

Original Article

Comparing the Accuracy of the Braden and the Waterlow Scales for Pressure Ulcer Risk Assessment in Intensive Care Unit

Sina Valiee, Syede Mona Nemati¹, Midia Hossaini¹, Hajar Kashefi², Hiwa Mohammadi³

Clinical Care Research Center, Research Institute for Health Development, Kurdistan University of Medical Sciences, ¹Student Research Committee, Kurdistan University of Medical Sciences, Sanandaj, ²Research Center for Environmental Determinants of Health, Health Institute, Kermanshah University of Medical Sciences, Kermanshah, ³Department of Nursing, Boroujerd School of Nursing, Lorestan University of Medical Sciences, Khorramabad, Iran

ORCID:

Sina Valiee:
0000-0002-5419-1004

Syede Mona Nemati:
0000-0002-8281-5179

Midia Hossaini:
0000-0002-7726-7315

Hajar Kashefi:
0000-0001-9603-0789

Hiwa Mohammadi:
0000-0003-2421-3396

ABSTRACT

Background: Pressure ulcer (PU) is a common problem in intensive care unit (ICU). Risk assessment is the first step to PU prevention. Nonetheless, there is no consensus over the best PU risk assessment scale. **Objectives:** The objective of the present study was to compare the accuracy of the Braden and the Waterlow scales in predicting the risk of PU in ICU. **Methods:** This cross-sectional study was conducted in 2019 on 186 patients hospitalized in ICUs of Tohid and Kowsar teaching hospitals, Sanandaj, Iran. The Braden and the Waterlow scales were simultaneously used by two trained nurses for daily PU risk assessment for 15 consecutive days. The predictive validity of the scales was assessed in terms of sensitivity, specificity, and positive and negative predictive values. **Results:** The mean of participants' age was 55.6 ± 20.3 years. In total, 102 participants (54.8%) developed PU during the study. The sensitivity and the specificity of the Braden scale at the cutoff score of 18 were 97% and 34.5% and the sensitivity and the specificity of the Waterlow scale at the cutoff score of 10 were 95% and 28.5%, respectively. **Conclusion:** Compared with the Waterlow scale, the Braden scale has a slightly better predictive validity for PU risk assessment.

KEYWORDS: Braden, Pressure ulcer, Scale, Waterlow

INTRODUCTION

Pressure ulcer (PU) is an ulcer over a bony prominence due to pressure or a mixture of pressure, shearing, and friction.^[1] It annually affects 2.5 million hospitalizations in the United States^[2] and its prevalence in patients in intensive care unit (ICU) is 0.4%–38%.^[3] PU management requires a significant amount of time and imposes high costs on

Address for correspondence: Mr. Hiwa Mohammadi, Department of Nursing, Boroujerd School of Nursing, Lorestan University of Medical Sciences, Khorramabad, Iran.
E-mail: hiva.nursing@gmail.com

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health-care systems and patients.^[3] PU also is associated with intense pain, prolongs the length of hospital stay, and increases the risk of nosocomial infection by 25%.^[4] The cost of treating PU is estimated to be 125–451 dollars for Stages I and II PUs and 1400–2300 dollars for Stages III and IV PUs. Accordingly, the annual cost of PU management in the United States is 1300–3100 million dollars.^[5] Ineffective PU prevention also reduces patient satisfaction and results in indemnity payments in more than 87% of cases.^[6] Moreover, PU and its associated complications increase patient mortality.^[7] High-quality nursing care is a key to effective PU prevention. Preventive measures for PU include PU risk assessment, skin hygiene and care, and use of pressure-reducing modalities such as pads and air mattresses, dietary modifications, and patient and family education.^[8] Careful risk assessment is the most basic step to PU prevention.^[9] Valid and reliable scales are needed for PU risk assessment.^[10] Such scales provide information about the possibility of PU by measuring the contributing factors of PU such as general health conditions, skin conditions, mobility, activity, moisture, incontinence, and nutrition.^[11]

There are more than 40 scales for PU risk assessment. However, there is still no consensus on the best scales.^[1] The two most commonly used scales in this area are the Braden and the Waterlow scales. The Braden scale is mostly used in North America, while the Waterlow scale is widely used in England.^[12] Both these scales are used in ICUs in Iran for PU risk assessment. Nonetheless, previous studies into the accuracy of these two scales reported inconsistent and even contradictory results.^[12–16] For example, a study reported that compared with the Braden scale, the Waterlow scale provided more reliable information about PU risk among patients in ICU,^[13] while some studies showed the higher sensitivity and specificity of the Braden scale.^[14,15] A study also found no significant difference between these scales respecting their ability to predict PU.^[10] Moreover, a study on these two scales reported that it was impossible to decide which scale had better predictive validity and recommended further studies in this area.^[16] Therefore, the present study was conducted to provide more evidence concerning the accuracy of the Braden and the Waterlow scales.

