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Predictive Performance of the Braden Scale and Additional Clinical Risk Factors for Pressure Ulcer Development in Intensive Care Patients: An Observational Study

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Braden Scale; pressure ulcer; intensive care unit; risk assessment; predictive performance; critically ill patients.

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Abstract

Background: Pressure ulcers remain an important concern among critically ill patients. The Braden Scale is widely used for risk assessment; however, its predictive performance may vary across clinical settings. This study evaluated the performance of the Braden Scale and explored additional factors associated with pressure ulcer development among ICU patients.
Methods: This hospital-based observational study included 50 critically ill patients recruited consecutively. Braden Scale assessments were performed within 24 hours of ICU admission, and patients were monitored for pressure ulcer development. Clinical, ICU-related, and preventive care factors were assessed. ROC analysis evaluated discriminative performance, while univariable Firth penalised logistic regression identified factors associated with pressure ulcer development.
Results: Ten patients (20%) developed pressure ulcers. Their median Braden score was significantly lower than that of patients without pressure ulcers (10 vs. 17; $p<0.001$). All pressure ulcer cases occurred among patients classified as high or very high risk. The Braden Scale demonstrated an AUC of 1.000, with an optimal cut-off of 12.5 and apparent sensitivity and specificity of 100%. Each one-point increase in Braden score was associated with 74% lower odds of pressure ulcer development (OR=0.26; 95% CI: 0.06–0.49; $p<0.001$).
Conclusion: The Braden Scale demonstrated strong apparent predictive performance among ICU patients. Larger multicentre studies are required to validate these findings.

Introduction

Pressure ulcers continue to be a major patient safety issue for critically ill patients. Those in intensive care units (ICUs) are especially at risk due to factors such as prolonged immobility, reduced blood flow, altered sensation, poor nutrition, moisture, friction, and exposure to treatments such as mechanical ventilation, sedation, and vasopressor therapy [1–4]. Pressure ulcers can lead to more health problems, longer hospital stays, higher healthcare costs, and greater strain on healthcare systems. This makes early risk detection and prevention crucial in critical care [5,6].

The Braden Scale is a common tool for assessing the risk of pressure ulcers. It looks at six areas: sensory perception, moisture, activity, mobility, nutrition, and friction and shear. Lower scores mean a higher risk [7]. While the scale is simple and easy to use, its predictive power can

vary across patient groups and healthcare settings [8–10]. This is especially important for critically ill patients, whose risk may also be affected by other health problems, unstable blood flow, long ICU stays, mechanical ventilation, sedation, and other factors not included in the scale [8,11,12].

Previous studies have demonstrated an association between lower Braden scores and the development of pressure ulcers among critically ill patients [8,13]. However, systematic reviews and meta-analyses have reported considerable heterogeneity in its predictive performance, suggesting that the Braden Scale may not perform uniformly across different clinical populations [14,15]. Recent evidence has therefore emphasised the potential value of considering additional demographic and clinical characteristics alongside conventional Braden assessment to improve risk stratification [16]. Preventive practices, including regular repositioning and pressure-relieving support surfaces, may further influence the relationship between assessed risk and actual pressure ulcer occurrence [17–19].

Although the Braden Scale is widely used, there is limited evidence on how well it predicts risk when combined with clinical, ICU-related, and preventive care factors in Indian critical care settings [20,21]. Examining differences between Braden-assessed risk and actual pressure ulcer outcomes may help identify patients whose outcomes do not match their predicted risk and reveal where the usual risk classification falls short.

Therefore, the primary objective of this study was to evaluate the performance of the Braden Scale in identifying pressure ulcer risk among critically ill patients and to explore clinical, ICU-related, and preventive care factors associated with discordance between Braden-assessed risk and actual pressure ulcer development. The secondary objectives were to compare total and domain-specific Braden scores between patients with and without pressure ulcers; assess associations between clinical characteristics, ICU-related exposures, and pressure ulcer development; examine the relationship between preventive care practices and pressure ulcer occurrence; and explore factors associated with discordance between Braden risk classification and observed outcomes.

Materials and Methods

Study design and setting

A hospital-based observational study was conducted among patients admitted to the intensive care units (ICUs) of Sree Balaji Medical College and Hospital, Chennai, India, from November 2024 to January 2026. The study aimed to evaluate the predictive performance of the Braden Scale for pressure ulcer development and explore clinical, ICU-related, and preventive care factors associated with pressure ulcer occurrence.

