Received: 7 November 2023 | Accepted: 8 December 2023

DOI: 10.1111/iwj.14602

ORIGINAL ARTICLE

IWJ WILEY

Comparing the Waterlow and Jackson/Cubbin pressure injury risk scales in intensive care units: A multi-centre study

Qiuxia Yang[1,2] | Zhuang Yang[3] | Lin Lv[4] | Hongyan Zhang[2] | Hongxia Tao[1] | Juhong Pei[1] | Yuxia Ma[3] | Lin Han[1,2,3]

[1]The First Clinical Medical College, Lanzhou University, Lanzhou, China

[2]Department of Nursing, Gansu Provincial Hospital, Lanzhou, China

[3]School of Nursing, Lanzhou University, Lanzhou, China

[4]Wound and Ostomy Care Center, Gansu Provincial Hospital, Lanzhou, China

Correspondence

Yuxia Ma, School of Nursing, Lanzhou University, #28, Yanxi Road, Chengguan District, Lanzhou, 730000, China.
Email: yuxiama@lzu.edu.cn

Lin Han, The First Clinical Medical College, Lanzhou University, Evidence-based Nursing Center, School of Nursing, Lanzhou University, Gansu Provincial Hospital, # 240, Donggang Road, Chengguan District, Lanzhou, China.
Email: lzu-hanlin@hotmail.com

Funding information

Provincial Talent Project of Gansu Province, Grant/Award Number: Organization Department of the CPC Gansu Provincial Committee, Grant/Award Number: [2022] Number 77; Gansu Provincial Science and Technology Plan Projects, Grant/Award Number: 22JR5RA892; the Scientific Research Project of Health Industry of Gansu Province, Grant/Award Number: GSWSHL-2021-003

Abstract

To compare the predictive properties of the Jackson/Cubbin scale and Waterlow scales in intensive care unit patients. A multi-centre study. This study was conducted between April 2021 and February 2023 in 72 intensive care units of 38 tertiary hospitals in Gansu Province, China. All adults admitted to the intensive care unit for 24 hours or more without pressure injury on admission were screened using the Waterlow scale and Jackson/Cubbin scales in intensive care. Additionally, the negative predictive value, positive predictive value, sensitivity, specificity and receiver operating characteristic curve with area under the curve of the Waterlow scale and Cubbin/Jackson scales were determined. The participant population for this study included 6203 patients. Predictive properties for the Jackson/Cubbin scales and Waterlow scales, respectively, were as follows: Cut-off scores, 28 versus 22; AUC, 0.859 versus 0.64; sensitivity, 92.4% versus 51.9%; specificity, 67.26% versus 71.46%; positive predictive value, 35% versus 23%; negative predictive value, 99.9% versus 99.1%. Both Waterlow scales and Jackson/Cubbin scales could predict pressure injury risk for patients in the intensive care unit. However, the Jackson/Cubbin scale demonstrated superior predictive properties than the Waterlow scale.

KEYWORDS

Cubbin/Jackson scale, intensive care unit, pressure injury, risk assessment, Waterlow scale

Key Messages

- It is the vital first step for prevention of pressure injuries using a valid and reliable assessment tool to identify high-risk patients and implement effective preventive measures.
- Comparison of the predictive properties of the Jackson/Cubbin scale and the Waterlow scale for pressure injury using a multi-centre study design.

- Cubbin/Jackson scale showed a high sensitivity, positive predictive value and negative predictive values. Waterlow scale shows a high specificity. The AUC of the Jackson/Cubbin scale was higher than the Waterlow scale.

1 | INTRODUCTION

Pressure injuries (PIs) continue to be a healthcare concern worldwide.[1] The occurrence of PI is regarded as an essential indicator of both quality of care and patient safety.[2] Patients admitted to intensive care units (ICUs) are usually severely ill and have a high risk of developing PI.[3] It is reported[4] that the overall prevalence of PI in the ICU was 26.6% and ICU-acquired prevalence was 16.2%, with data from 1117 ICUs (90 countries). PI has detrimental impacts on patients' physical, social and psychological health including decreases in quality of life,[5,6] causing infection[6–8] and pain, extending the length of hospital stay(average of 5–8 days per PI patient),[4] increasing morbidity, mortality and treatment burden.[9] Reportedly, PI treatment costs per patient per day in various contexts ranged from 1.71 € to 470.49 €.[10]

A plethora of complexly interacting intrinsic and extrinsic risk factors with patient-related factors are the main reasons for the higher incidence of PIs in ICUs,[11] which included haemodynamic instability, limited activity and mobility, poor tissue perfusion, mechanical ventilation, medical history(cardiovascular disease, peripheral vascular disease, pneumonia), malnutrition, body temperature, low haemoglobin, continuous sedation and use of vasoactive drugs.[11–13] According to recent findings, vasoconstrictor drug administration significantly doubled the incidence of PI in patients receiving critical care.[14] Besides, a retrospective cohort study[15] also emphasizes that critically ill adults in the ICU identified a mean arterial pressure <60 mmHg as a predictor of PI. Therefore, selecting an appropriate risk assessment scale and accurate identification of PI risk factors is essential.

