

Postprint of a Study on the Epidemiological Characteristics of Pressure Injuries and the Predictive Diagnostic Role of the Braden Scale in Adult Inpatients Across 46 Tertiary Hospitals in China

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Abstract

Purpose: To conduct a cross-sectional investigation of the epidemiological characteristics of pressure injuries among inpatients in 46 tertiary hospitals across 13 provinces nationwide, and to analyze the predictive value of the Braden Scale and its six subscales for pressure injury and hospital-acquired pressure injury risk. **Methods:** Forty-six hospitals were recruited for this cross-sectional investigation. A total of 1,060 trained and qualified nurses used convenience sampling to, within a unified timeframe and employing consistent research tools, methods, and procedures, include adult inpatients aged 18 years and above, examine their entire body skin for pressure injuries, and utilize the Braden Scale to score each of the six subscales: sensory perception, moisture, activity, mobility, nutrition, and friction/shear. The total score ranges from 6-23 points, with lower scores indicating higher risk of pressure injury. Statistical software was used to analyze the area under the receiver operating characteristic curve (AUC) of the Braden Scale and its six subscales for predicting pressure injuries and hospital-acquired pressure injuries, as well as their sensitivity, specificity, and Youden's index. **Results:** A total of 60,555 valid cases were obtained, including 32,518 males (53.70%) and 28,037 females (46.30%), with a mean age of 55.88 ± 17.16 years. The overall prevalence rate of pressure injuries was 1.67% (n=1,010), with a hospital-acquired pressure injury prevalence rate of 0.74% (n=448). The prevalence rate was higher in males than in females (2.08% vs. 1.19%), and highest in ICU patients and those aged ≥ 80 years (10.58% and 5.98%, respectively). The AUC of the Braden Scale for predicting risk of pressure injuries and hospital-acquired pressure injuries in adults was 0.95 and 0.91, respectively, with sensitivity of 0.92 and 0.90, specificity of 0.87 and 0.79, and Youden's

index of 0.79 and 0.69. The cutoff value of \$ \$19 on the Braden Scale yielded the maximum AUC and Youden' s index for predicting pressure injury risk (0.83 and 0.51). Among the subscales, activity, friction/shear, and mobility demonstrated the highest AUC values (0.92-0.81) and Youden' s indices (0.75-0.71) for predicting pressure injury risk. Conclusion: The Braden Scale is applicable for predicting pressure injury risk among inpatients in tertiary hospitals in China, with a total score of \$ \$19 demonstrating superior predictive performance. The activity, friction/shear, and mobility subscales exhibited the greatest predictive value. Utilizing these three subscales to predict pressure injury risk under conditions of staff shortage or in special circumstances can improve efficiency and save time.

Full Text

Preamble

Study on Epidemiological Characteristics of Pressure Injury and the Predictive Role of Braden Scale Among Adult Inpatients in 46 Tertiary Hospitals in China

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Abstract

Objective: To investigate the epidemiological characteristics of pressure injury among inpatients in 46 tertiary hospitals across 13 provinces in China, and to analyze the predictive efficacy of the Braden Scale and its six subscales in

identifying risk for pressure injury (PI) and hospital-acquired pressure injury (HAPI).

Methods: A cross-sectional survey was conducted with 46 recruited hospitals. A total of 1,060 trained and qualified nurses used convenience sampling to collect data using standardized tools, methods, and procedures within a unified time-frame. Adult inpatients aged 18 years and older were included and underwent comprehensive skin examinations for pressure injury. The Braden Scale was administered to assess risk across six subscales: sensory perception, moisture, activity, mobility, nutrition, and friction/shear, with total scores ranging from 6 to 23 (lower scores indicating higher risk). Statistical software was used to analyze the area under the receiver operating characteristic curve (AUC), sensitivity, specificity, and Youden' s index for the Braden Scale and its subscales in predicting PI and HAPI.

