the final model, the area under the curve was 0.71. The baseline area under the curve for the Braden scale was 0.68.

Conclusions—Body mass index and incidence of pressure ulcers were related in intensive care patients. Addition of body mass index did not appreciably improve the accuracy of the Braden scale for predicting pressure ulcers.

Pressure ulcers are costly complications of bed rest, and patients admitted to the intensive care unit (ICU) are at high risk for these ulcers.¹⁻³ ICU patients are often bedridden and ventilator-dependent, characteristics that limit their mobility. Immobility is a risk factor for pressure ulcers in hospitalized patients.^{4,5} Obesity contributes to immobility in the ICU and subsequent pressure on skin surfaces.⁶ Helping obese patients change their position in bed to relieve sites of increased skin pressure is a challenge for caregivers.⁷

The purposes of our study were to compare the incidence of pressure ulcers in 4 groups of ICU patients with different body mass index (BMI) values, including underweight, normal, obese, and extremely obese; to determine the odds ratio for pressure ulcers across the groups; and to determine if inclusion of BMI values complements scores on the Braden scale in predicting pressure ulcers in ICU patients.

Review of the Literature

A pressure ulcer is defined as “localized injury to the skin and/or underlying tissue, usually over a bony prominence, as a result of pressure, or pressure in combination with shear.”⁸ According to a national cross-sectional cohort study,² the prevalence of pressure ulcers in ICU patients in the United States is 16.6% to 20.7%. In a comparison study⁹ in Germany, the rates of hospital-acquired pressure ulcers were 14.9% in ICU patients and 3.9% in patients in general hospital units. In the United States, 2.5 million patients are treated for pressure ulcers each year, at an annual cost of \$9.1 billion to \$11.6 billion.¹⁰

The Braden scale¹¹ is one of the most widely used scales for assessing the risk for pressure ulcers in a variety of care settings. The scale consists of 6 subscales: sensory perception, moisture, activity, mobility, nutrition, and friction/shear. The scores of the subscales range from 1 to 4, with the exception of friction/shear, which has a range of 1 to 3. The total Braden score ranges from 6 to 23. Lower total scores on the Braden scale indicate a higher risk for pressure ulcers.¹² In clinical practices, a patient with a total score less than 18 is generally considered at high risk for pressure ulcers.¹¹ Reliability and validity of the Braden scale have been tested in various settings, such as acute care units, nursing homes, and tertiary care hospitals; however, scores on the scale have poorer predictive value for ICU patients than for other patients.¹³⁻¹⁵ In addition, modification of the Braden scale has been suggested for ICU-specific risk assessment.^{16,17}

Pressure ulcer prevalence in US intensive care units ranges from 16.6% to 20.7%.

Immobility is a marked risk factor for pressure ulcers in ICU patients.^{9,18} Obesity decreases mobility in patients, increasing the risk for pressure ulcers.¹⁹ The prevalence of obesity in adults has increased greatly.²⁰ More than one-third of US adults (35.7%) are obese,²¹ and one-fourth of ICU patients are obese.²² Obesity is associated with several health issues, such as stroke, heart disease, and diabetes.²³ In addition, obesity among patients is a main reason for injuries among care providers.¹⁹ Extreme obesity has been associated with an increased prevalence of pressure ulcers in patients in a tertiary medical center,⁶ and among elderly patients, pressure ulcers are less likely to develop in nonobese patients^{24,25} and in general surgery patients.²³ In critical care, BMI has been associated with the development of pressure ulcers in patients treated with mechanical ventilation who had acute lung injury.²⁶ BMI is considered an alternative measure of body fat,²⁷ and it is used to classify people as underweight, overweight, and obese.

Methods

The research design was a retrospective cohort study with data from cumulative electronic health records of ICU patients. The study was approved by the appropriate institutional review board.