2 | BACKGROUND

Waterlow scale is one of the most frequently used scales in PI risk assessment[16,17] and consists of the following categories: built/weight for height, BMI, assessment of the skin, gender, age, continence, mobility, nutrition, medication, tissue malnutrition and neurological deficits and major surgery or trauma, which assesses the patient's basic condition and is used widely. However, there is evidence in the literature that both support and oppose this interpretation. A prospective cohort study with 55 patients in the ICU proved that the Waterlow scale has better predictive power.[18] In contrast, another study highlighted the limitations of the Waterlow scale. For instance, Šateková[6] demonstrated that the Waterlow scale has a low predictive validity with a sample of 123 patients. Therefore, the predictive effectiveness of the Waterlow scale as a tool for assessing risk for ICU patients has been put into question. In addition, both of these two studies also had smaller sample size, and larger sample sizes are needed to validate these findings.

The Jackson/Cubbin scale was designed particularly for assessing PI risk in ICU patients. This scale consists of both general risk factors and ICU patient-specific risk factors and includes age, weight, past medical history, general skin condition, mobility, nutrition, incontinence, hygiene, mental condition, haemodynamics, respiration and oxygen requirement,[19] which is also applied in the ICU.[11,20] However, the evidence to support to use of the Jackson/Cubbin scale to assess the risk of PI in ICU patients is still limited and contradictory. Higgins et al[20] and Delawder et al[21] all demonstrated that Jackson/Cubbin scale has a moderate prediction value. While a meta-analysis[2] showed that the previous search had low-quality evidence and important heterogeneity was observed and need to be validated in future works.

From the above, it is clear that the Waterlow scale and the Jackson/Cubbin scale were used in the ICU, and different studies have shown different perspectives on predictive properties. Therefore, this study used the Waterlow scale and the Jackson/Cubbin scale to assess and compare 6203 patients to determine the best predictive tool by sensitivity, specificity, positive predictive value (PPV), negative predictive values (NPV), positive likelihood ratio, negative likelihood ratio and area under the receiver operating characteristic curve to guide clinical practice.

3 | AIM AND OBJECTIVE

The study aimed to compare the predictive validity of the Waterlow and Jackson/Cubbin PI risk assessment scales in ICU patients.

4 | METHODS

4.1 | Study design

This is a multi-centre study.

4.2 | Setting and samples

This study was performed in ICUs of 38 tertiary hospitals in Gansu Province, China, from April 2021 to February 2023. The inclusion criteria for the hospitals were as follows: tertiary care general hospitals in Gansu Province, and agreement and support were obtained from the management department. Adult inclusion criteria of the study were as follows: age over 18 years; no PIs at the time of admission to the ICU; stayed in the ICU for more than 24 h; and agreement for participation. The exclusion criteria for patients were as follows: patients who had burns, electric shocks and systemic lupus erythematosus may have influenced the judgement of PI: death.

4.3 | Variables and measurement

4.3.1 | Waterlow scale

In 1985, the Waterlow scale was developed in the United Kingdom for elderly patients in acute healthcare institutions.[22] The Waterlow scale revised scale included the following factors: built/weight for height, BMI, assessment of the skin, gender, age, continence, mobility, nutrition, medication, tissue malnutrition, neurological deficits, and major surgery or trauma. The total score varies between 4 and 40. The higher the score, the higher the risk of pressure sores.

4.3.2 | Cubbin /Jackson scale

The scale was revised in 1999 after being developed in 1991 for ICU patients. The revised version[19] consists of 12 items: age, weight tissue viability, past medical history, affecting condition, mental, mobility, haemodynamics, respiration, oxygen requirement, nutrition, incontinence and hygiene. Each item is rated from 1 to 4 points. If the patients require blood products, check if they have undergone surgery or a scan in the last 48 h and warm them if hypothermic. It is recommended 1-point deduction from the total score of the scale for each of these cases. The lowest score of the scale is 9 and the highest score is 48. Low scores on the Jackson/Cubbin scale imply higher risk. The cut point for "high risk" was established as 29.