Results: Valid data were obtained from 60,555 cases (32,518 males [53.70%] and 28,037 females [46.30%]), with a mean age of 55.88 \pm 17.16 years. The overall prevalence of pressure injury was 1.67% (n=1,010), with HAPI prevalence at 0.74% (n=448). Male patients had higher prevalence than females (2.08% vs. 1.19%). The highest prevalence rates were observed in ICU patients (10.58%) and those aged \geq 80 years (5.98%). The Braden Scale demonstrated excellent predictive performance for adult PI and HAPI risk, with AUC values of 0.95 and 0.91, sensitivities of 0.92 and 0.90, specificities of 0.87 and 0.79, and Youden' s indices of 0.79 and 0.69, respectively. A cutoff value of \geq 19 points yielded the maximum AUC (0.83) and Youden' s index (0.51) for PI prediction. Among the subscales, activity, friction/shear, and mobility showed the strongest predictive efficacy, with AUC values of 0.92-0.81 and Youden' s indices of 0.75-0.71.

Conclusion: The Braden Scale is suitable for predicting pressure injury risk among adult inpatients in Chinese tertiary hospitals. A total score \geq 19 points provides optimal predictive value. The activity, friction/shear, and mobility subscales demonstrate the greatest predictive power. In resource-constrained or special environments, using these three subscales alone can improve efficiency and save time while maintaining predictive accuracy.

Keywords: Pressure injury; Hospital-acquired pressure injury; Risk assessment; Predictive role

Introduction

Pressure injury (PI) is localized damage to the skin and/or underlying tissue resulting from multiple contributing factors [1]. Hospital-acquired pressure injury (HAPI), which occurs during hospitalization, increases nursing time, treatment costs, and imposes additional burdens on families and society [1,3-4]. Preventing PI, particularly reducing HAPI incidence, represents a key patient safety

objective in healthcare systems worldwide [5-8]. Identifying at-risk populations through risk assessment is a critical preventive measure [1-4,8].

The Braden Scale, developed in 1987 with an initial cutoff value of \$ \$16 points indicating PI risk requiring preventive interventions, has become a globally recognized universal assessment tool for adults [9-11] and has played an important role in PI prevention across countries [12-16]. However, its predictive validity remains controversial. Some studies suggest the Braden Scale fails to capture the critical and dynamic nature of critically ill patients, limiting its effectiveness in ICU settings [17-19] and potentially leading to over-prediction and resource waste [19]. Additionally, its predictive efficacy may decline in older adults with multiple comorbidities [20-22].

Recent research has proposed that the mobility, activity, and nutrition subscales of the Braden Scale can independently predict PI risk while saving time, offering significant clinical utility [16,23-24]. The 2019 international guidelines strongly recommend assessing the contributions of mobility, activity, and friction/shear to PI development (Grade A evidence) [1]. However, these new perspectives have not been validated or applied in China. Therefore, this multicenter study, based on large-scale data, analyzes the validity and accuracy of the Braden Scale and its six subscales in predicting PI risk among Chinese inpatients, and explores optimal cutoff values to provide evidence for rational and effective clinical use of the scale.

1. Materials and Methods

1.1 General Data

A multicenter collaborative research group was established at the General Hospital of Eastern Theater Command. After obtaining ethics committee approval (2020NZKY-027-02), the study publicly recruited tertiary Grade A hospitals with \$ \$500 beds across China. Following qualification review and bilateral cooperation agreements, 46 eligible hospitals from 13 provinces were enrolled as multicenter research units: 21 in Jiangsu, 9 in Guangdong, 3 in Guizhou, 2 each in Hubei, Anhui, and Sichuan, and 1 each in Guangxi, Hunan, Fujian, Henan, Hebei, Shaanxi, and Ningxia. The distribution by bed capacity was: 500-1,000 beds (10 hospitals, 21.74%), 1,001-2,000 beds (21 hospitals, 45.65%), 2,001-3,000 beds (9 hospitals, 19.56%), 3,001-4,000 beds (4 hospitals, 8.70%), and >4,000 beds (2 hospitals, 4.35%).

Inclusion criteria comprised all hospitalized patients aged \$ \$18 years with hospitalization duration \$ \$24 hours on the survey day who provided informed consent, regardless of gender or disease type. Exclusion criteria included psychiatric patients and those with unstable conditions, medical orders prohibiting turning, or inability to cooperate with skin examinations.

1.2 Survey Instruments

The study utilized a PI survey record form developed by the research group [25] as the data collection tool. The form included: hospital characteristics (institution type, bed capacity); patient demographics (age, gender, diagnosis, department, serum albumin and hemoglobin values from the most recent week); incontinence status (type, frequency, duration); Braden Scale assessment results; and skin examination findings (presence of PI, location, and stage).

