

Complementing Braden scale for pressure ulcer risk with clinical and demographic-related factors in a large cohort of hospitalized Italian patients

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ABSTRACT

Aims: To determine the prevalence, risk, and determinants of pressure ulcer risk in a large cohort of hospitalized patients.

Design: A prospective cross-sectional study with data collection in January 2023.

Methods: Registered nurses collected data from 798 patients admitted to 27 health care units of an Italian hospital. The pressure ulcer risk was assessed using the Braden scale. The presence of comorbidities was collected from clinical reports. Obesity was assessed according to international indicators (Body Mass Index). The receiver operating characteristic (ROC) curve was used to estimate the sensitivity and specificity of different Braden scores for identifying participants with pressure ulcers.

Results: The prevalence of pressure ulcers was 9.5%, and 57.4% of the sample were at risk of developing pressure ulcers. The area under the ROC curve was 0.88. The best sensitivity and specificity were found for a Braden cutoff score of 15.5 (sensitivity = 0.76; specificity = 0.85). The determinants of lower Braden scores were older age ($p < 0.001$), comorbidities ($p < 0.001$), wounds of other nature ($p = 0.001$), urinary incontinence ($p < 0.001$), fecal incontinence ($p < 0.001$), and urinary catheterization ($p < 0.001$).

Conclusion: Several demographic factors and specific clinical indicators have been identified as determinants of the risk of developing pressure ulcers, which are easily ascertainable by healthcare providers; thus, they may routinely complement the Braden Scale in the assessment of pressure ulcer risk in order to reinforce and accelerate clinical judgment.

1. Introduction

Pressure ulcers (PUs) are prevalent in the healthcare sector as a result of the expansion of older populations and improvements in medical care [1]. According to a recent meta-analysis the pooled prevalence of PUs is 11.7% [2] among hospitalized patients. However, this amount can potentially be greater, as evidenced by an Italian cross-sectional study where they found a prevalence between 17 and 19.5% [3].

PUs have a detrimental impact on patients' physical, social, and

mental health, including pain and distress, body image disorders, and poor quality of life above others [2,4]. Likewise, PUs also carry a significant economic burden as a result of prolonged rehabilitation and hospital stays [5].

The poor health outcomes associated with PUs require a comprehensive risk assessment [6]. Among the scales used to stratify patients based on their PUs risk, the Braden scale is undoubtedly the most thoroughly validated and best estimate of risk. Since its inception, this instrument has been extensively studied in various population types and

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has generally demonstrated a satisfactory balance of sensitivity and specificity when compared to other scales [7].

International guidelines recommend that the available assessment instruments be used in conjunction with other forms of nursing judgment, to enrich the estimation of the patient level of risk [6,8]. Notably, this recommendation was anticipated by the author of the scale herself: “patients will have additional risk factors and comorbidities not measured by the Braden Scale, and good nursing judgment would reveal the need for a higher intensity of preventive intervention” [9].

This complementary approach lies in the fact that many instruments, including the Braden scale, assess key factors that help in risk estimation (e.g., mobility), but neglect many other important factors, which may limit their diagnostic accuracy [10].

To the best of our knowledge, only a small number of studies have explored the potential link between the risk of PU and patient-related factors (P. [11]), and up to date there is no data available for the Italian population, where, similar to other European countries, the prevalence of PUs remains alarmingly high. An interesting recent research by Skogestad et al. [12] found a set of patient-related symptoms as variables supplementing the Braden scale. However, they limited the analysis to an acute medical ward with a sample that may be deemed relatively small. Moreover, comorbidities were self-reported, as well as symptoms, with all the shortcomings that these measures carry ahead (e.g., variability in reporting, and measurement errors) [13]. Detecting more predictive and rapid patient-related factors associated with the entity of risk would allow a more effective, rapid, and easier assessment by healthcare professionals. Rapidity in assessment is deemed crucial in this context given that PU can develop very quickly.

1.1. Study aims

The purpose of our study was to (i) describe the prevalence of PU in patients admitted to an Italian University hospital, (ii) estimate PU risk, and (iii) examine potential risk factors of PUs risk according to the Braden scale score, among sociodemographic, contextual, and clinical variables.

2. Materials and methods

2.1. Study design and population

This is a cross-sectional study on data from 798 adult patients admitted to the Careggi University Hospital (Florence, Italy) in January 2023. The study included all patients being cared for in the surgery, medicine, and intensive care units of the hospital. Obstetrics and pediatric units were excluded because of low risk of PUs in these settings.