4.3.3 | Research tool

We used an information platform of PI risk management called the "Longhuhui applet". The "Longhuhui applet" was developed by the nursing department of a 2600-bed tertiary hospital in north-western China via the WeChat mini program, which expected four parts about PIs (PI assessment, preventive care, PI reporting and quality management) and there are others, such as socio-demographic clinical characteristics (gender, age, height, weight, education level, weight, body mass index (BMI), admission diagnosis, smoking, etc.); all items of the Waterlow scale and Jackson/Cubbin scale; vital signs (body temperature, blood pressure, heart rate, blood oxygen saturation), biochemical indexes (arterial pH, $PaCO_2$, PaO_2, etc.); treatment measures (vasoactive drugs, sedative/analgesic, procoagulant, antineoplastic, hormonal, antiarrhythmic, asthma, antibacterial, inotropic, anticoagulant, mechanical ventilation, etc.); and nursing measures included the use of pressure reduction devices, local skin protection, frequency of turning, shear force avoidance and nutritional support.

The frequency of assessment is first based on the Waterlow scale scores. The Waterlow scale scores were categorized as 0–10 low risk, >10 at risk, >15 high risks and 20+ very high risks. According to the Waterlow score on admission, patients at risk will be regularly assessed at least once a week, at high risk at least twice a week, and at extremely high risk at least once a day. This applet might notify nurses to complete routine assessments and maintain records of all preventive actions, as well as automatically generate assessment frequencies depending on patients' risk grades of PIs. Waterlow score and Jackson/Cubbin scale were evaluated respectively according to the frequency of APP evaluation results. PI staging using the 2019 edition of prevention and treatment of pressure ulcers/injuries: Clinical Practice Guideline.[23]

4.4 | Data collection

Before the study, the principal researcher explained the study protocol to the liaison nurses in each hospital, provided training on the mobile information platform, Waterlow scale and Jackson/Cubbin scale, PI evaluation, and cleared up any confusion. Each hospital provided at least one research nurse and one liaison nurse for each shift. When patients were admitted to the ICU, responsible nurses logged into the "Longhuhui applet" with their WeChat accounts on their mobile phones, which registered with their real names. Then patients, according to the risk grades suggested, at risk would be regularly assessed and provided with preventive measures. Once PI occurred, on-site diagnosis by the PI expert team in each hospital was determined. All collected information was recorded and uploaded through the applet. The head nurse can review all data, which are then submitted to

TABLE 1 Demographic and clinical characteristics of study participants.[a,b]

Variables	Pressure Injury		*p*
	No ($n = 6124$)	Yes ($n = 79$)	
Gender			
Female	3758 (61.4%)	60 (75.9%)	0.011
Male	2366 (38.6%)	19 (24.1%)	
Age mean (SD), y	61.0 (15.4)	58.1 (15.9)	0.104
BMI(kg/m^2)[c]			
BMI<18.5	467 (7.6%)	5 (6.3%)	0.91
18.5 ≤ BMI ≤ 23.9	5254 (85.8%)	70 (88.6%)	
24 ≤ BMI ≤ 27.9	3 (0.0%)	0 (0%)	
BMI ≥28	400 (6.5%)	4 (5.1%)	
Mechanical ventilation			
No	4050 (66.1%)	35 (44.3%)	<0.001
Non-invasive mechanical ventilation	279 (4.6%)	4 (5.1%)	
Invasive mechanical ventilation	1795 (29.3%)	40 (50.6%)	
PICC			
No	6026 (98.4%)	76 (96.2%)	0.278
Yes	98 (1.6%)	3 (3.8%)	
Oedema			
No	5405 (88.3%)	63 (79.7%)	0.032
Yes	719 (11.7%)	16 (20.3%)	
Forced position			
No	5817 (95.0%)	71 (89.9%)	0.072
Yes	307 (5.0%)	8 (10.1%)	
Malignant tumour			
No	5504 (89.9%)	76 (96.2%)	0.095
Yes	620 (10.1%)	3 (3.8%)	
Smoking			
No	4940 (80.7%)	56 (70.9%)	0.042
Yes	1184 (19.3%)	23 (29.1%)	
DPB mean (SD)	127 (27.7)	122 (27.5)	0.111
SPB mean (SD)	74.0 (17.6)	70.8 (17.0)	0.099
Heart rate mean (SD)	91.2 (22.7)	99.6 (24.9)	0.004
SpO_2 mean (SD)	93.1 (8.53)	94.1 (6.95)	0.247
Semi-recumbent position (head of the bed raised to 30)			
No	2353 (38.4%)	31 (39.2%)	0.974
Yes	3771 (61.6%)	48 (60.8%)	
Diagnosis			
Neurological diseases	830 (13.4%)	23 (29%)	<0.001
Respiratory diseases	623 (10.2%)	13 (16.5%)	
Heart disease	363 (5.9%)	7 (8.9%)	
Digestive disease	412 (6.7%)	6 (7.6%)	
Neoplastic diseases	357 (5.8%)	5 (3.8%)	
Others	3539 (57.8%)	25 (34.2%)	