1.3 Researcher Training and Assessment

Each hospital appointed an enterostomal therapist or nursing director as the research coordinator. The number of survey personnel was determined based on total inpatient volume. A total of 1,060 wound care 骨 干 nurses (core nurses) with \$ \$2 years of experience were selected and underwent unified online training and assessment, with a passing score of \$ 90points[26]. *All participants passed and participated in the survey, with an average nursing experience of 10.60 ± 2.33 years (range: 2-33 years).*

1.4 Survey Methods

The cross-sectional survey was conducted on two dates: March 30 and May 29, 2021. The 1,060 qualified nurses were organized into 530 survey pairs. Each pair collected data and performed comprehensive skin examinations using standardized methods [27]. When skin breakdown was identified, the 2019 international guideline definitions and staging criteria were applied to determine PI presence and stage (Stages 1-4, deep tissue injury, or unstageable). For confirmed PI cases, medical records were reviewed, and injuries occurring after admission to intact skin were classified as HAPI [1-2]. Simultaneously, the Braden Scale was administered to assess risk across six subscales: mobility (1-4 points), activity (1-4 points), friction/shear (1-3 points), nutrition (1-4 points), moisture (1-4 points), and sensory perception (1-4 points), with total scores ranging from 6 to 23 (lower scores indicating higher risk) [9]. In cases of disagreement, patient information was submitted to the multicenter quality control group, where 71 wound care specialists discussed and reached consensus [27-28]. Final results were confirmed by dual signatures and uploaded to the research group via the Wenjuanxing platform.

1.5 Statistical Methods

Data were exported from Wenjuanxing and verified by two researchers to establish the database. SPSS 22.0 was used for statistical analysis of valid data. Categorical variables were described using frequencies and percentages, with between-group comparisons performed using ² tests. Continuous variables were expressed as means ± standard deviations, with normally distributed data compared using t-tests. P<0.05 was considered statistically significant. Univariate and multivariate logistic regression analyses were conducted with PI presence

as the dependent variable to identify influencing factors. Receiver operating characteristic (ROC) curve analysis was performed to evaluate the AUC, sensitivity, specificity, and Youden' s index of the Braden Scale total score and six subscales at different cutoff values for predicting PI and HAPI. AUC values range from 0 to 1, with higher values indicating greater accuracy [29]: <0.50 indicates no accuracy, \$ \$0.60 indicates poor accuracy, \$ \$0.70 indicates acceptable accuracy, \$ \$0.80 indicates good accuracy, and \$ \$0.90 indicates excellent accuracy [29-30]. Sensitivity represents the proportion of true PI cases correctly identified (0-100%), with higher values indicating better identification of true cases [29]. Specificity represents the proportion of non-cases correctly identified (0-100%), with higher values indicating better exclusion of false cases. Youden' s index (sensitivity + specificity - 1) evaluates the validity of cutoff values, ranging from 0 to 1, with higher values indicating better validity [29]. The cutoff value corresponding to the maximum AUC and Youden' s index was considered optimal.

2. Results

2.1 Basic Data

The survey yielded 60,555 valid cases (32,518 males [53.70%] and 28,037 females [46.30%]), with a mean age of 55.88 ± 17.16 years. Age distribution was: 18-49 years (34.92%, n=21,146), 50-59 years (20.00%, n=12,131), 60-69 years (22.24%, n=13,470), 70-79 years (14.22%, n=8,610), and ≥ 80 years (8.58 ± 8.38 g/L and 122.26 ± 22.99 g/L, respectively). The mean Braden score was 20.45 ± 3.44 points, with a median of 7 days. Department distribution was: internal medicine (n=27,212, 44.79%), surgery (n=24,887, 41.10%), neurology (5.19%), ICU (5.05%), geriatrics (2.09%), and others (obstetrics, ENT, ophthalmology, etc.) (1.62%).

2.2 Epidemiological Characteristics and Influencing Factors of Pressure Injury

The overall PI prevalence was 1.67% (n=1,010), with HAPI prevalence at 0.74% (n=448). Male patients exhibited significantly higher PI (2.08% vs. 1.19%) and HAPI (1.02% vs. 0.51%) prevalence than females (P<0.001). ICU patients showed the highest PI and HAPI prevalence (10.58% and 4.67%), followed by geriatric patients (4.97% and 1.34%). The ≥ 80 age group had the highest PI prevalence (5.98%), followed by the 70-79 age group (2.61%). The most common PI location was the sacrococcygeal area (61.09%, n=617), followed by heels (8.81%, n=89) and ankles (6.14%, n=62). The most frequent stage was Stage 1 (41.10%, n=415), followed by Stage 2 (31.78%, n=321), Stage 3 (8.81%, n=89), unstageable (8.32%, n=84), Stage 4 (6.14%, n=62), and deep tissue injury (3.86%, n=39).