Data Collection

Patients' data were included in the study if the patients were 18 years old or older. ICU patient data collected from January 2007 through December 2010 were obtained from the information warehouse of an academic medical center in the Midwest. The data collected included age, sex, race/ethnicity, length of ICU stay, body weight, admission and discharge diagnoses, discharge disposition (ie, whether the patient died during the hospital stay or survived), and score on the Braden scale at the time of ICU admission. Data on patients whose ICU stay was less than 3 days were excluded, because pressure ulcers generally develop more than 72 hours after admission.^{28,29}

Data on body mass index were obtained from diagnostic codes upon hospital discharge.

Admission and discharge diagnoses were reviewed to identify patients in whom a pressure ulcer developed during hospitalization because data on pressure ulcers that developed during the ICU stay were not available. Data on patients who had a pressure ulcer at the time of hospital admission were excluded. If a patient's discharge diagnoses included pressure ulcer, the patient was considered "pressure ulcer present." If the diagnoses did not include pressure ulcer, the patient was considered "pressure ulcer absent."

BMI is calculated on the basis of a person's weight and height.³⁰ BMI values could not be calculated for individual patients in the study because height information for the ICU patients was not available. As an alternative, BMI data from the discharge diagnoses were used. BMI information had been recorded in the electronic health records by using codes from the *International Classification of Diseases, Ninth Revision*,³¹ upon hospital discharge. For instance, patients whose BMIs were less than 19 were coded as V85.0 and those whose BMIs were between 39.0 and 39.9 were coded as V85.39. The coding system additionally

included more specific BMI codes, such as V85.43 for BMI between 50.0 and 59.9 and V85.45 for BMI of 70 and greater.

Data Analysis

Patients were classified into 4 BMI groups: underweight, normal weight, obese, and extremely obese. The classification was made by referring to the BMI categorization of the National Heart, Lung, and Blood Institute.³⁰ The groups were defined as follows: underweight, BMI less than 19; normal weight, BMI 19 or greater but less than 25; obese, BMI 25 or greater but less than 40; and extremely obese, BMI 40 or greater.

Patient demographics and incidence of pressure ulcer were summarized by using descriptive statistics. Comparisons between patients with and without a pressure ulcer were made by using χ^2 analysis or the Fisher exact test for categorical variables and the Wilcoxon rank sum test for continuous variables. For comparisons of the 4 BMI groups, χ^2 analysis was used for categorical variables, and the Kruskal-Wallis test was used for continuous variables. Univariate logistic regression models with age, sex, race/ethnicity, weight, BMI, length of ICU stay, and total score on the Braden scale were used to evaluate the predictability of each individual variable. Multiple logistic regression models were used to assess the overall predictability of a set of variables selected on the basis of results of the univariate analysis. Areas under the curve were reported. Goodness-of-fit of the model was examined by using Hosmer Lemeshow test statistics.

Results

The data set included information on 2632 patients from medical and surgical ICUs. Medical and surgical ICU patients could not be differentiated from each other because each type of ICU had treated patients from the other type of unit depending on the status of bed capacity and patient condition (eg, postoperative care for medical patients, weaning from mechanical ventilation for surgical patients). Among the sample, 54.5% were men, 81% were white, and 15% were black. The categories Hispanic, American Indian or Alaska Native, and Asian or Pacific Islander were each less than 1%. The mean age of the patients was 58.3 years. The mean length of ICU stay was 11 days. Mean body weight was 221 lb (100 kg), with a range of 80 to 696 lb (36-316 kg).

Patients with and without a pressure ulcer did not differ in age, sex, or race/ethnicity (Table 1). However, patients with a pressure ulcer had significantly lower total scores on the Braden scale than did patients without an ulcer. Patients with a pressure ulcer also tended to stay longer in the ICU and had significantly higher mean weight. The most frequent diagnoses at admission were acute respiratory failure (8.4%), coronary atherosclerosis (4.6%), shortness of breath (3.2%), septicemia (2.7%), aortic valve disorder (2.7%), subarachnoid hemorrhage (1.9%), multiple myeloma (1.8%), altered mental status (1.8%), and intracerebral hemorrhage (1.4%). Other types of admission diagnoses were represented by less than 1% of the sample.