TABLE 1 (Continued)

Variables	Pressure Injury		
	No ($n = 6124$)	Yes ($n = 79$)	p
Waterlow score mean (SD)	19.2 (6.00)	22.2 (5.92)	<0.001
Cubbin and Jackson scale score mean (SD)	25.2 (4.30)	18.9 (2.99)	<0.001

[a]Comparisons between groups with and without pressure injuries were made using independent t-tests and χ^2 analyses or Fisher exact test, depending on the distribution of data and level of measurement of each variable.
[b]Data are presented as No. (%) unless otherwise indicated.
[c]Calculated as weight in kilograms divided by height in meters squared.

the nursing department's quality control team. After collecting the data, the engineers who sign a confidentiality agreement export all the collected information via the application's terminal. The project leader manages the data desensitization and privacy management.

4.5 | Ethical considerations

The project was approved by the Ethics Committee of Lanzhou University School of Nursing (Decision No: LZUHYXY20210033). All patients or their legal guardians provided written informed consent before participation in the study.

4.6 | Statistical analysis

Data analysis was conducted using R(R version 4.3.1), a language and environment for statistical computing (http://www.r-project.org). Using independent t-tests, χ^2 analysis or Fisher's exact test, demographic and clinical variables were compared between the two groups (patients with and without PI), depending on the distribution of data and level of measurement of each variable. In addition, we used MedCalc statistical software (MedCalc statistical software 18,2,1,0, United States) to analyse the AUC, optimal cut-off value, sensitivity, specificity, PPV and NPV, and the area under the ROC curve. The statistical tests were performed at a significance level of 5%.

5 | RESULTS

5.1 | Demographic and clinical characteristics

A total of 6203 patients were studied, 79 (1.27%) of whom developed PIs. The demographic data of the patients are summarized in Table 1. Their mean age was 60.99 years (SD = 15.88). The mean scores were 24.33(SD = 3.37) for the Jackson/Cubbin scale and 22.19(SD = 5.88) for the Waterlow scale. Compared with those who did not develop PI ($n = 6124$), those who developed PI ($n = 79$) were female, and about half of them required invasive mechanical ventilation. 88.6% of the patients were in normal weight. Nearly one third (45.5%) had smoking and neurological diseases. 60.8% of patients were in a semi-recumbent position with the head of the bed elevated to 30 degrees.

5.2 | Locations and categories of PI

PIs occurred in 106 sites in total, and the sacrococcygeal area was the most frequent location (49%), followed by the heel (11.3%) and hip areas (Figure 1). PIs mainly occur in stage II (61.3%): 26 PIs (24.5%) were stage I, 7 PIs (6.6%)were stage III, 2 PIs (1.89%)were stage IV, 4 PIs (3.77%) were unstageable, and 2 PIs (1.89%) had suspected deep tissue injury (Figure 2).

5.3 | Predictive validities and ROC analyses of the scales

The cut-off scores of the Waterlow scale and Cubbin and Jackson scale were 28 and 22. The sensitivity, specificity, positive likelihood ratio, negative likelihood ratio, positive predictive value and negative predictive value of the Jackson/Cubbin scale were 92.4%, 67.26%, 2.82, 0.11, 35%, and 99.9% respectively, while those of the Waterlow scale was 51.90%, 71.46%, 1.82, 0.67, 23% and 99.1%, respectively (Table 2). The area under the AUC curves of the Jackson/Cubbin scale was 0.859 (95% CI, 0.850–0.868), and the Waterlow scale was 0.644 (95% CI, 0.632–0.656) (Figure 3).

6 | DISCUSSION

6.1 | The location of PI

In the present study, we found that sacrococcygeal and heel were the most commonly occurring sites for PI,

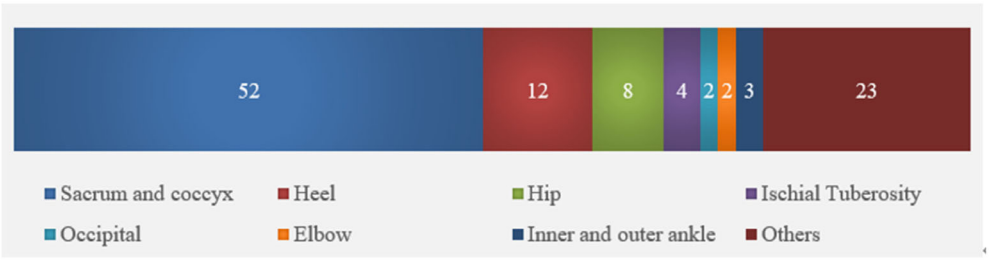

FIGURE 1 Distribution of PI locations.