Study population and sampling

Patients admitted to the ICU for more than 48 hours were recruited using consecutive sampling. Patients who underwent Braden Scale assessment within 24 hours of ICU admission and provided written informed consent, either directly or through a legally authorised representative, were included. Patients with pressure ulcers at ICU admission, an ICU stay of less than 48 hours, skin conditions interfering with pressure ulcer assessment, or unwillingness to participate were excluded.

Sample size calculation

The sample size was estimated using the single population proportion formula:

$$n = \frac{Z^2 P(1-P)}{d^2}$$

where *n* represents the required sample size, *Z* is the standard normal variate corresponding to a 95% confidence level (1.96), *P* is the anticipated prevalence of pressure ulcers among ICU patients, and *d* is the absolute precision. Based on an anticipated pressure ulcer prevalence of 15% from previous ICU-based studies [16,17] and an absolute precision of 10%:

$$n = \frac{(1.96)^2 \times 0.15 \times (1-0.15)}{(0.10)^2}$$
$$n = \frac{3.8416 \times 0.15 \times 0.85}{0.01}$$
$$n = 48.98$$

this calculation is mathematically consistent: using P = 15% and d = 10% gives n = 48.98 ≈ 49, rounded to 50. This is much stronger than merely stating that previous prevalence was 10–20% and that 50 participants were selected.

Data collection and Braden Scale assessment

Data were collected using structured clinical assessment forms. Variables included age, gender, diabetes mellitus, hypertension, hypoalbuminaemia, anaemia, coronary artery disease, chronic kidney disease, neurological illness, duration of ICU stay, vasopressor use, duration of mechanical ventilation, and sedation. Preventive care variables included repositioning interval and use of pressure-relieving mattresses.

Pressure ulcer risk was assessed using the Braden Scale, comprising six domains: sensory perception, moisture, activity, mobility, nutrition, and friction and shear [1,2]. Total scores range from 6 to 23, with lower scores indicating greater risk. The initial assessment was performed within 24 hours of ICU admission, followed by reassessment at 48-hour intervals or earlier when clinically indicated. Assessments were performed by trained nursing personnel under clinical supervision.

Participants underwent daily skin assessment throughout their ICU stay for the development of new pressure ulcers. Patients with pressure ulcers at admission were excluded to ensure that only incident pressure ulcers were evaluated. Clinical information was cross-verified using patient records and nursing documentation.

Statistical analysis

Data were entered in Microsoft Excel and analysed using IBM SPSS Statistics version 25.0. Continuous and categorical variables were summarised as median (IQR) and frequency (percentage), respectively, and compared using the Wilcoxon rank-sum and Fisher's exact tests. ROC analysis assessed the discriminative performance of the Braden score, with the optimal cut-off determined using Youden's index and corresponding diagnostic performance measures calculated. Univariable Firth penalised logistic regression was used to identify factors associated with pressure ulcer development, with results reported as odds ratios (ORs) and 95% confidence intervals (CIs). A p-value <0.05 was considered statistically significant.

Ethical considerations

The Institutional Ethics Committee of Sree Balaji Medical College and Hospital approved the study. Written informed consent was obtained from participants or their legally authorised representatives. Participant confidentiality was maintained using anonymised study identification codes, and the study was conducted in accordance with the principles of the Declaration of Helsinki.

Results

A total of 50 ICU patients were included, with a median age of 52 years (IQR: 41–68); 60.0% were male. The median ICU stay was 6.5 days (IQR: 3.0–10.0), and 10 patients (20.0%) developed pressure ulcers (Table 1). No statistically significant differences were observed between patients with and without pressure ulcers in demographic characteristics, comorbidities, ICU-related factors, or preventive care measures (all p>0.05) (Table 2).