According to total scores on the Braden scale, 62% of patients (n = 1642) were at risk for pressure ulcers (score $\leq$ 18) at the time of ICU admission. Twenty-nine percent of patients

(n = 753) were classified as high risk (score 10-12) or very high risk (score 9). The incidence of pressure ulcers was 5.6% (n = 147).

Association Between BMI and Incidence of Pressure Ulcers

Among the patients in the sample, 7.5% (n=197) were underweight, 17.9% (n = 470) were normal weight, 48.5% (n = 1277) were obese, and 26.1% (n = 688) were extremely obese. Table 2 summarizes characteristics of the 4 groups. The rates of pressure ulcers in the underweight, normal weight, obese, and extremely obese groups were 8.6%, 5.5%, 2.8%, and 9.9%, respectively.

In paired comparisons between the groups, normal weight and underweight groups did not differ in age, sex, and length of ICU stay. However, underweight patients had lower total scores on the Braden scale than did normal weight patients ($P = .003$), indicating a higher risk for pressure ulcers in the underweight patients. The incidence of pressure ulcers did not differ significantly between the underweight and the normal weight groups. The mortality rate during hospitalization was 19.0% for underweight patients and 11.8% for normal weight patients ($P = .02$).

Normal weight patients did not differ from obese patients in age, sex, or total scores on the Braden scale. However, the incidence of pressure ulcers in normal weight patients was significantly greater than that in obese patients ($P = .007$). In general, obese patients stayed longer in the ICU than did normal weight patients ($P = .02$). The percentage of females differed significantly ($P < .001$) between the extremely obese group (60.3%) and the normal weight group (40.0%). In addition, extremely obese patients were generally younger ($P < .001$) and had lower total scores on the Braden scale upon ICU admission ($P < .001$). Length of ICU stay did not differ between normal weight and extremely obese patients. The incidence of pressure ulcers among extremely obese patients was significantly greater than that among normal weight patients ($P = .008$).

Age and sex did not differ between the underweight patients and the obese patients. Obese patients stayed significantly longer in the ICU than did underweight patients ($P = .002$). The mortality rate during hospitalization differed significantly ($P < .001$) between these 2 groups: 19% for underweight patients and 9.4% for obese patients. In addition, compared with obese patients, underweight patients had significantly lower total scores on the Braden scale ($P < .001$) and a significantly lower incidence of pressure ulcers ($P < .001$).

About 62% were classified via the Braden scale as “at risk” for a pressure ulcer on admission to the intensive care unit.

Extremely obese patients were significantly younger than obese patients ($P < .001$). The percentage of women also differed significantly ($P < .001$) between the 2 groups: 60% in extremely obese patients and 41% in obese patients. The percentage of blacks also differed significantly ($P < .001$) between the 2 groups: 20% in extremely obese patients and 12.5% in obese patients. Compared with obese patients, extremely obese patients had significantly lower total scores on the Braden scale on ICU admission ($P < .001$) and a significantly higher incidence of pressure ulcers ($P < .001$). The 2 groups did not differ in the length of

ICU stay. Mortality during hospitalization was 16% for extremely obese patients and 9% for obese patients ($P < .001$).

Predictive Models

From the univariate logistic analysis, weight, BMI, and total scores on the Braden scale appeared to be associated with the occurrence of pressure ulcers. On the basis of the results, the final model was constructed with total scores on the Braden scale and BMI by using multiple logistic regressions. The goodness-of-fit of the model as indicated by the Hosmer Lemeshow test was acceptable ($P = .86$). The area under the curve of the final model was 0.71, a slight increase compared with 0.68 for the Braden scale as the baseline. In a secondary analysis, when BMI alone was used for a predictor, the area under the curve was 0.65.

When both total scores on the Braden scale and BMI category were predictors of the likelihood of pressure ulcers, extremely obese patients were 3.7 times more likely to have a pressure ulcer than were obese patients and 1.9 times more likely than were normal weight patients. Underweight patients were 3.3 times more likely to have a pressure ulcer than were obese patients. Normal weight patients were 2 times more likely to have a pressure ulcer than were obese patients (Table 3).