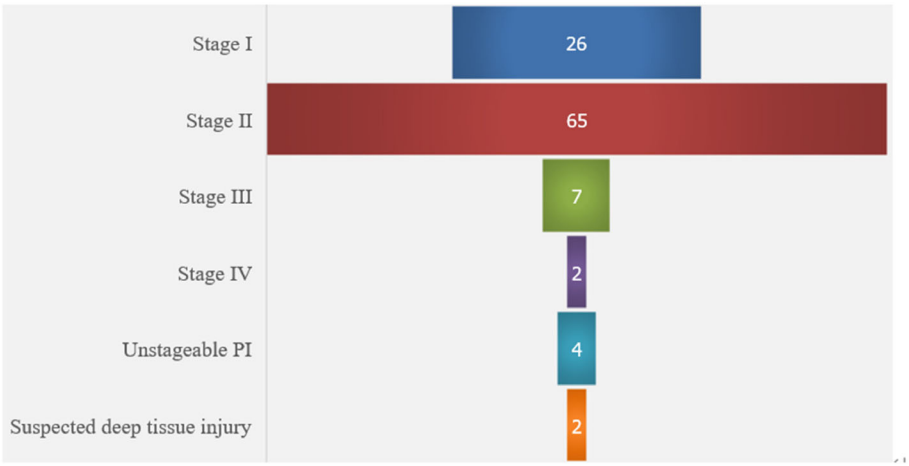

FIGURE 2 Stage of PI.

TABLE 2 The test performance of each scale at the optimal cut-off point in predicting the risk of PI.

Scale	AUC	Cut-off point	Sensitivity (%)	Specificity (%)	+LR	−LR	PPV (%)	NPV (%)
Cubbin/Jackson scale	0.859	≤28	92.41	67.26	2.82	0.11	35	99.9
Waterlow scale	0.640	>22	51.90	71.46	1.82	0.67	23	99.1

Abbreviations: +LR, Positive likelihood ratio; −**LR**, negative likelihood ratio; NPV, negative predictive value; PPV, positive predictive value.

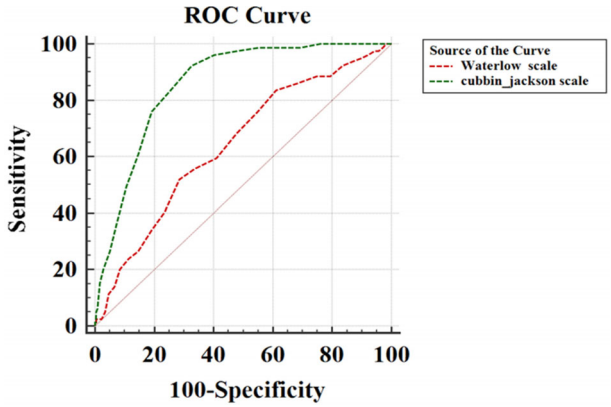

FIGURE 3 ROC curve of Cubbin/Jackson scale and Waterlow scale.

which is congruent with those of previous studies.[4,24,25] The following reasons may cause PI to occur in the higher risk segment: Primarily, sacrococcygeal and heel areas were both bone prominences with thin cortical layers. ICU patients are critically ill and the supine position is often chosen for frequent interventions and treatments, which may lead to the development and occurrence of PI in these sites. Moreover, to minimize ventilator-associated pneumonia, patients on mechanical ventilation should have their heads of beds lifted. This puts more pressure on the sacrum and feels.[23] Further, due to its proximity to the perineum and susceptibility to moisture and germs, the sacrococcygeal region is particularly vulnerable to skin barrier damage and pH changes. Studies[26,27] revealed that dressings are an effective prevention measure to protect sacrococcygeal and heel sites. A meta-analysis[26] revealed 78% and 69% reductions in the risk of PI in patients with dressings on the sacrum and heel, respectively. In addition, another study[27] also demonstrated that the dressing decreased PI in the sacrococcygeal region by 70%. Therefore, it is important to keep the sacrococcygeal skin dry, clean and use dressings to protect the heel and sacrococcygeal area.

6.2 | The stages of PI

The result of this study showed that the most common PIs were mainly in stages II and I, which is consistent with a previous study.[28] In this study, PI was mainly in stage II, while another research study demonstrated a higher proportion of stage I.[29] The reason for the analysis may be PI recovery and related studies are not used as an outcome indicator.[12] And next, currently, clinical recognition of PI mainly depends on routine visual skin assessments; however, these methods may be affected by the original skin colour of the patient and have limited accuracy. The pathophysiological changes, such as local tissue ischaemia, reperfusion injury, increased capillary permeability and soft tissue oedema, compromised lymphatics, direct mechanical insult to cells, etc., may already be occurring even though there are no visible PIs in the skin and/or underlying tissue.[30] Besides, an interesting but not surprising finding showed unexpected results; they found that nearly one third (32.4%) of critically ill patients with stage I experienced worsening of their injury.[31] Thus, it is important to enhance the identification of stage I of PI. Studies[32,33] have revealed that subepidermal moisture and ultrasound are the best methods to assess early skin/tissue damage. Therefore, to care for patients with darker skin tones, the National Pressure Ulcer Advisory Panel[34] recommends nurses carefully assess patients for changes in temperature, sensation or skin texture/tightness to identify stage I of PI early. In addition, prevention strategies can be enhanced by the compatibility of subepidermal moisture[35] and ultrasound monitoring tools for earlier monitoring of PI.