Table 1. Characteristics of the study participants (N = 50)

Participant characteristics	**Overall (N = 50)**[1]
Age (years)	52.0 (41.0–68.0)
Gender	
Female	20 (40.0%)
Male	30 (60.0%)
Diabetes mellitus	18 (36.0%)
Hypertension	20 (40.0%)
Hypoalbuminaemia	24 (48.0%)
Anaemia	22 (44.0%)
Coronary artery disease	7 (14.0%)
Chronic kidney disease	5 (10.0%)
Neurological illness	4 (8.0%)
Duration of ICU stay (days)	6.5 (3.0–10.0)

Table 1. Characteristics of the study participants (N = 50)	
Participant characteristics	**Overall (N = 50)**[1]
Vasopressor use	15 (30.0%)
Mechanical ventilation (days)	1.5 (0.0–6.0)
Sedation	35 (70.0%)
Repositioning interval	
<=2hr	40 (80.0%)
>2hr	10 (20.0%)
Pressure-relieving mattress	45 (90.0%)
Pressure ulcer developed	10 (20.0%)
Braden risk category	
Very High Risk	2 (4.0%)
High Risk	8 (16.0%)
Moderate Risk	1 (2.0%)
At Risk	33 (66.0%)
No Risk	6 (12.0%)
[1] Median (Q1–Q3); n (%)	

Table 2. Clinical and ICU characteristics according to pressure ulcer development

Characteristics	Overall N = 50[1]	No Pressure Ulcer N = 40[1]	Pressure Ulcer N = 10[1]	p-value[2]
Age (years)	52.0 (41.0–68.0)	53.0 (42.0–68.5)	49.5 (40.0–66.0)	0.585
Gender				0.171
Female	20 (40.0%)	14 (35.0%)	6 (60.0%)	
Male	30 (60.0%)	26 (65.0%)	4 (40.0%)	
Diabetes mellitus	18 (36.0%)	16 (40.0%)	2 (20.0%)	0.295
Hypertension	20 (40.0%)	18 (45.0%)	2 (20.0%)	0.279
Hypoalbuminaemia	24 (48.0%)	19 (47.5%)	5 (50.0%)	>0.999
Anaemia	22 (44.0%)	18 (45.0%)	4 (40.0%)	>0.999
Coronary artery disease	7 (14.0%)	6 (15.0%)	1 (10.0%)	>0.999
Chronic kidney disease	5 (10.0%)	4 (10.0%)	1 (10.0%)	>0.999
Neurological illness	4 (8.0%)	3 (7.5%)	1 (10.0%)	>0.999
Duration of ICU stay (days)	6.5 (3.0–10.0)	5.0 (3.0–9.5)	8.0 (5.0–14.0)	0.407
Vasopressor use	15 (30.0%)	13 (32.5%)	2 (20.0%)	0.702
Mechanical ventilation (days)	1.5 (0.0–6.0)	2.0 (0.0–6.0)	0.0 (0.0–2.0)	0.159
Sedation	35 (70.0%)	27 (67.5%)	8 (80.0%)	0.702

Table 2. Clinical and ICU characteristics according to pressure ulcer development

Characteristics	Overall N = 50[1]	No Pressure Ulcer N = 40[1]	Pressure Ulcer N = 10[1]	p-value[2]
Repositioning interval				0.663
<=2hr	40 (80.0%)	31 (77.5%)	9 (90.0%)	
>2hr	10 (20.0%)	9 (22.5%)	1 (10.0%)	
Pressure-relieving mattress	45 (90.0%)	35 (87.5%)	10 (100.0%)	0.569

[1] Median (Q1–Q3); n (%)

[2] Wilcoxon rank sum test; Fisher's exact test

Patients who developed pressure ulcers had markedly lower total Braden scores than those who did not [median: 10.0 (IQR: 10.0–11.0) vs. 17.0 (IQR: 16.0–18.0); p<0.001] (Table 3; Figure 1). Significant differences were also observed across sensory perception, moisture, activity, mobility, and friction and shear domains (all p<0.001), while nutrition scores also differed significantly (p=0.011).