Objectives

The objective of the present study was to compare the accuracy of the Braden and the Waterlow scales in predicting the risk of PU in ICU.

METHODS

Study design and participants

This cross-sectional study was conducted from April to August 2019. Participants were 186 patients

hospitalized in ICUs of Tohid and Kowsar teaching hospitals, Sanandaj, Iran. They were conveniently recruited to the study based on the following criteria: age over 18 years, no PU at the time of recruitment to the study, and agreement for participation. Early discharge from ICU in <15 days and reluctance to stay in the study were the exclusion criteria. The sample size was calculated with a confidence level of 0.95 and using the results of a study that reported PU prevalence of 0.14.^[15] The sample size calculation formula [Figure 1] showed that 185 participants were needed.

Data collection instruments

A demographic and clinical characteristics questionnaire, the Glasgow Coma Scale (GCS), the Full Outline of Responsiveness (FOUR), the Braden scale, and the Waterlow scale were used for data collection. The demographic and clinical characteristics questionnaire had items on age, gender, length of hospital stay, and diagnosis. GCS comprises three main criteria, namely eye-opening, verbal response, and motor response and its possible total score is 3–15. FOUR is a consciousness assessment scale with four main criteria, namely eye response, motor response, brainstem reflexes, and respiration. Each criterion is scored from zero (“Worst possible condition”) to 4 (“Best possible condition”) and the possible total score is 0–16.^[13]

The Braden scale covers six criteria, namely sensory perception, moisture, activity, mobility, nutrition, and friction and shear. Criteria are scored 1–4, except for the last criterion that is scored 1–3. The lowest score in each criterion stands for “Worst possible condition” and the highest score stands for “Best possible condition.” Therefore, the possible total score of the scale is 6–23 [Table 1] with lower scores showing a higher risk of PU. The cutoff score of the scale is 18 and scores <18 show the risk of PU.^[17]

The Waterlow scale has 11 items on the risk of PU, namely height/weight, continence, skin appearance, mobility, age/gender, appetite, tissue malnutrition, neurological deficit, surgery, trauma, and medication. Each item is scored from zero or 1–8 and hence, the total possible score on the scale is 2–100 [Table 2], with higher scores standing for a greater risk of PU. Scores more than 10 show that the patient is at risk for PU.^[18] Previous studies reported the acceptable validity and reliability of the Braden and the Waterlow scales.^[10,14,16]

$$n = \frac{(Z_{1-\alpha/2})^2 pq}{d^2}$$

Figure 1: Sample size calculation formula

Table 1: The Braden scale for pressure ulcer risk assessment

Parameters	Scores			
	1	2	3	4
Sensory perception	Completely limited	Very limited	Slightly limited	No impairment
Moisture	Constantly moist	Very moist	Occasionally moist	Rarely moist
Activity	Bedfast	Chairfast	Walks occasionally	Walks frequently
Mobility	Completely immobile	Very limited	Slightly limited	No limitation
Nutrition	Very poor	Probably inadequate	Adequate	Excellent
Friction and shear	Problem	Potential problem	No apparent problem	-

Table 2: The Waterlow scale for pressure ulcer risk assessment

Parameters	Score	Parameters	Score	Parameters	Score
Gender		Continence		Special risks (tissue malnutrition)	
Male	1	Complete/catheterized	0	Smoking	1
Female	2	Urine incontinence	1	Anemia (hemoglobin <8)	2
Age		Fecal incontinence	2	Single organ failure (e.g., cardiac, renal, respiratory)	5
14-49	1	Urinary and fecal incontinence	3	Peripheral vascular disease	5
50-64	2	Skin type		Multiple organ failure/terminal cachexia	8
65-74	3	Healthy	0	Special risks (neurological deficit)	
75-80	4	Tissue paper/dry	1	Diabetes/MS/CVA	4-6
>81	5	Edematous	1	Motor/sensory	4-6
Body mass index		Clammy/pyrexia	1	Paraplegia	4-6
20-24.9	0	Discolored	2	Special risks (surgery/trauma)	
25-29.9	1	Broken (established ulcer)	3	Orthopaedic/spinal	5
≥30	2	Nutrition		On table >2 h (up to 48 h postoperative)	5
<20	3	Normal	0	On table >6 h	8
Mobility		Scarce/feeding tube	1		
Fully mobile	0	Liquid intravenous	2		
Restless/fidgety	1	Anorexia/absolute diet	3		
Apathetic	2	Special risks (medication)			
Restricted	3	Cytotoxic	4		
Bedbound	4	Anti-inflammatory	4		
Chairbound	5	High-dose steroid	4		