2.2. Data collection

The data were gathered by 15 wound care nurse specialists who routinely performed risk assessments in everyday care. Before beginning the study, nurses received specific training on how to complete the survey sheets. Other variables were collected directly at the patients' beds through direct observation. All data was directly imputed in the LimeSurvey® software [14].

2.3. Instruments

The Braden scale was used to assess the PUs risk [15]. This scale comprises six items that measure sensory perception, moisture, activity, mobility, nutrition, friction, and shear. Each item is rated on a Likert scale of 1–3 or 4 points, and the total score ranges from 6 to 23. Higher scores indicate a lower risk. A cut off value below 19 is indicative of PU risk. Satisfactory validity and reliability of this scale were demonstrated in many healthcare settings including intensive care units [16].

An online sociodemographic and clinical questionnaire was created

ad hoc to collect variables of interest. Body Mass Index (BMI) was used to classify the patients as obese (≥ 30) or underweight (< 18.5) [17]. The presence of comorbidities, PU, and other wounds was ascertained by consulting clinical records. The PUs stage was assigned according to the classification of the National Pressure Ulcer Advisory Panel (NPUAP) as normal or abnormal (stage I–IV) [6,18].

2.4. Data analysis

Data were downloaded from LimeSurvey® and imported into EXCEL®, where the accuracy of the data entry and missing values were checked. The data were then transferred to STATA® v.16 [19] to perform the statistical analyses, which were conducted in consecutive steps. First descriptive statistics (means and standard deviations, and frequencies and percentages) were used to present the sample's characteristics. Second, we assessed the concurrent validity of the Braden scale in predicting the presence of PUs. The Receiver Operating Characteristic (ROC) curves were plotted, and the area under the curve (AUC) was calculated. An area under the ROC curve greater than 80% is considered a good model for classifying with an outcome of interest against those without the outcome [20].

We also computed the sensibility and specificity of the tool; the optimal cut off point was determined using Youden's index. Finally, multilevel mixed-effects linear regressions were performed using a random intercept for each type of hospital care unit to understand the relationship between a set of demographic and clinical variables and the risk of PUs, measured using the Braden score. The possible determinants of PUs risk were selected according to the literature and whether they satisfied the characteristics of being easily and rapidly assessed during the routine clinical practice.

Initial univariate analyses were conducted to explore potential confounders. Subsequently, all variables were entered into a multivariate regression model. We chose to retain the confounders in the multivariate model in order to obtain a more authentic picture of the independence of possible determinants of PUs risk. The regressions were estimated using the maximum likelihood estimation. The total variance of the multivariate model was computed according to the procedure described by Snijders and Bosker [21]. A probability level of < 0.05 was considered significant for all analyses.

2.5. Ethical considerations

This study was conducted in accordance with the Declaration of Helsinki. All data were kept by the principal investigator, and patient identification was limited to the case number assigned, thereby complying with Italian legislation regarding personal data protection. Authorization to carry out the prevalence study was released by the University Hospital of Careggi (Florence, Italy), and all patients (or their families) provided written informed consent on the first day of admission.

3. Results

3.1. Characteristics of the sample

Table 1 shows the participants' sociodemographic characteristics. The mean age of the total sample was 64.85 (SD = 17.78), with a Braden score of 17.68 (SD = 4.39) representing mild PUs risk. Most patients were admitted to the surgical (40.2%) and medical wards (39.5%), exhibited comorbidities (47.9%), and had urinary incontinence (68.7%). Patients with PUs accounted for approximately 10% of the sample and were most prevalent in medical units (32.9%). The proportion of patients at risk for PUs was 41.1%; this subsample was significantly older ($p < 0.001$) and more prevalent in terms of comorbidity status ($p < 0.001$) than their counterparts. The Braden score was 14.62 in those at risk, representing a mild risk classification. Other

Table 1
Sociodemographic and clinical characteristics of the sample.

