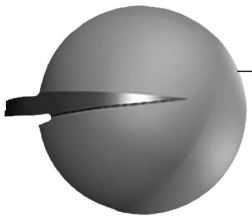

Original Article

Admission Braden Scale Score as an Early Independent Predictor of In-Hospital Mortality Among Inpatients With COVID-19: A Retrospective Cohort Study

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Key words
Braden Scale, COVID-19, frailty, outcomes

ABSTRACT

Background: The COVID-19 pandemic has put a strain on health systems. Predictors of adverse outcomes need to be investigated to properly manage COVID-19 patients. The Braden Scale (BS), commonly used for the assessment of pressure ulcer risk, has recently been proposed to identify frailty.

Objective: To investigate the predictive utility of the BS for prediction of in-hospital mortality in a cohort of COVID-19 patients admitted to non-ICU wards.

Methods: We conducted a retrospective single-center cohort study evaluating all patients with SARS-CoV-2 infection consecutively admitted over a 2-month period (from March 6 to May 7, 2020) to the COVID-19 general wards of our institution. Demographic, clinical, and nursing assessment data, including admission BS, were extracted from electronic medical records. Univariable and multivariable logistic regression models were used to explore the association between the BS score and in-hospital death.

Results: Braden Scale was assessed in 146 patients (mean age 74.7 years; 52% males). On admission, 46 had a BS ≤ 15, and 100 patients had a BS > 15. Mortality among patients with BS ≤ 15 was significantly higher than in patients with BS > 15 (45.7% vs. 16%; $p < .001$). On multivariable regression analysis, adjusting for potentials confounders (age, Barthel scale, chronic kidney disease, atrial fibrillation, and hypertension), the admission BS remained inversely associated with the risk of in-hospital mortality (OR = 0.76; 95% CI [0.60, 0.96]; $p = .020$).

Linking Evidence to Action: Admission BS could be used as a simple bedside predictive tool able to early identify non-ICU COVID-19 patients with poor prognosis who might benefit from specific and timely interventions.

INTRODUCTION

The ongoing COVID-19 pandemic is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which was first documented in China in late 2019 (Huang et al., 2020). Older age and chronic medical illnesses such as hypertension, diabetes, chronic cardiac disease, obesity, and history of cancer have been recognized as major risk factors for mortality in COVID-19 patients (Grasselli et al., 2020; Guan, Liang, et al., 2020; Guan, Ni, et al., 2020; Liang et al., 2020; Onder, Rezza, & Brusaferro, 2020; Richardson et al., 2020; Yang et al., 2020; Zhou et al., 2020). Frailty is a state of increased vulnerability to stressors and decreased functional reserve (Arendts et al., 2017; Jia et al., 2020; Walker et al., 2018) resulting from the interaction of progressive age-related decline in physiologic systems with chronic diseases. Previous studies have shown that frailty is an independent predictor of adverse outcomes in chronic and acute diseases (Clegg, Young, Iliffe, Rikkert, & Rockwood, 2013; Guan, Ni, et al., 2020). Recently, frailty has been identified as a predictor of poor prognosis (i.e., in-hospital mortality or ICU admission), even in hospitalized patients with COVID-19 (Bellelli, Rebora, Valsecchi, Bonfanti, & Citerio, 2020; Hewitt et al., 2020; Labenz et al., 2020).

Since December 2019, the COVID-19 pandemic has strained health systems in numerous countries because of the surge of severely ill patients needing hospitalization and supportive treatment. Given the limited number of resources, it is of pivotal importance to identify simple prognostic predictors that enable timely decisions for the optimal management of patients with COVID-19. A potential candidate predictor is the Braden Scale (BS).

The BS is a widely used indicator to predict pressure ulcer events. However, it is also recommended for use as a bedside frailty identification instrument, as it examines

several factors associated with frailty, such as function, nutrition, and cognition (Cohen et al., 2012; Cooper, 2013; Jia et al., 2020; Sørensen, Abdullah, & Nielsen, 2019).

Previous studies in different populations of hospitalized patients have shown that the BS may be associated with short-term mortality in acutely ill patients, especially with BS ≤ 15 (Bandle et al., 2017; Jentzer et al., 2019; Rothman, Solinger, Rothman, & Finlay, 2012; Sundaram et al., 2017). In the present study, we sought to examine BS as a potential marker of frailty in COVID-19 patients, defining its association with hospital mortality in this population after adjustment for other known outcome predictors.