Discussion

BMI appeared to be associated with occurrence of pressure ulcers in ICU patients. Patients in the underweight and extremely obese groups had higher rates of pressure ulcers than did patients in the normal weight or obese groups. This finding is consistent with the US data from an international pressure ulcer prevalence survey in which the prevalence of pressure ulcers was higher in underweight and extremely obese patients.^{6,32} The underweight and extremely obese groups did not differ in race/ethnicity, total scores on the Braden scale, incidence of pressure ulcers, length of ICU stay, or discharge disposition; however, differences in sex and mean age were significant. Compared with patients in the other groups, extremely obese patients were 4 to 5 years younger and more likely to be women.

In the United States, 154.7 million adults (age ≥ 20 years) are at least overweight, and 5% are extremely obese. These percentages continue to increase.^{7,33} Hospital admission rates of extremely obese patients have correspondingly increased.³² In our study, 26% of the ICU patients were extremely obese. Extremely obese patients are likely to become immobile and present difficult challenges to the care providers who must move or reposition the patients.^{7,34} Sometimes, more caregivers are needed to provide routine care for obese patients than for nonobese patients.³² Therefore, additional consideration is needed for care of extremely obese patients in ICU settings, including special resources such as safe patient-handling equipment to mobilize the patients and reduce the risk for injury in caregivers.

All of the ICU patients in our study had received preventive interventions included in the ICU's standard ulcer prevention protocol. We were unable to examine whether the score on the Braden scale at admission made a difference in care provision in this retrospective cohort study. Three types of beds were used in the ICUs: regular, special, and bariatric.

Because information on bed type had been recorded only once at the time of ICU discharge, we could not determine whether a special bed helped prevent pressure ulcers. Among the patients in the sample, 89.5% (n=2355) used the regular bed, 4.1% (n=108) used the special bed, and 6.4% (n = 169) used the bariatric bed. The incidence of pressure ulcers was 34% for patients placed on the special bed, 25% for the bariatric bed, and 5% for the regular bed. A possible reason for this finding is that patients in whom a pressure ulcer was developing were placed on a special bed.

Although extreme obesity was associated with development of pressure ulcers, obesity (BMI 25 or greater but less than 40) appeared to protect patients from the development of pressure ulcers. In our study, patients in the obese group were significantly less likely to have a pressure ulcer than were normal weight patients. This finding is consistent with the results of previous research.³² The range of BMI value may be a factor that can be considered when the risk for pressure ulcers is assessed.

When total scores on the Braden scale were examined as a predictor, 62% (n = 1642) of the patients were classified as at least at risk, indicating that interventions to prevent pressure ulcers must be considered for 62% of all patients admitted to the ICU. In our sample, a pressure ulcer developed in 5.6% of patients (n = 147). For future research, further analysis with additional potentially influential data elements (eg, nutritional data, repositioning) will be conducted to determine in which at-risk patients a pressure ulcer actually developed. Overprediction results in costly and unnecessary preventive interventions, whereas underprediction contributes to adverse patient outcomes. When BMI values were added to scores on the Braden scale in the model, the area under the curve slightly increased compared with the Braden scale as the baseline.

Our study had several limitations. The data field that included the information about when the pressure ulcer occurred during the ICU stay could not be located because the data had been stored in multiple different data fields and clusters in the information warehouse. Thus, discharge diagnoses with *International Classification of Diseases, Ninth Revision*, codes³¹ were used to identify patients in whom a pressure ulcer developed. The diagnoses of pressure ulcer could not be validated in our retrospective secondary analysis. In addition, the incidence of pressure ulcers may have been underestimated if the occurrence of pressure ulcers was not reflected in the discharge documentation. BMI data were limited to data added at discharge. We could not calculate BMI for individual patients because information on patients' height was not available. We did not consider variability in severity of illness because the data were not available. Interpretation of the results may be limited because data were from a single institution.

Obesity (25 ≤ BMI < 40) appeared to protect patients from the development of pressure ulcers.