	Total sample (n = 798, 100%)	Patients with PU (n = 76, 9.52%)	Patients without PU (n = 708, 88.72%)	Patients at risk of PU (Braden <19) (n = 328, 41.1%)	Patients not at risk of PU (Braden ≥19) (n = 380, 47.62%)
Age (mean, SD)	64.85 (17.78)	69.98 (16.12)	64.39 (17.84)	69.05 (17.27)	60.37 (17.36)
Gender (male) (n, %)	439 (55)	45 (59.2)	389 (54.9)	184 (56.1)	205 (53.9)
Braden ^a (total score)	17.68 (4.39)	11.87 (2.68)	18.31 (4.07)	14.62 (2.88)	21.49 (1.34)
Sensory perception	3.43 (0.90)	2.38 (1.03)	3.54 (0.81)	3.03 (0.95)	3.98 (0.17)
Moisture	3.39 (0.71)	2.67 (0.66)	3.47 (0.67)	2.99 (0.65)	3.88 (0.32)
Activity	2.54 (1.22)	1.34 (0.55)	2.67 (1.20)	1.61 (0.71)	3.58 (0.69)
Mobility	3.04 (0.95)	1.87 (0.66)	3.27 (0.89)	2.45 (0.74)	3.79 (0.41)
Nutrition	2.86 (0.73)	2.11 (0.53)	2.94 (0.70)	2.53 (0.62)	3.3 (0.57)
Friction and shear	2.43 (0.74)	1.5 (0.6)	2.53 (0.68)	2.01 (0.69)	2.96 (0.19)
Hospital unit (n, %)					
Surgical	321 (40.2)	8 (10.5)	308 (43.5)	118 (36)	190 (50)
Intensive care unit	122 (15.3)	28 (36.8)	90 (12.7)	67 (20.4)	23 (6.1)
Medical	315 (39.5)	28 (36.8)	282 (39.8)	120 (36.6)	162 (42.6)
Spinal unit	40 (5)	12 (15.8)	28 (4)	23 (7)	5 (1.3)
Obesity (n, %)	54 (6.8)	13 (17.1)	41 (5.8)	29 (8.8)	12 (3.2)
Comorbidities (n, %)	382 (47.9)	55 (72.4)	327 (46.3)	194 (59.1)	133 (35)
Other wounds ^a (n, %)	82 (10.3)	7 (9.2)	75 (10.6)	50 (15.2)	25 (6.6)
Arteriopathy (n,%)	77 (10.4)	13 (17.1)	68 (9.6)	48 14.6)	20 (5.3)
Urinary incontinence (n, %)	548 (68.7)	14 (18.4)	534 (75.4)	144 (43.9)	32 (8.4)
Fecal incontinence (n, %)	132 (16.5)	46 (60.5)	86 (12.1)	72 (22)	14 (3.7)
A urinary catheter (n, %)	317 (39.7)	64 (84.2)	253 (35.7)	188 (57.3)	65 (17.1)

Legend. SD, standard deviation; M, mean. Some percentages may not add up to 100% due to missing values.

Note.
^a Most wounds are diabetic foot ulcers.

patient-related factors were low in prevalence in the total sample but had high numerosity in PUs patients and those at risk.

3.2. Characteristics of the wounds

Table 2 describes the prevalence and characteristics of PUs. The

Table 2
Prevalence and characteristics of the pressure ulcers (n = 76).

Pressure ulcer stage ^a	
1	13 (17.1)
2	27 (35.5)
3	12 (15.8)
4	7 (9.2)
5	9 (11.8)
6	8 (10.5)
PU development time (n, %)	
Before admission	29 (38.7)
During admission	45 (60)
Number of pressure ulcers per patient (n, %)	
1	16 (21.3)
2	29 (38.7)
3	11 (14.7)
4	5 (6.7)
5	7 (9.3)
6	6 (8)
>6	1 (1.3)
Type of pressure ulcer (n, %)	
Sacrum	52 (69.3)
Occiput	3 (4)
Trochanter	4 (5.3)
Ischium	5 (6.7)
Malleolus	3 (4)
Heel	17 (22.7)
Elbow	1 (1.3)
Other (not specified)	17 (22.7)

Note. The variable “type of pressure ulcer” does not have mutually exclusive conditions.

Legend.
^a According to Kottner et al. [18].

overall PUs prevalence was 9.52%, with the most prevalent lesions located at the sacrum (69.3%), followed by the heel (22.7%) and ischium (6.7). Most cases were classified in the second stage (35.5), developed before admission (38.7), and were mostly prevalent in intensive care (36.8) and medical units (34.2). Based on a Braden score <19, 54 patients were at risk of developing PUs (54/708, 46.3%) (data not shown).

3.3. Concurrent validity of the Braden scale

Fig. 1 shows the ROC curves of the Braden score for predicting the presence of PUs in the total sample (n = 798). The area under the curve was 0.89 [95% confidence interval (CI) 0.86, 0.92] and the best cut-off was a score of 15.5, which corresponded to a sensibility of 0.76 and a specificity of 0.85.