Table 3. Braden Scale total and domain scores according to pressure ulcer development

Braden Scale characteristics	Overall N = 50[1]	No Pressure Ulcer N = 40[1]	Pressure Ulcer N = 10[1]	p-value[2]
Total Braden score	17.0 (15.0–18.0)	17.0 (16.0–18.0)	10.0 (10.0–11.0)	**<0.001**
Sensory perception				**<0.001**
1	1 (2.0%)	0 (0.0%)	1 (10.0%)	

Table 3. Braden Scale total and domain scores according to pressure ulcer development

Braden Scale characteristics	**Overall** N = 50[1]	**No Pressure Ulcer** N = 40[1]	**Pressure Ulcer** N = 10[1]	**p-value**[2]
2	14 (28.0%)	5 (12.5%)	9 (90.0%)	
3	30 (60.0%)	30 (75.0%)	0 (0.0%)	
4	5 (10.0%)	5 (12.5%)	0 (0.0%)	
Moisture				**<0.001**
1	4 (8.0%)	0 (0.0%)	4 (40.0%)	
2	8 (16.0%)	3 (7.5%)	5 (50.0%)	
3	28 (56.0%)	27 (67.5%)	1 (10.0%)	
4	10 (20.0%)	10 (25.0%)	0 (0.0%)	
Activity				**<0.001**
1	8 (16.0%)	2 (5.0%)	6 (60.0%)	
2	23 (46.0%)	19 (47.5%)	4 (40.0%)	
3	18 (36.0%)	18 (45.0%)	0 (0.0%)	
4	1 (2.0%)	1 (2.5%)	0 (0.0%)	
Mobility				**<0.001**
1	4 (8.0%)	0 (0.0%)	4 (40.0%)	
2	11 (22.0%)	5 (12.5%)	6 (60.0%)	

Table 3. Braden Scale total and domain scores according to pressure ulcer development

Braden Scale characteristics	Overall N = 50[1]	No Pressure Ulcer N = 40[1]	Pressure Ulcer N = 10[1]	p-value[2]
3	26 (52.0%)	26 (65.0%)	0 (0.0%)	
4	9 (18.0%)	9 (22.5%)	0 (0.0%)	
Nutrition				**0.011**
1	2 (4.0%)	0 (0.0%)	2 (20.0%)	
2	15 (30.0%)	10 (25.0%)	5 (50.0%)	
3	26 (52.0%)	23 (57.5%)	3 (30.0%)	
4	7 (14.0%)	7 (17.5%)	0 (0.0%)	
Friction and shear				**<0.001**
1	5 (10.0%)	0 (0.0%)	5 (50.0%)	
2	31 (62.0%)	26 (65.0%)	5 (50.0%)	
3	14 (28.0%)	14 (35.0%)	0 (0.0%)	
Braden risk category				**<0.001**
Very High Risk	2 (4.0%)	0 (0.0%)	2 (20.0%)	
High Risk	8 (16.0%)	0 (0.0%)	8 (80.0%)	
Moderate Risk	1 (2.0%)	1 (2.5%)	0 (0.0%)	
At Risk	33 (66.0%)	33 (82.5%)	0 (0.0%)	

Table 3. Braden Scale total and domain scores according to pressure ulcer development

Braden Scale characteristics	**Overall** N = 50[1]	**No Pressure Ulcer** N = 40[1]	**Pressure Ulcer** N = 10[1]	**p-value**[2]
No Risk	6 (12.0%)	6 (15.0%)	0 (0.0%)	

[1] Median (Q1–Q3); n (%)

[2] Wilcoxon rank sum test; Fisher's exact test

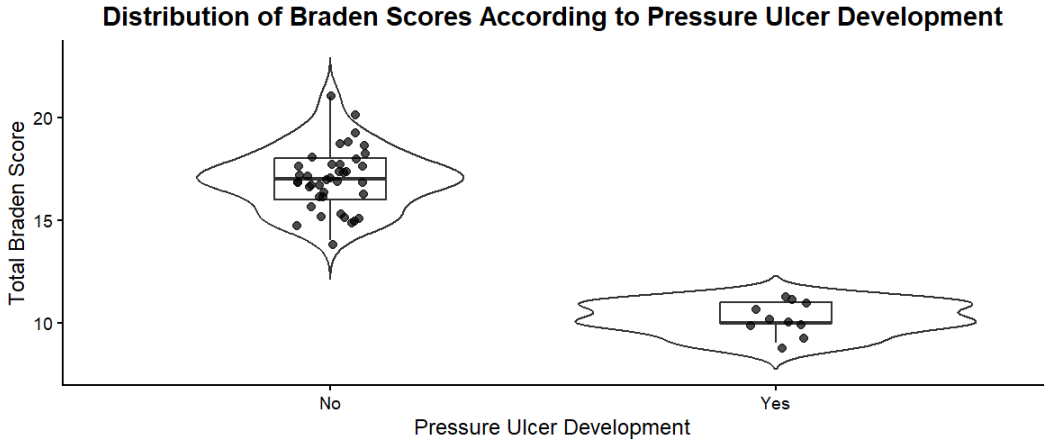

Figure 1. Distribution of total Braden scores according to pressure ulcer development. Violin and box plots with individual observations demonstrate the distribution of total Braden scores among patients with and without pressure ulcer development.