6.3 | The Jackson/Cubbin scale has a better practical value

It is generally understood that $0.5 < AUC < =0.7$ indicates a low predictive value of the model, $0.7 < AUC < =0.9$ indicates a moderate prediction value and $AUC > 0.9$ indicates a high predictive value.[36] The present study demonstrated that both the Jackson/Cubbin scale and the Waterlow scale can predict the occurrence of PI, with the AUC of the Waterlow scale being 0.644 and the Jackson/Cubbin scale being 0.859. However, according to general understanding, the Jackson/Cubbin scale prediction value was better than the Waterlow scale. The results of our study were consistent with Zhang et al reports.[2] Evaluating ICU patients with the use of the Jackson/Cubbin index revealed good diagnostic test accuracy; mainly this scale was specially designed for ICU patients and included 10 categories. The main reason for this is most likely that the Waterlow scale is more suitable for evaluating PI in intraoperative settings.[37] Besides, although the AUC of the Waterlow scale was 0.644, age and gender are beneficial,[38] and can be modifications to the most difficult items, such as "poor nutrition", "mobility", and "skin type"[39] and conjunction with a clinical assessment to provide optimum results.[38]

6.4 | The Jackson/Cubbin scale showed a high sensitivity and negative predictive values

Indicators for predicting the occurrence of risks in a patient include sensibility, specificity, PPV and NPV. The sensibility represents the proportion of patients who develop PI and are evaluated as risky. The specificity regards the proportion of patients who did not develop PI, and the assessment indicated that they were not at risk. The PPV consists of the proportion of evaluated patients as risky and who developed PI. The NPV applies to the proportion of patients who after the assessment are declared as not being at risk and who did not develop PI. In our study, the sensitivity of Jackson/Cubbin and Waterlow scales, respectively, was 92.4% versus 51.9%; specificity was 67.26% versus 71.46%; PPV was 35% versus 23%; NPV was 99.9 versus 99.1. The findings of our investigation aligned with those of earlier studies.[11,38] The ideal diagnostic test has both high sensitivity (true positive rate) and specificity (true negative rate), but this is often not possible in a clinical setting, which is usually impossible to achieve. PI risk assessment is a screening test that tends to use more sensitive tools rather than a screening test, which favours the use of more sensitive tools over higher specificity tools. Our results found that the Jackson/Cubbin scale has a higher sensitivity than the Waterlow scale and can better identify PI risk patients and facilitate timely preventive measures. This is consistent with previous reports.[40] Chen et al[40] have reported Jackson/Cubbin scale sensitivity values were 81.85, 95%CI (58%–88%). If only sensitivity is considered, overprediction and overuse of preventive measures can lead to a waste of healthcare resources. Therefore, risk assessment tools should also have a high negative predictive value. In this study, the negative predictive values of both scales were high and can effectively identify patients with non-pressure injuries.

7 | STUDY LIMITATIONS

This study surveyed 38 tertiary general hospitals in Gansu Province of China with a sample size of 6203. However, there were limitations. We only surveyed a

sample size of one province in China. Therefore, it is not possible to generalise the findings to the whole population of patients in China. Next, we did not match cases and controls, and we did not provide a detailed classification of device-related and mucosa PI; future investigations might use measures of illness severity and focus on device-related and mucosal membrane PI.

8 | CONCLUSIONS

The results of this study indicated that both the Waterlow scale and the Jackson/Cubbin scale could predict PI risk in ICU patients. However, the Jackson/Cubbin scale has a better predictive validity than the Waterlow scale. Considering the specificity of the Jackson/Cubbin scale in this study, we recommend analysing the features of ICU patients, enhancing specificity moving forward and offering patients better PI evaluation and care.

ACKNOWLEDGEMENTS

The authors thank the patients and their legal guardians who agreed to participate in this study and the health professionals of the participating ICUs.

FUNDING INFORMATION

This study was funded by the Gansu Provincial Science and Technology Plan Projects (22JR5RA892), the Scientific Research Project of Health Industry of Gansu Province (grant GSWSHL-2021-003) and Provincial Talent Project of Gansu Province, Grant/Award Number: Organization Department of the CPC Gansu Provincial Committee [2022] Number 77.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data is true and reliable.