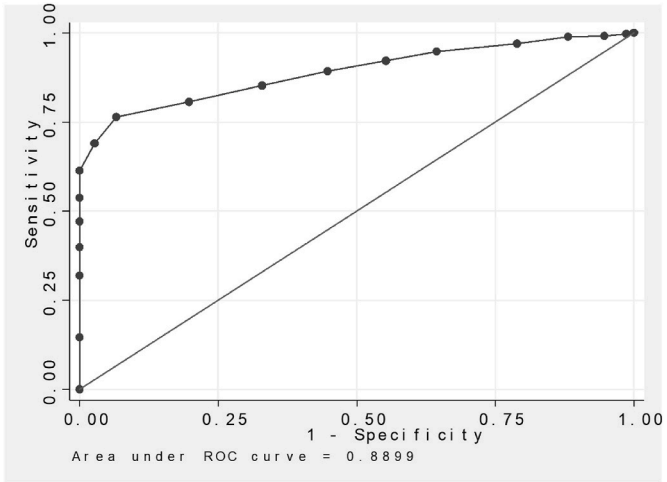


Fig. 1. Graph of the ROC curves of the Braden score predicting pressure ulcers.
Legend. ROC, receiver operating characteristic.

3.4. Determinants of Braden score

Table 3 shows the results of the univariate and multivariate linear regressions of the determinants associated with Braden scores. In univariate analysis, gender and the presence of arteriopathy were not associated with Braden score. In the multivariate analysis, these variables were reconfirmed as not significant, while the determinants of a lower Braden score were older age ($p < 0.001$), comorbidities ($p < 0.001$), other wounds ($p = 0.001$), urinary incontinence ($p < 0.001$), fecal incontinence ($p < 0.001$), and the presence of a urinary catheter ($p < 0.001$).

4. Discussion

This study aimed to describe the prevalence of PUs in patients admitted to a large Italian hospital, estimate PUs risk, and examine its risk factors based on their Braden score. The results indicated that 41.1% of patients were at risk of developing PUs, with a total PUs prevalence of nearly 10%. Additionally, we found a series of patient-related determinants of lower Braden scores, including age, comorbidities, other wounds, urinary and fecal incontinence, and presence of a urinary catheter. To the best of our knowledge, this study is among the first to include a series of easy-to-assess patient-related factors associated with PU risk. Our results contribute to expanding this novel research and helping nurses and other healthcare providers with a more rapid and effective risk assessment.

The prevalence of PUs in the Careggi hospital is relatively high, which is in line with previous international studies. For example, the meta-analysis by Shiferaw et al. [2], which included studies conducted in Ethiopia, found a pooled prevalence of 11.7%. Another recent systematic review by Al Mutairi and Hendrie [22] reported a point prevalence of 14.8% over a span of two decades. Interestingly, a study by Olivo et al. [3] on more than 7000 patients across 50 hospitals found a prevalence between 17 and 19.5%, suggesting high variability across Italian hospitals.

Our findings indicated a relatively high-risk of PUs development in our cohort. However, this parameter has high variability across studies, mainly because of the adopted Braden cut-off points. In this regard, we chose a cut-off point of 19 because it seems to have the greatest sensitivity in general wards [23], where most of our patients came from, but other studies, for example, computed the risk based on a score < 17 [24].

Age was found to be an independent determinant of the Braden score. Notably, older age is well-known to be an indirect causal factor that leads to a higher prevalence of PUs [25,26]. In our model, age was dichotomized in order to facilitate stratification of risk assessment in routine practice.

Other variables that emerged as determinants of PUs risk have also been found in the literature. Notably, patients with lesions other than PU had lower Braden scores than those without ulcers. Given that our wounds were mostly diabetes-related, this result provides further

evidence that diabetic patients have additional risks of developing PU compared to their counterparts. A recent meta-analysis concluded that diabetes increases the risk of developing surgery-related PUs approximately 1.5 times more than others [27]. The presence of other lesions in patients indirectly corroborates the well-established evidence that PUs themselves are a risk factor for other PUs (P. M. G. [28]).

Surprisingly, the presence of arteriopathy was not a determinant of PUs risk. The evidence is lacking, but indeed, arteriopathy seems to slow down the healing process [29] by altering perfusion, which has been identified as one of the most important pathophysiological risk factors for PUs [30]. We could explain our results by the fact that we did not measure the severity of arteriopathy; therefore, it is possible that the patients were in the initial stage of peripheral alteration, so that perfusion was not significantly altered.

Finally, we found that urinary incontinence was highly prevalent in our sample, as well as a determinant of PUs risk. A study dedicated to estimating the risk of developing PUs in incontinent patients found that not only this variable was a PU-related risk factor, but also that incontinence was more strongly associated with severe PUs (e.g., stage IV ulcers) than those without this problem [31].