Conclusion

BMI and the incidence of pressure ulcers were related in ICU patients. Underweight and extremely obese patients were at higher risk for pressure ulcers than were normal weight or obese patients. If a patient has an extremely low or extremely high BMI, additional care to

prevent pressure ulcers is desirable. Although BMI did not appreciably improve the accuracy of scores on the Braden scale in predicting development of pressure ulcers in ICU patients, our findings suggest that BMI should be considered in the assessment of patients for such ulcers.

Acknowledgments

We thank Tara Payne, Marcia Belcher, and information warehouse staff for their assistance with data extraction.

FINANCIAL DISCLOSURES

The project was supported by grant UL1RR025755 from the National Center For Research Resources.

References

1. Shahin ES, Dassen T, Halfens RJ. Pressure ulcer prevalence and incidence in intensive care patients: a literature review. *Nurs Crit Care*. 2008; 13(2):71–79. [PubMed: 18289185]
2. VanGilder C, Amlung S, Harrison P, Meyer S. Results of the 2008-2009 International Pressure Ulcer Prevalence Survey and a 3-year, acute care, unit-specific analysis. *Ostomy Wound Manage*. 2009; 55(11):39–45. [PubMed: 19934462]
3. Reddy M, Gill SS, Rochon PA. Preventing pressure ulcers: a systematic review. *JAMA*. 2006; 296(8):974–984. [PubMed: 16926357]
4. Lindgren M, Unosson M, Fredrikson M, Ek AC. Immobility—a major risk factor for development of pressure ulcers among adult hospitalized patients: a prospective study. *Scand J Caring Sci*. 2004; 18(1):57–64. [PubMed: 15005664]
5. Cox J. Pressure ulcer development and vasopressor agents in adult critical care patients: a literature review. *Ostomy Wound Manage*. 2013; 59(4):50–54. 56–60. [PubMed: 23562874]
6. Drake D, Swanson M, Baker G, et al. The association of BMI and Braden total score on the occurrence of pressure ulcers. *J Wound Ostomy Continence Nurs*. 2010; 37(4):367–371. [PubMed: 20644369]
7. Alexander JW, Cafiero M, Conroy S, et al. Does skin care for the obese patient require a different approach? *Bariatric Nurs Surg Patient Care*. 2006; 1(3):157–165.
8. Prevention and Treatment of Pressure Ulcers: Quick Reference Guide. Washington, DC: National Pressure Ulcer Advisory Panel; 2009. European Pressure Ulcer Advisory Panel and National Pressure Ulcer Advisory Panel.
9. Lahmann NA, Kottner J, Dassen T, Tannen A. Higher pressure ulcer risk on intensive care? Comparison between general wards and intensive care units. *J Clin Nurs*. 2012; 21(2-3):354–361. [PubMed: 21385258]
10. Are We Ready for This Change? Preventing Pressure Ulcers in Hospitals: A Toolkit for Improving Quality of Care. Rockville, MD: Agency for Healthcare Research and Quality; Apr. 2011 <http://www.ahrq.gov/professionals/systems/long-term-care/resources/pressure-ulcers/pressureulcertoolkit/putool1.html> [July 21, 2014]
11. Bergstrom N, Braden BJ. Predictive validity of the Braden scale among black and white subjects. *Nurs Res*. 2002; 51:398–403. [PubMed: 12464760]
12. Bergstrom N, Braden BJ, Laguzza A, Holman V. The Braden Scale for Predicting Pressure Sore Risk. *Nurs Res*. 1987; 36(4):205–210. [PubMed: 3299278]
13. Boyle M, Green M. Pressure sores in intensive care: defining their incidence and associated factors and assessing the utility of two pressure sore risk assessment tools. *Aust Crit Care*. 2001; 14:24–30. [PubMed: 11899757]
14. Jun Seongsok RN, Jeong Ihnsook RN, Lee Younghee RN. Validity of pressure ulcer risk assessment scales: Cubbin and Jackson, Braden, and Douglas scale. *Int J Nurs Stud*. 2004; 41(2): 199–204. [PubMed: 14725784]
15. Cox J. Predictors of pressure ulcers in adult critical care patients. *Am J Crit Care*. 2011; 20:364–375. [PubMed: 21885457]