MS: Multiple Sclerosis, CVA: Cerebrovascular Accident

Two nurses, who had been trained by the first author, daily assessed participants in the evening shift for PU risk using both Braden and Waterlow scales. Moreover, they used the National PU Advisory Panel to daily assess participants for PU, if any, and its stage.^[19] The interrater Cohen’s kappa agreement was 0.78. All participants received routine PU prevention care services, including regular position change and pressure reduction over bony prominences using soft pads and air mattresses.

Ethical considerations

The Ethics Committee of Kurdistan University of Medical Sciences, Sanandaj, Iran, approved this study (code: IR.MUK.REC.1396.257). The introduction letter and permissions for the study were received from Kurdistan University of Medical Sciences, Sanandaj, Iran, and provided to the authorities of the study setting. Participants or their families were informed about data confidentiality, voluntary participation in the study, freedom to withdraw from the study, and their access to the summary of the

findings upon personal request. Informed consent was obtained from all participants or their family members.

Data analysis

The SPSS software v. 16.0. (SPSS Inc, Chicago, IL) was used for data analysis. Data were described using the measures of descriptive statistics, namely absolute and relative frequencies for categorical variables and mean and standard deviation for numerical variables. The predictive validity of the Braden and the Waterlow scales was evaluated through evaluating their sensitivity, specificity, and positive and negative predictive values. Sensitivity is the ability of an instrument to give positive results when the actual risk exists, while specificity is the ability to give negative results when the actual risk does not exist.^[16] The positive predictive value of a PU assessment test is the proportion of patients classified as being at risk for PU who actually develop PU and the negative predictive value is the proportion of patients classified as having no risk who actually do not develop PU [Table 3].

RESULTS

Participants were 125 male (67.2%) and 61 female (32.8%) patients in ICU (i.e., 186 in total). The mean of their age was 55.6 ± 20.3 years and most of them were married (85%). The reason for ICU admission was medical problems in 45.2% of cases, surgery in 26.3% of cases, and trauma in 28.5% of cases. The mean scores of GCS and FOUR were 8.12 and 8.66, respectively. In total, 102 participants (54.8%) developed PU during the study, mostly in the sacral area (61.7%). The prevalence rates of Stages I, II, and III PUs were 47%, 42.8%, and 10.8%, respectively [Table 4]. The mean score of the Braden scale was 11.01 [Table 5] and its sensitivity, specificity, and positive and negative predictive values at the cutoff score of 18 were 97%, 34.5%, 64.2%, and 90%, respectively [Table 6]. The mean score of the Waterlow scale was 18.33 [Table 5] and its sensitivity, specificity, and positive and negative predictive values at the cutoff score of 10 were 95%, 28.5%, 61.7%, and 82.7%, respectively [Table 6].

DISCUSSION

The prevalence of PU in the present study was 54.8%. This is in line with the findings of previous studies which reported that PU prevalence was 45% in Iran, 52% in Brazil, 49% in Germany, 38% in the Netherlands, and 39% in Saudi Arabia.^[20-23] These findings denote the high prevalence of PU in ICU and highlight the necessity of special attention to PU prevention in ICU through different strategies such as improving nurses' knowledge and attitudes about PU prevention. Contrary to our findings, some studies reported that PU prevalence was 4% in Denmark, 14% in Germany, 18% in the Netherlands, and 8% in Iran. The main reason for such a low prevalence rate in these studies is that they did not assess Stage I PU.^[24-26] Our findings also revealed the sacral area as the most common site of PU. Similarly, two systematic reviews reported that sacral PU was the most common PU with a prevalence of 48% and 54%.^[26,27] Therefore, nurses in ICU need to pay special attention to sacral PU prevention.