Overall, the advantage of this study is that by our predictive model, we found variables that are easy and rapid to assess during admission, which also permits assessment of risk across a variety of hospital settings. We intentionally excluded other complicated scores and measurements from our models, such as nutritional or functional status, laboratory data or self-reported symptoms, which cannot be readily assessed at admission, and their inclusion would by far complicate and slow down the process of risk assessment by nurses.

4.1. Strengths and limitations

This study has several strengths. First, we collected data on patients admitted to almost all general wards of a large university hospital. As this screening is routinely performed as part of risk management protocols, our sample was not subjected to eligibility bias. This gives more strength to the generalization of the results to the other wards of Italian hospitals. The second strength was the large sample size, which allowed us to have more power to detect statistically significant associations. Third, our prediction model was built using a theoretically driven approach, which, as opposed to other traditional selection procedures (e.g., stepwise regression), ensures greater stability of the regression coefficients across other samples. Finally, we demonstrated the adequate concurrent validity of the Braden scale in our sample, thus providing more credit to the findings of our determinants.

The limitations of this study include its cross-sectional design, which may have overestimated the diagnostic accuracy of the Braden scale in predicting PU. However, we tried to counterbalance this bias by offering nurses specific training on the use of the Braden scale; they were also made aware of the importance of not changing the total score to match a subjective perception of the risk. Another limitation is that there are

Table 3

Univariate and multivariate mixed linear regressions for determinants of Braden score risk ($n = 708$).

Variable	Category (description)	Univariate			Multivariate		
		B	95% CI	p	B	95% CI	p
Age	(≥ 65 vs < 65 years)	-1.72	-2.26 -1.19	<0.001	-0.87	-1.33 -0.41	<0.001
Gender	Male vs female	-0.19	-0.72 0.35	0.498	0.07	-0.37 0.50	0.761
Obesity	Yes vs no	-1.49	-2.61 -0.36	0.009	-0.77	-1.68 0.14	0.098
Comorbidities	Yes vs no	-1.81	-2.46 -1.16	<0.001	-1.16	-1.69 -0.62	<0.001
Other wounds	Yes vs no	-1.30	-2.24 -0.35	0.007	-1.19	-1.95 -0.44	0.001
Arteriopathy	Yes vs no	-1.03	-2.07 0.01	0.053	-0.46	-1.32 0.40	0.293
Urinary incontinence	Yes vs no	-4.50	-5.19 -3.80	<0.001	-2.50	-3.21 -1.80	<0.001
Fecal incontinence	Yes vs no	-4.70	-5.66 -3.74	<0.001	-2.24	-3.15 -1.33	<0.001
Urinary catheter	Yes vs no	-3.79	-4.31 -3.27	<0.001	-2.51	-3.02 -1.99	<0.001

Legend. CI, confidence interval; B, non-standardized coefficient; p, p-value.

Note. R^2 at level 1 = 0.41. R^2 at level 2 = 0.47.

other variables not accounted for in the analysis which are known to impact on PU development, such as laboratory tests and illness-related factors. For example, Coyer et al. [32] found that ICU patients were almost 4 times likely to develop PU compared to non-ICU patients, reflecting the severity of the illness as a possible additional factor involved in injury development.

Finally, we did not collect data on patients referred to emergency departments, where the prevalence is still high and it is known that even rapid admissions to these services can lead to PU development 2023 (P. M. G. [33]). Future studies are recommended to estimate prevalence and incidence of PU also in hospital emergency departments.

4.2. Implications for clinical practice and research

Because PUs can develop quickly, it is critical to assess the entity of risk and identify vulnerable patients as soon as possible, especially during hospital admission. Not surprisingly, several authors advise performing this step as soon as possible, preferably within 1 h of admission, to prevent the onset of PUs. The variables discovered in this study can be used to promote such a rapid clinical judgment; for example, knowing that the presence of other lesions poses an additional risk to PU, a thorough skin examination immediately after admission and systematically throughout the stay is highly recommended. In addition, regular audits and feedback should be scheduled to improve the quality and safety of care by addressing the identified risk factors. From a research perspective, future studies are needed to understand whether addressing these risk factors would actually reduce the incidence of PUs.

5. Conclusion

The results of our study indicate a high prevalence of patients with PUs in line with international literature. We found several determinants of the risk of developing PUs factors among demographic and clinical indicators. Given that such indicators can be easily and rapidly ascertained by healthcare providers, they can routinely complement the assessment of PUs risk with the Braden scale.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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