16. Cox J. Predictive power of the Braden scale for pressure sore risk in adult critical care patients: a comprehensive review. *J Wound Ostomy Continence Nurs.* 2012; 39:613–621. [PubMed: 22948495]
17. Hyun S, Vermillion B, Newton C, et al. Predictive validity of the Braden scale for patients in intensive care units. *Am J Crit Care.* 2013; 22(6):514–520. [PubMed: 24186823]
18. Allman R, Goode P, Patrick M, Burst N, Bartolucci A. Pressure ulcer risk factors among hospitalized patients with activity limitation. *JAMA.* 1995; 273:865–870. [PubMed: 7869557]
19. Walden CM, Bankard SB, Cayer B, et al. Mobilization of the obese patient and prevention of injury. *Ann Surg.* 2013; 258:646–651. [PubMed: 23979276]
20. Ogden C, Carroll M, Curtin L, McDowell M, Tabak C, Flegal K. Prevalence of overweight and obesity in the United States, 1999–2004. *JAMA.* 2006; 295:1549–1555. [PubMed: 16595758]
21. Centers for Disease Control and Prevention. [July 21, 2014] Adult overweight and obesity. <http://www.cdc.gov/obesity/adult/index.html>. Last updated April 27, 2012
22. Honiden S, McArdle J. Obesity in the intensive care unit. *Clin Chest Med.* 2009; 30:581–599. [PubMed: 19700054]
23. Mullen J, Moorman D, Davenport D. The obesity paradox: body mass index and outcomes in patients undergoing nonbariatric general surgery. *Ann Surg.* 2009; 250:166–172. [PubMed: 19561456]
24. Compher C, Kinoshian B, Ratcliffe S, Baumgarten M. Obesity reduces the risk of pressure ulcers in elderly hospitalized patients. *J Gerontol A Biol Sci Med Sci.* 2007; 62(11):1310–1312. [PubMed: 18000154]
25. Baumgarten M, Margolis D, Localio A, et al. Pressure ulcers among elderly patients early in the hospital stay. *J Gerontol A Biol Sci Med Sci.* 2006; 61:749–754. [PubMed: 16870639]
26. O'Brien JM Jr, Phillips G, Ali N, Lucarelli M, Marsh C, Lemeshow S. Body mass index is independently associated with hospital mortality in mechanically ventilated adults with acute lung injury. *Crit Care Med.* 2006; 34:738–744. [PubMed: 16521268]
27. National Center for Chronic Disease Prevention and Health Promotion; About BMI for adults. Division of Nutrition, Physical Activity, and Obesity. http://www.cdc.gov/healthyweight/assessing/bmi/adult_BMI/. Last updated July 14, 2014 [July 21, 2014]
28. Carlson E, Kemp M, Shott S. Predicting the risk of pressure ulcers in critically ill patients. *Am J Crit Care.* 1999; 8:262–269. [PubMed: 10392227]
29. Compton F, Hoffmann F, Hortig T, et al. Pressure ulcer predictors in ICU patients: nursing skin assessment versus objective parameters. *J Wound Care.* 2008; 17:417–420. 422–424. [PubMed: 18947019]
30. National Heart, Blood, and Lung Institute. [August 21, 2014] Classification of overweight and obesity by BMI. https://www.nhlbi.nih.gov/health-pro/guidelines/current/obesity-guidelines/e_textbook/txgd/414.htm
31. International Classification of Diseases, Ninth Revision. Geneva, Switzerland: World Health Organization; 1996.
32. VanGilder C, MacFarlane G, Meyer S, Lachenbruch C. Body mass index, weight, and pressure ulcer prevalence: an analysis of the 2006–2007 International Pressure Ulcer Prevalence Surveys. *J Nurs Care Qual.* 2009; 24(2):127–135. [PubMed: 19287251]
33. Go A, Mozaffarian D, Roger V, et al. American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics—2013 update: a report from the American Heart Association. *Circulation.* 2013; 127(1):e6–e245. published correction appears in *Circulation.* 2013;127(23):e841. [PubMed: 23239837]
34. Brindle CT, Malhotra R, O'Rourke S, et al. Turning and repositioning the critically ill patient with hemodynamic instability: a literature review and consensus recommendations. *J Wound Ostomy Continence Nurs.* 2013; 40(3):254–267. [PubMed: 23652698]