The findings of the present study also indicated that at the cutoff score of 18, the sensitivity, specificity, positive and negative predictive values, and accuracy of the Braden scale were 97%, 34.5%, 64.2%, 90%, and 69%, respectively. A study on 7790 patients in ICU found that the sensitivity and the negative predictive value of the Braden scale at a cutoff score of 17 were respectively 97% and 98%^[28] which is consistent with our findings. Contrarily, a study reported that the sensitivity and specificity of the Braden scale at a cutoff score of 15 were 50% and 70%, respectively.^[16] This contradiction

Table 3: Definitions of the measures of predictive validity

Measures	Definition
Sensitivity	$\frac{\text{True positive}}{\text{True positive} + \text{False negative}}$
Specificity	$\frac{\text{True negative}}{\text{True negative} + \text{False positive}}$
Positive predictive value	$\frac{\text{True positive}}{\text{True positive} + \text{False positive}}$
Negative predictive value	$\frac{\text{True negative}}{\text{True negative} + \text{False negative}}$

Table 4: The frequency distribution of the different sites and stages of pressure ulcer

Site	Stage			Total (%)
	1	2	3	
Sacrum	30	27	6	63 (61.7)
Heel	11	6	4	21 (20.5)
Shoulder	5	7	1	13 (12.7)
Mouth and nose	1	3	0	4 (4)
Head	0	1	0	1 (1)
Total (%)	47 (46)	44 (43.7)	11 (10.3)	102 (100)

Table 5: The mean scores of the Braden and the Waterlow scales in the 15 days of the study

Day	Mean±SD	
	Braden scale	Waterlow scale
1	10.1±2.7	18.9±5.1
2	10±2.7	18.9±5
3	10.2±2.6	18.7±5
4	10.4±2.5	18.7±4.9
5	10.6±2.5	18.5±4.9
6	10.6±2.6	18.2±4.9
7	10.8±2.8	18.3±4.9
8	10.9±2.9	18.3±5.2
9	11.1±3.1	18.2±5.2
10	11.3±3.5	18.1±5.3
11	11.6±3.7	18±5.4
12	11.7±3.8	18±5.5
13	11.7±3.8	17.9±5.7
14	11.8±4.2	17.8±5.8
15	11.7±4.3	17.7±6
Total	11.1±3.2	18.33±5.2

SD: Standard deviation

is attributable to the difference among studies with respect to their cutoff scores for the Braden scale. It is noteworthy that previous studies used different cutoff scores such as 12, 14, 15, 16, and 18, to evaluate the predictive validity of the Braden scale.^[11,16,24,28,29]

The sensitivity, specificity, positive and negative predictive values, and accuracy of the Waterlow scale at

Table 6: The predictive validity indices of the Braden and the Waterlow scales

Scales	Indices				
	Cutoff score	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Braden	18	97	34.5	64.2	90
Waterlow	10	95	28.5	61.7	82.7

a cutoff score of 10 were 95%, 28.5%, 61.7%, 92%, and 65%, respectively. This is in agreement with the findings of a study which found that sensitivity, specificity, and negative predictive value of the scale at a cutoff score of 13 were 85%, 30%, and 92%, respectively.^[16] Another study reported that at a cutoff score of 15, the sensitivity and specificity of the Waterlow scale were 67% and 79%, respectively.^[30] Previous studies into the predictive validity of the Waterlow scale in ICU settings used different cutoff scores such as 8, 10, 12, 13, and 15.^[11,16,17,24,30]

Based on the findings of the present study, the Braden scale had a slightly better predictive validity compared with the Waterlow scale which is consistent with the findings of several previous studies.^[16,24,31] In the present study, both Braden and Waterlow scales had high sensitivity and low positive predictive value, denoting the high rate of false-positive cases. On the other hand, the specificity of these scales was respectively 34.5% and 28.5%, denoting that none of these scales had high diagnostic power to detect negative cases of PU. Several studies concluded that both Braden and Waterlow scales are appropriate for PU risk assessment and noted that the Braden scale is mostly used for PU risk assessment at the time of ICU admission, while the Waterlow scale is used for PU risk assessment during ICU stay.^[11,32] A study reported that the Waterlow scale had higher predictive validity than the Braden scale.^[13] Due to the inconsistent and even contradictory results of previous studies on the predictive validity of the Braden and the Waterlow scales, there are ambiguities and uncertainties over their applicability in clinical settings, particularly about their best cutoff scores.^[33] Therefore, more studies are needed to determine the best cutoff scores of these scales. An appropriate cutoff score is a basis for producing reliable clinical data and making sound decisions for PU prevention.^[34] One of the limitations of the present study was the use of different PU prevention interventions in the study setting, including soft pads, air mattresses, position changes, and lotions. Of course, all participants almost similarly received these interventions and hence, the use of these interventions might have had little, if any, effect on the results.

CONCLUSION

This study concludes that most patients in ICU are at risk for PU. Moreover, the Braden scale has a slightly

better predictive validity than the Waterlow scale and both of them have high sensitivity and low specificity. There are still concerns about the superiority of either of these scales because previous studies used different cutoff scores for these scales. Further studies are needed to determine the best cutoff scores of these scales for the accurate prediction of PU risk in ICU settings.

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Conflicts of interest

There are no conflicts of interest.

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