Univariate analysis comparing PI and non-PI groups revealed significant differences in age, gender, Braden scores, serum albumin, hemoglobin, incontinence type, frequency, and duration, as well as bedridden status (Table 1). Multivariate logistic regression analysis (backward method) with PI presence as the dependent variable (0=absent, 1=present) and variables with $P < 0.05$ from univariate analysis as independent variables retained seven factors: Braden score, bedridden status, serum albumin, hemoglobin, gender, age, and incontinence type (incontinence frequency and duration were excluded). The model demonstrated excellent predictive performance with $AUC = 0.954$ (95% CI: 0.949-0.958), sensitivity=0.95, specificity=0.86, and Youden' s index=0.81 (Table 2 ; Figure 1 [Figure 1: see original paper]).

2.3 Predictive Efficacy of Braden Scale and Subscales

Multivariate logistic regression analysis with PI presence as the dependent variable and the six Braden subscales (sensory perception 1-4, moisture 1-4, activity 1-4, mobility 1-4, nutrition 1-4, friction/shear 1-3) as independent variables revealed that all six subscales were significantly associated with PI. The model achieved $AUC = 0.953$ (95% CI: 0.949-0.958), sensitivity=0.93, specificity=0.86, and Youden' s index=0.79 (Table 3 ; Figure 2 [Figure 2: see original paper]).

ROC curve analysis demonstrated the Braden Scale' s predictive accuracy across different departments and age groups (Table 4). Analysis of different cutoff values showed that \$ \$19 points yielded the maximum AUC and Youden' s index for predicting PI (Table 5).

3. Discussion

3.1 Epidemiological Profile of Pressure Injury in Chinese Tertiary Hospital Adults

This cross-sectional survey of 46 tertiary hospitals yielded PI and HAPI prevalence rates of 1.67% and 0.74% among 60,555 inpatients, with ICU patients showing the highest rates (10.58% and 4.67%). The predominance of Stage 1-2 injuries and common involvement of sacrococcygeal and heel areas are remarkably consistent with our 2014 multicenter study of 12 tertiary hospitals (PI: 1.58%, HAPI: 0.63%; ICU PI: 11.88%, HAPI: 4.48%) [30]. Given the broader geographic representation and larger sample size in the current study, these findings likely reflect the true epidemiological characteristics of PI in Chinese tertiary hospitals.

This study newly identified several clinically relevant risk factors. Univariate analysis confirmed that lower Braden scores correlated with higher PI incidence, consistent with the scale' s original design [9]. Male gender and advancing age were associated with increased PI risk, aligning with previous findings [30]. Novel discoveries included higher PI rates with dual incontinence compared to

fecal or urinary incontinence alone, dose-response relationships between incontinence frequency/duration and PI risk, and elevated risk with serum albumin <35 g/L, hemoglobin <120 g/L, and bedridden status.

Multivariate analysis revealed that Braden score, serum albumin, bedridden status, hemoglobin, incontinence type, age, and gender were independent predictors. Patients with Braden scores of 17-18, 15-16, 12-14, and ≤ 11 had 12.10-fold, 30.30-fold, 76.40-fold, and 167.76-fold increased PI risk, respectively, compared to those with scores ≥ 19 . Serum albumin <35 g/L and bedridden status increased PI risk by 2.14 and 2.22 times, respectively; hemoglobin <120 g/L increased risk by 1.52 times; dual incontinence increased risk by 2.41 times; and ages 60-69, 70-79, and ≥ 80 years conferred 1.38, 1.41, and 1.49 times greater risk, respectively, compared to ages 18-49. Male gender increased PI risk by 1.38 times. The seven-factor model combining Braden score with other variables achieved AUC=0.95, sensitivity=0.95, specificity=0.86, and Youden's index=0.81, demonstrating excellent accuracy and validity nearly identical to the six-factor Braden Scale model. These results confirm the Braden Scale's suitability for predicting PI risk in Chinese adult inpatients, offering advantages of fewer items, clear scoring criteria, ease of use by nurses, and time efficiency.