Table 1Demographics of patients in the intensive care unit^a

Characteristic	Pressure ulcers		χ^2 or <i>t</i>	<i>P</i>
	Present (n = 147)	Absent (n = 2485)		
Sex			0.2	.63
Male	83 (56.5)	1352 (54.4)		
Female	64 (43.5)	1133 (45.6)		
Race/ethnicity				
White	116 (81.1)	2010 (82.1)	0.1	.76
Nonwhite	27 (18.9)	438 (17.9)		
White	116 (83.5)	2010 (84.1)	0.1	.83
Black	23 (16.5)	379 (15.9)		
Age, mean (SD), y	57 (14.8)	58 (15.2)	0.81	.42
Weight, mean (SD), lb	256.4 (119)	218.6 (86)	2.02	<.001
Days in intensive care unit, mean (SD)	14 (15.6)	111 (10.7)	-2.07	.04
Braden total score, mean (SD)	12 (2.3)	14 (3.4)	-3.59	<.001

^aSome numbers in the columns do not add up to 2632 because of missing data. Values in columns are number (%) of patients unless otherwise indicated.

Table 2Characteristics of the 4 body mass index (BMI) groups^a

Characteristic	Underweight BMI < 19 (n = 197)	Normal weight 19 BMI < 25 (n = 470)	Obese 25 BMI < 40 (n = 1277)	Extremely obese 40 BMI (n = 688)
Sex				
Female	75 (38.1)	188 (40)	519 (40.6)	415 (60.3)
Male	122 (61.9)	282 (60)	758 (59.4)	273 (39.7)
Race/ethnicity				
White	151 (77)	381 (81.6)	1067 (85.4)	527 (77.7)
Nonwhite	45 (23)	86 (18.4)	183 (14.6)	151 (22.3)
White	151 (79.9)	381 (83.2)	1067 (87.5)	527 (79.6)
Black	38 (20.1)	77 (16.8)	152 (12.5)	135 (20.4)
Disposition				
Alive	158 (81)	412 (88.2)	1151 (90.6)	576 (84.3)
Died	37 (19)	55 (11.8)	120 (9.4)	107 (15.7)
Pressure ulcer				
Present	17 (8.6)	26 (5.5)	36 (2.8)	68 (9.9)
Absent	180 (91.4)	444 (94.5)	1241 (97.2)	620 (90.1)
Age, mean (SD), y	58.3 (16.4)	59.6 (18.1)	58.4 (15.3)	55.1 (15.3)
Weight, ^b mean (SD), lb	122.3 (24.5)	149.4 (28.4)	202.7 (39.5)	325.4 (87.6)
Days in intensive care unit, mean (SD)	8 (6.3)	8.4 (7.3)	9 (7.0)	10 (10.6)
Braden total score, mean (SD)	13.1 (3.0)	14 (3.5)	14 (3.6)	13 (3.0)

^aSome numbers in the columns do not add up to 2632 because of missing data. Values in columns are number (%) of patients unless otherwise indicated. BMI calculated as weight in kilograms divided by height in meters squared.

^bTo convert to kilograms, divide by 2.2.

Table 3

Group comparison in the model with total scores on the Braden scale and body mass index

Comparison	Odds ratio	95% CI	P
Normal vs underweight	0.62	0.33-1.17	.14
Normal vs obese	2.02	1.21-3.38	.008
Normal vs extremely obese	0.53	0.33-0.85	.009
Underweight vs obese	3.26	1.79-5.91	<.001
Obese vs extremely obese	0.27	0.18-0.40	<.001