Braden risk classification was significantly associated with pressure ulcer development ($p<0.001$) (Table 4). All 10 patients who developed pressure ulcers were classified as either high risk (80.0%) or very high risk (20.0%). Conversely, none of the patients classified as no risk, at risk, or moderate risk developed pressure ulcers. The distribution of pressure ulcer development across Braden risk categories is illustrated in Figure 2.

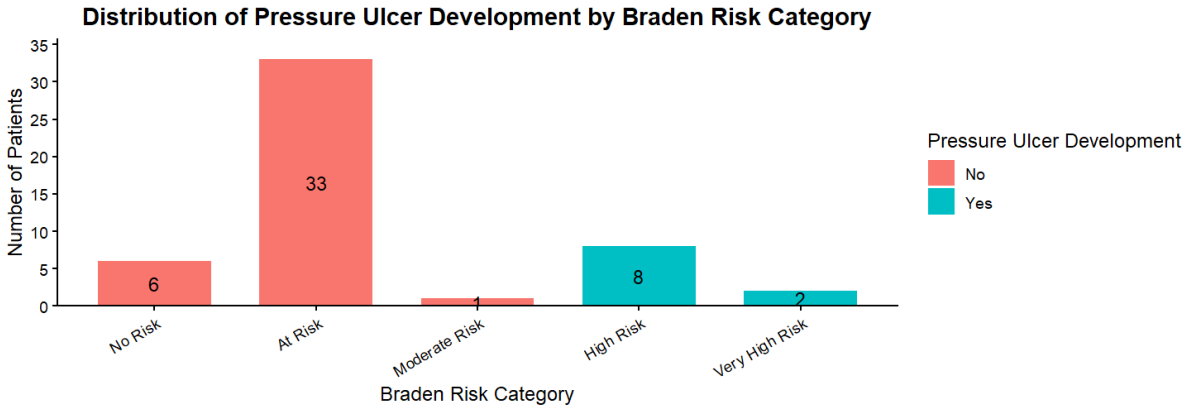

Figure 2. Distribution of pressure ulcer development across Braden risk categories. The figure presents the number of patients with and without pressure ulcer development across the five Braden risk categories

Table 4. Distribution of Braden risk categories according to pressure ulcer development

Braden risk category	**Overall** N = 50[1]	**No Pressure Ulcer** N = 40[1]	**Pressure Ulcer** N = 10[1]	**p-value**[2]
Braden risk category				**<0.001**
Very High Risk	2 (4.0%)	0 (0.0%)	2 (20.0%)	
High Risk	8 (16.0%)	0 (0.0%)	8 (80.0%)	
Moderate Risk	1 (2.0%)	1 (2.5%)	0 (0.0%)	
At Risk	33 (66.0%)	33 (82.5%)	0 (0.0%)	
No Risk	6 (12.0%)	6 (15.0%)	0 (0.0%)	

[1] n (%)

[2] Fisher's exact test

Receiver operating characteristic analysis demonstrated perfect apparent discrimination of the total Braden score within the study sample, with an AUC of 1.000 (Figure 3). The optimal cut-off identified using Youden's index was 12.5, yielding an apparent sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of 100.0% each (Table 5).

Table 5. Predictive performance of the Braden Scale for pressure ulcer development	
Performance measure	Estimate
Area under the ROC curve (AUC)	1.000
Optimal cut-off value	12.5
Sensitivity	100.0%
Specificity	100.0%
Positive predictive value	100.0%
Negative predictive value	100.0%
Accuracy	100.0%
The optimal cut-off was determined using Youden's index. Performance estimates represent apparent in-sample performance.	