3.2 Predictive Validity of Braden Scale Across Settings

Despite 30 years of global use in PI prediction and prevention [10-19], substantial variation in Braden Scale performance across different countries and populations has complicated clinical decision-making. This multicenter study aimed to evaluate the scale's applicability and predictive value across diverse adult patient populations in Chinese tertiary hospitals. The Braden Scale demonstrated excellent predictive performance for PI and HAPI risk in 60,555 adult inpatients aged 18-105 years, with AUC and sensitivity values exceeding 0.90, accurately identifying over 90% of true PI and HAPI cases. This clinical significance lies in enabling nurses to efficiently identify at-risk patients among large inpatient populations, optimizing allocation of limited healthcare resources and improving preventive care effectiveness—the dual goals of risk assessment and PI management [1,7-8].

Department-specific analysis (Table 4) revealed excellent predictive performance in internal medicine, surgery, and neurology patients (AUC and sensitivity >0.90, Youden's index 0.72-0.88), good performance in geriatric patients (AUC and sensitivity >0.80), and acceptable performance in ICU patients (AUC >0.70, sensitivity >0.80). These findings align with a Mayo Clinic retrospective analysis of 12,556 ICU patients showing moderate predictive efficacy for HAPI (3.3%) [17], but exceed results from Thai (AUC=0.65 in 288 ICU patients) [22] and US (AUC=0.67 in 7,790 ICU patients) studies [18].

Age-stratified analysis demonstrated satisfactory predictive performance across 18-79 year age groups (AUC and sensitivity >0.90, Youden's index >0.74) and good performance in patients ≥ 80 years (AUC=0.89, sensitivity=0.90, Youden's

s index=0.62). These results contrast with a single-center Chinese retrospective study of 303 patients over 80 years that reported AUC=0.61 and concluded the Braden Scale was unsuitable for this population [20]. The discrepancy likely stems from differences in sample size and methodology. Our prospective multicenter design included 5,198 patients ≥ 80 years from 46 hospitals across 13 provinces, with all participating nurses receiving unified training and certification [26], using dual assessment and confirmation to minimize bias. These robust results support the Braden Scale's applicability across different departments and age groups in Chinese tertiary hospitals, though for critically ill ICU patients, supplementation with comprehensive severity assessments (e.g., evaluating potential impacts of hypoxia, fever, hyperglycemia, and hypoalbuminemia) may further enhance predictive efficacy [1,22].

3.3 Optimal Cutoff Value: Braden Score ≥ 19

Research continuously seeks to improve the predictive effectiveness of the Braden Scale and its subscales. Recent meta-analyses and systematic reviews show global cutoff values ranging from 12-18 to 14-20 points [13-15], with ICU-specific cutoffs concentrated at 12-13 points [18,22]. Chinese studies in ICU and emergency geriatric patients reported moderate efficacy for the ≥ 16 cutoff (AUC >0.71 , sensitivity and specificity >0.72) [18,24]. A US retrospective analysis of 7,790 ICU patients found that ≥ 16 points yielded high sensitivity (0.95) but low specificity (0.21), recommending ≥ 13 points for ICU patients [18,22]. The Mayo Clinic study suggested ≥ 18 points had good predictive efficacy for ICU patients [17]. The 2019 international guidelines reported sensitivity and specificity of 0.74 and 0.68, respectively, for ≥ 18 points, with AUC=0.77 [1]. A Singaporean case-control study found ≥ 17 points superior to ≥ 18 [16], while two Dutch intervention studies used ≥ 19 points [31-32].

Our results (Table 5) demonstrate that ≥ 19 points yields the maximum AUC, sensitivity, and Youden's index, indicating optimal predictive accuracy and validity. Synthesizing these findings with international literature showing cutoff values ranging from 12-20 points across different settings [14-15], we propose ≥ 19 points as the optimal cutoff for Chinese inpatients. This means patients scoring ≥ 19 should be identified as at-risk and receive preventive interventions.

3.4 Limitations

This cross-sectional study precludes longitudinal observation of dynamic Braden score changes in relation to PI development. Future longitudinal studies are needed to evaluate the effectiveness and cost-benefit of the ≥ 19 cutoff in predicting PI and HAPI across different hospital settings.

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