ORCID

Qiuxia Yang https://orcid.org/0009-0004-1263-8770
Yuxia Ma https://orcid.org/0000-0002-5557-4306
Lin Han https://orcid.org/0000-0001-7821-5253

REFERENCES

1. Ayello EA, Sibbald RG. Marching forward with global pressure injury data. *Adv Skin Wound Care*. 2023;36(3):119.
2. Zhang Y, Zhuang Y, Shen J, et al. Value of pressure injury assessment scales for patients in the intensive care unit: systematic review and diagnostic test accuracy meta-analysis. *Intensive Crit Care Nurs*. 2021;64:103009.
3. Lee SY, Oh DK, Hong S-B, Lim C-M, Huh JW. Neuromuscular blocking agents and opioids are major risk factors for developing pressure injuries in patients in the intensive care unit. *Korean J Intern Med*. 2022;37(6):1186-1194.
4. Labeau SO, Afonso E, Benbenishty J, et al. Prevalence, associated factors and outcomes of pressure injuries in adult intensive care unit patients: the DecubICUs study. *Intensive Care Med*. 2021;47(2):160-169.
5. Chotchoungchatchai S, Krairit O, Tragulpiankit P, Prathanturarug S. The efficacy of honey and a Thai herbal oil preparation in the treatment of pressure ulcers based on Thai traditional medicine wound diagnosis versus standard practice: an open-label randomized controlled trial. *Contemp Clin Trials Commun*. 2020;17:100538.
6. Šateková L, Žiaková K, Zeleníková R. Predictive validity of the Braden scale, Norton scale, and Waterlow scale in The Czech Republic. *Int J Nurs Pract*. 2017;23(1):e12499.
7. Yang LL, Peng WX, Wang CQ, Li Q. Elevated risk of infections after spinal cord surgery in relation to preoperative pressure ulcers: a follow-up study. *Sci Rep*. 2018;8(1):14027.
8. Huang C, Ma Y, Wang C, et al. Predictive validity of the Braden scale for pressure injury risk assessment in adults: a systematic review and meta-analysis. *Nurs Open*. 2021;8(5):2194-2207.
9. Salawu AI, Ipinnimo TM, Bamidele TA, et al. Assessing the correlation between patient-specific characteristics and Braden pressure injury risk score at a suburban tertiary Hospital in Nigeria. *Cureus*. 2023;15(5):e39373.
10. Demarré L, Van Lancker A, Van Hecke A, et al. The cost of prevention and treatment of pressure ulcers: a systematic review. *Int J Nurs Stud*. 2015;52(11):1754-1774.
11. Adibelli S, Korkmaz F. Pressure injury risk assessment in intensive care units: comparison of the reliability and predictive validity of the Braden and Jackson/Cubbin scales. *J Clin Nurs*. 2019;28(23–24):4595-4605.
12. Alderden J, Rondinelli J, Pepper G, Cummins M, Whitney J. Risk factors for pressure injuries among critical care patients: a systematic review. *Int J Nurs Stud*. 2017;71:97-114.
13. Cox J. Risk factors for pressure injury development among critical care patients. *Crit Care Nurs Clin North Am*. 2020;32(4):473-488.
14. Tang W, Li AP, Zhang WQ, Hu SQ, Shen WQ, Chen HL. Vasoconstrictor agent administration as a risk factor for pressure injury development in intensive care unit patients: a systematic review and meta-analysis. *Adv Wound Care (New Rochelle)*. 2023;12(10):560-573.
15. Sala JJ, Mayampurath A, Solmos S, et al. Predictors of pressure injury development in critically ill adults: a retrospective cohort study. *Intensive Crit Care Nurs*. 2021;62:102924.
16. Compton F, Strauss M, Tino Hortig JF, Hoffmann F, Zidek W, Schäfer J-H. Validity of the Waterlow scale for pressure ulcer risk assessment in the intensive care unit: a prospective analysis of 698 patients. *Pflege*. 2008;21(1):37-48.
17. 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(10): 417–20, 22–4, 424.
18. Borghardt AT, Prado TN, Araújo TM, Rogenski NMB, Bringuente MEO. Evaluation of the pressure ulcers risk scales with critically ill patients: a prospective cohort study. *Rev Lat Am Enfermagem*. 2015;23(1):28-35.