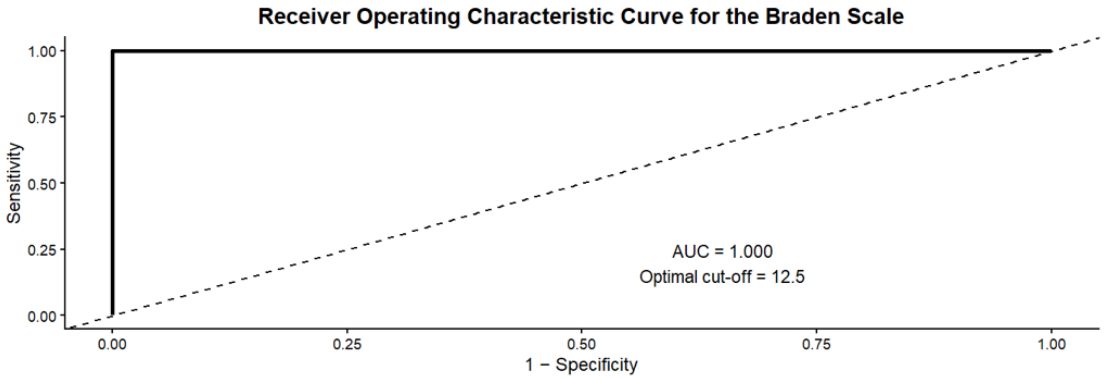

Figure 3. Receiver operating characteristic curve for the Braden Scale in discriminating pressure ulcer development. The total Braden score demonstrated an apparent area under the receiver operating characteristic curve of 1.000. The optimal cut-off value determined using Youden's index was 12.5.

In univariable Firth penalised logistic regression, the total Braden score was the only factor significantly associated with pressure ulcer development. Each one-point increase in Braden score was associated with 74% lower odds of pressure ulcer development (OR=0.26; 95% CI: 0.06–0.49; p<0.001). None of the other demographic, clinical, ICU-related, or preventive care variables showed

statistically significant associations (Table 6; Figure 4). Given the small sample size and limited number of outcome events, the observed predictive performance represents apparent in-sample discrimination and should be interpreted cautiously.

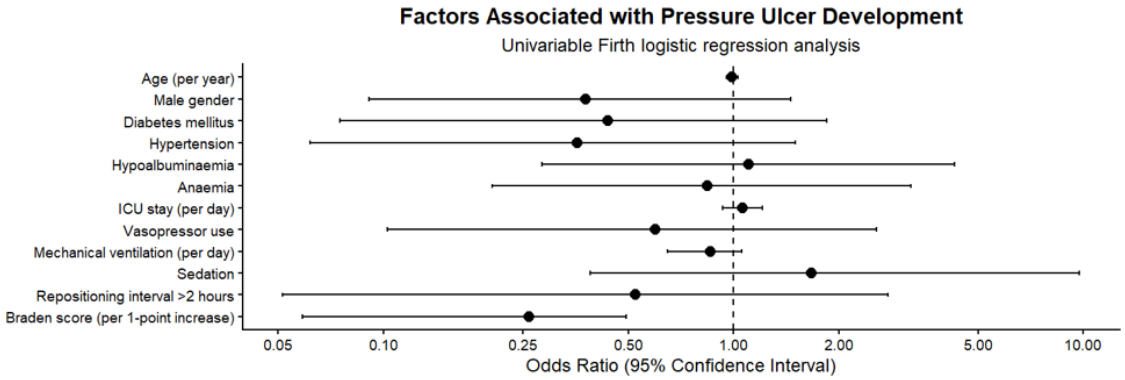

Figure 4. Forest plot of factors associated with pressure ulcer development. Odds ratios and 95% confidence intervals were estimated using univariable Firth penalised logistic regression. The total Braden score was the only variable significantly associated with pressure ulcer development.

Table 6. Univariable Firth logistic regression analysis of factors associated with pressure ulcer development

Variable	Odds ratio (95% CI)	p-value
Age (per year)	0.99 (0.95–1.03)	0.607
Male gender	0.38 (0.09–1.46)	0.158
Diabetes mellitus	0.44 (0.08–1.84)	0.271
Hypertension	0.36 (0.06–1.50)	0.167
Hypoalbuminaemia	1.10 (0.28–4.28)	0.886
Anaemia	0.84 (0.20–3.22)	0.802
Duration of ICU stay (per day)	1.06 (0.93–1.21)	0.363
Vasopressor use	0.60 (0.10–2.57)	0.506
Mechanical ventilation (per day)	0.86 (0.65–1.06)	0.165

Table 6. Univariable Firth logistic regression analysis of factors associated with pressure ulcer development

Variable	Odds ratio (95% CI)	p-value
Sedation	1.67 (0.39–9.77)	0.506
Repositioning interval >2 hours	0.52 (0.05–2.77)	0.475
Total Braden score (per 1-point increase)	0.26 (0.06–0.49)	<0.001

OR, odds ratio; CI, confidence interval. Firth penalised logistic regression was used because of the small number of outcome events and complete separation observed for the Braden score.

Discussion

The present study evaluated the predictive performance of the Braden Scale and explored clinical, ICU-related, and preventive care factors associated with pressure ulcer development among critically ill patients. The principal findings were that patients who developed pressure ulcers had significantly lower total Braden scores and poorer scores across all six Braden domains. Pressure ulcer development occurred exclusively among patients classified as high- or very-high risk. Furthermore, the total Braden score demonstrated perfect apparent discrimination and was the only variable significantly associated with pressure ulcer development in univariable Firth penalised logistic regression.

Patients who developed pressure ulcers had a median Braden score of 10, compared with 17 among those who did not. This finding supports the predictive utility of the Braden Scale in critically ill patients. **Hyun et al.** demonstrated that lower Braden scores were associated with pressure ulcer development among ICU patients and highlighted the importance of evaluating its predictive validity specifically within critical care populations [3]. Similarly, **Iranmanesh et al.** reported a significant relationship between Braden Scale scores and pressure ulcer development among trauma ICU patients [4].

Significant differences were observed across all six Braden domains, including sensory perception, moisture, activity, mobility, nutrition, and friction and shear. The findings suggest that pressure ulcer development in critically ill patients may reflect the combined influence of multiple dimensions of tissue vulnerability rather than any single risk component. **Coleman et al.** identified impaired mobility, poor perfusion, and skin-related factors as important contributors to pressure ulcer development [9]. **Allman et al.** also

demonstrated the importance of activity limitation and other clinical factors in the occurrence of pressure ulcers among hospitalised patients [17].

The present study demonstrated a particularly strong relationship between Braden risk classification and observed outcomes. All patients who developed pressure ulcers were classified as high- or very-high risk, whereas no pressure ulcers occurred among patients in the remaining risk categories. Correspondingly, ROC analysis demonstrated an AUC of 1.000, with an optimal cut-off of 12.5 yielding apparent sensitivity and specificity of 100%. However, these findings should be interpreted cautiously. **Huang et al.**, in a systematic review and meta-analysis, found that although the Braden Scale demonstrated predictive validity for pressure injury risk, its performance varied considerably across populations and clinical settings [8]. Similarly, **Pancorbo-Hidalgo et al.** reported variability in the performance of pressure ulcer risk assessment scales, highlighting the need for context-specific interpretation [13].

The cut-off value of 12.5 found in this study suggests that lower Braden scores may help identify pressure ulcer risk in critically ill patients. However, this threshold was based on a small group and needs more validation before being used in practice. Kottner and Dassen raised concerns about the accuracy of pressure ulcer risk assessment in critical care patients [11]. These results show that larger studies are needed to see if ICU-specific thresholds can improve risk classification.

In the univariable Firth regression analysis, each 1-point increase in the total Braden score was associated with about a 74% lower odds of developing a pressure ulcer. The Braden score was the only factor that reached statistical significance. Cox noted that pressure ulcer development in critically ill patients can be affected by several clinical and treatment factors, not just risk scores [10]. **Giovannoni et al. recently** suggested that adding clinical and demographic details to Braden assessments could help identify at-risk patients [5]. However, this study did not find significant links between pressure ulcer development and demographic factors, comorbidities, or ICU exposures, possibly due to the small sample size and few pressure ulcer cases.

The lack of significant links between individual clinical factors and pressure ulcer development should be viewed with caution. Several variables had wide confidence intervals, showing limited statistical precision. These results do not mean that factors like comorbidities, long ICU stays, vasopressor use, mechanical ventilation, or sedation are unimportant. Instead, the study may not have had enough power to detect smaller or moderate associations.