19. Jackson C. The revised Jackson/Cubbin pressure area risk calculator. *Intensive Crit Care Nurs*. 1999;15(3):169-175.
20. Higgins J, Casey S, Taylor E, Wilson R, Halcomb P. Comparing the Braden and Jackson/Cubbin pressure injury risk scales in trauma-surgery ICU patients. *Crit Care Nurse*. 2020;40(6):52-61.
21. Delawder JM, Leontie SL, Maduro RS, Morgan MK, Zimbro KS. Predictive validity of the Cubbin-Jackson and Braden skin risk tools in critical care patients: a multisite project. *Am J Crit Care*. 2021;30(2):140-144.
22. Waterlow J. Pressure sores: a risk assessment card. *Nurs Times*. 1985;81(48):49-55.
23. Kottner J, Cuddigan J, Carville K, et al. Prevention and treatment of pressure ulcers/injuries: the protocol for the second update of the international clinical practice guideline 2019. *J Tissue Viability*. 2019;28(2):51-58.
24. Chaboyer WP, Thalib L, Harbeck EL, et al. Incidence and prevalence of pressure injuries in adult intensive care patients: a systematic review and meta-analysis. *Crit Care Med*. 2018; 46(11):e1074-e1081.
25. Jacq G, Valera S, Muller G, et al. Prevalence of pressure injuries among critically ill patients and factors associated with their occurrence in the intensive care unit: the PRESSURE study. *Aust Crit Care*. 2021;34(5):411-418.
26. Lovegrove J, Fulbrook P, Miles S, Steele M. Effectiveness of interventions to prevent pressure injury in adults admitted to intensive care settings: a systematic review and meta-analysis of randomised controlled trials. *Aust Crit Care*. 2022;35(2):186-203.
27. Fulbrook P, Mbuzi V, Miles S. Effectiveness of prophylactic sacral protective dressings to prevent pressure injury: a systematic review and meta-analysis. *Int J Nurs Stud*. 2019;100:103400.
28. Kaşıkçı M, Aksoy M, Ay E. Investigation of the prevalence of pressure ulcers and patient-related risk factors in hospitals in the province of Erzurum: a cross-sectional study. *J Tissue Viability*. 2018;27(3):135-140.
29. Li Z, Lin F, Thalib L, Chaboyer W. Global prevalence and incidence of pressure injuries in hospitalised adult patients: a systematic review and meta-analysis. *Int J Nurs Stud*. 2020;105:103546.
30. Hajhosseini B, Longaker MT, Gurtner GC. Pressure injury. *Ann Surg*. 2020;271(4):671-679.
31. Alderden J, Zhao YL, Zhang Y, et al. Outcomes associated with stage 1 pressure injuries: a retrospective cohort study. *Am J Crit Care*. 2018;27(6):471-476.
32. Oliveira AL, Moore Z, Connor TO, Patton D. Accuracy of ultrasound, thermography and subepidermal moisture in predicting pressure ulcers: a systematic review. *J Wound Care*. 2017;26(5): 199-215.
33. Zena M, Natalie LM, Pinar A, et al. Measuring subepidermal moisture to detect early pressure ulcer development: a systematic review. *J Wound Care*. 2022;31(8):634-647.
34. Edsberg LE, Black JM, Goldberg M, McNichol L, Moore L, Sieggreen M. Revised National Pressure Ulcer Advisory Panel Pressure Injury Staging System: revised pressure injury staging system. *J Wound Ostomy Continence Nurs*. 2016;43(6): 585-597.
35. Nightingale P, Musa L. Evaluating the impact on hospital acquired pressure injury/ulcer incidence in a United Kingdom NHS acute trust from use of sub-epidermal scanning technology. *J Clin Nurs*. 2021;30(17–18):2708-2717.
36. Xu D, Dong Y, Zhang B, Li L, Jiang C. Validation of the meta-analysis global Group in Chronic Heart Failure risk score for the prediction of 1-year mortality in a Chinese cohort. *Chin Med J (Engl)*. 2022;135(23):2829-2835.
37. Nayar SK, Li D, Ijaiya B, Lloyd D, Bharathan R. Waterlow score for risk assessment in surgical patients: a systematic review. *Ann R Coll Surg Engl*. 2021;103(5):312-317.
38. Park S-H, Lee HS. Assessing predictive validity of pressure ulcer risk scales- a systematic review and meta-analysis. *Iran J Public Health*. 2016;45(2):122-133.
39. Kottner J, Dassen T, Tannen A. Inter- and intrarater reliability of the Waterlow pressure sore risk scale: a systematic review. *Int J Nurs Stud*. 2009;46(3):369-379.
40. Chen X, Diao D, Ye L. Predictive validity of the Jackson–Cubbin scale for pressure ulcers in intensive care unit patients: a meta-analysis. *Nursing in Critical Care*. 2022;28(3):370-378.

How to cite this article: Yang Q, Yang Z, Lv L, et al. Comparing the Waterlow and Jackson/Cubbin pressure injury risk scales in intensive care units: A multi-centre study. *Int Wound J*. 2024; 21(2):e14602. doi:10.1111/iwj.14602