Preventive care practices, including repositioning intervals and the use of pressure-relieving mattresses, were also not significantly associated with pressure ulcer development. However, these findings should not be interpreted as evidence that such preventive interventions are ineffective. **Vanderwee et al.** evaluated repositioning schedules and demonstrated the complexity of determining the independent effectiveness of turning practices in pressure ulcer prevention [21]. The international clinical practice guideline recommends comprehensive preventive strategies based on individual patient risk,

including repositioning and appropriate support surfaces [19].

An important objective of the present study was to explore discordance between Braden-assessed risk and actual pressure ulcer outcomes. However, the findings demonstrated substantial concordance rather than discordance, as all patients who developed pressure ulcers belonged to the high- or very-high-risk categories. Consequently, the limited number of discordant outcomes prevented meaningful statistical exploration of factors associated with disagreement between predicted risk and observed outcomes. **Cowan et al.** suggested that incorporating additional clinical characteristics may enhance the conventional Braden assessment [12]. Future studies with larger and more heterogeneous populations could specifically examine false-positive and false-negative classifications to determine whether additional variables improve risk prediction.

Overall, the findings support the clinical utility of the Braden Scale for identifying critically ill patients at increased risk of pressure ulcer development. Nevertheless, the perfect apparent discrimination observed in this study should be interpreted within the context of the small sample size and limited number of events. The results provide preliminary evidence supporting a Braden-based risk assessment but require validation in larger, more diverse ICU populations.

Limitations

This study has several limitations. The small sample size and few pressure ulcer cases reduced statistical power, especially when examining other clinical and ICU-related risk factors. Since the study was done at a single centre, the results may not apply everywhere. The cut-off and performance measures were based on the same group of patients, without extra validation, which could make the results seem better than they are. Because the study was observational, it cannot establish cause-and-effect between clinical features, preventive care, and pressure ulcer development. Also, because there was strong agreement between Braden-assessed risk and outcomes, there were few cases in which predictions and outcomes did not match.

Recommendations

The Braden Scale should still be used to assess pressure ulcer risk in critically ill patients, especially in those at high or very high risk. However, it should be used alongside a full clinical evaluation and tailored preventive care. Regular reassessment is important because patients' conditions and risk levels can change quickly during their ICU stay.

Future studies should be conducted across multiple centres with larger patient groups to confirm the predictive performance and the best cut-off value identified here. Researchers should also look at whether adding clinical, ICU, nutritional, and preventive care factors can improve prediction beyond the Braden Scale alone. Special focus should be given to patients whose predicted risk and actual outcomes do not match to identify the causes of false positives and false negatives.

Conclusion

The Braden Scale showed strong predictive ability for pressure ulcer development in critically ill patients. Those who developed

pressure ulcers had much lower total and domain-specific Braden scores, and all cases were in the high or very high risk groups. Each one-point increase in the total Braden score was linked to much lower odds of developing a pressure ulcer.

Although the Braden Scale showed perfect discrimination in this sample, these results should be viewed with caution due to the small sample size, few pressure ulcer cases, and lack of external validation. Larger studies across multiple centres are needed to confirm these findings and determine whether adding additional clinical factors to the Braden Scale can improve pressure ulcer risk assessment and prevention in critically ill patients.

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Author Contributions

All authors contributed to the conception and design of the study. Data collection, clinical assessment, and supervision were undertaken by the study investigators. All authors contributed to the analysis and interpretation of the findings, critically reviewed the manuscript for important intellectual content, and approved the final version for publication.

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Conflict of Interest

The authors declare that they have no conflicts of interest related to this study.

Ethical Approval

The study protocol was reviewed and approved by the Institutional Ethics Committee of Sree Balaji Medical College and Hospital, Chennai, India. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Ethics approval number:

Informed Consent

Written informed consent was obtained from all participants or their legally authorised representatives before enrolment in the study.

Consent for Publication

Not applicable. The manuscript does not contain identifiable personal information, images, or individual participant data requiring specific consent for publication.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to institutional and ethical requirements.

Authors' Declaration

The authors declare that the manuscript represents original work, has not been published previously, and is not under consideration for publication elsewhere. All authors have read and approved the final

manuscript and agree to be accountable for the integrity and accuracy of the work.

Use of Artificial Intelligence Statement

Generative artificial intelligence tools were used solely to assist with language refinement and manuscript editing. The authors critically reviewed and verified the manuscript content and take full responsibility for the accuracy, integrity, and final presentation of the work.

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