METHODS

Study Design and Participants

We performed a retrospective cohort study of patients with laboratory-confirmed SARS-CoV-2 infection, consecutively admitted from March 6 to May 7, 2020, to the three COVID-19 general wards of the San Giovanni di Dio Hospital, a mid-size acute-care hospital (296 beds) in Florence, Italy. The COVID-19 general wards were created at the beginning of March 2020 in response to the outbreak of SARS-CoV-2 infection by converting one palliative care ward and two surgical wards. The wards were equipped with 11 single, eight double, and eight quadruple rooms (59 beds total). Patients were assigned to single rooms or multiple-bed rooms depending on availability. The COVID-19 wards were managed exclusively by dedicated internal medicine staff, with the collaboration of some specialist doctors and surgeons. Overall, the staff was comprised of 124 healthcare workers (61 nurses, 22 physicians, and 28 health assistants). The COVID-19 wards accounted for a total of 59 beds exclusively dedicated to patients with COVID-19 who did not require invasive mechanical ventilation or intensive care. The wards were equipped with a full electronic clinical records system (ARGOS software, Dedalus, Italy).

Patients were admitted to one of the three COVID-19 wards, on the basis of bed availability, from the emergency department, hospital medical ward, or as step down from the ICU. Inclusion criteria were age >18 years and hospitalization due to COVID-19 infection. The diagnosis of SARS-CoV-2 infection was suspected on the basis of clinical picture and pulmonary imaging and was confirmed using real-time reverse transcriptase-polymerase chain reaction assay on nasopharyngeal swab specimens.

For each patient, medical and nursing assessment were performed upon hospital admission, and a close monitoring of clinical progression was performed during the whole stay period. The BS was part of the nursing admission assessment.

Braden Scale

The BS was developed more than three decades ago to predict risk of skin pressure injury (Bergstrom, Braden, Laguzza, & Holman, 1987; Bergstrom, Demuth, & Braden, 1987). It is a bedside nursing assessment requiring no laboratory data that evaluate skin integrity and overall patient status by examining each of six factors: sensory perception, activity, mobility, moisture, nutrition, and friction/shear (Cooper, 2013). Each factor is assigned a score, defined by narrative descriptors, ranging from 1 to 4, with the exception of the friction/shear item, which varies from 1 to 3.

The *sensory perception* subscale measures a patient's ability to detect and subsequently relieve discomfort. The *activity* and *mobility* subscales are derived from separate but related concepts. Impairment of mobility, the ability to relieve pressure through movement, can occur in bedfast patients and is a separate concept from activity. The *moisture* subscale measures the degree of exposure of the skin to moisture. *Nutrition* reflects the usual food intake of the patient and offers a range from very poor to excellent. *Friction and shear* looks at the individual's ability to move independently or be moved and the degree of slippage (Bergstrom, Braden, et al., 1987; Bergstrom, Demuth, et al., 1987). The sum of the points attributed to each factor determines the risk of pressure ulcers, which is inversely related to the total score.

Data Collection

For each patient, a thorough and well-documented clinical history was collected on the electronic record at the admission to the ward by the physician and accepting nurse. Specific data were extracted from each patient enrolled to the study: age, sex, body mass index (BMI), BS (score of 6–23), Barthel scale (score of 0–12), comorbidities (myocardial infarction, stroke, diabetes mellitus, cancer, lung disease, chronic kidney disease, dialysis, atrial fibrillation, hypertension), and outcome (in-hospital mortality). These data were extracted from individual patient electronic medical records and stored in a spreadsheet by one nurse practitioner and two experienced medical doctors. Based on the BS score, the study population was divided into two groups: (1) patients with admission BS greater than 15, and (2) patients with admission BS ≤ 15 (corresponding to the lowest BS quartile).

Study Outcome

The outcome of the study was the in-hospital mortality. The association between admission BS score and in-hospital mortality was explored.

Statistical Analysis

Descriptive statistics (mean, median, *SD*, range, quartile) were used to describe the baseline characteristics of the sample data. For normally distributed continuous variables (described as the mean), analysis was performed using Student's *t* test. Categorical variables (described as the numbers of cases) were analyzed by the Pearson's chi-square test and the Fisher's exact test. Univariable and multivariable logistic regression models were used

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to determine the adjusted association between BS score on admission and in-hospital mortality. We then investigated the diagnostic accuracy of BS as a predictor of death in COVID-19 patients by receiver operating characteristic curve analysis. An area under the curve (AUC) of 0.97–1.00 indicates excellent accuracy, 0.93–0.96 indicates very good accuracy, and 0.75–0.92 indicates good accuracy.

Differences were considered significant for a value of $p < .05$. The analyses were carried out using Med-Calc® version 12.3.0 (MedCalc Software Ltd, Ostend, Belgium) and GNU PSPP Statistical Analysis Software PSPP program.

Ethics

The authors declare that all procedures performed in this study are in accordance with ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study was approved by the Institutional Review Board of the Department of Internal Medicine and by the Hospital Management. Data have been de-identified to preserve participant anonymity.

RESULTS

Between March 6 and May 7, 2020, a total of 146 patients were admitted to the three COVID-19 general wards. Overall, the mean (*SD*) age of patients in the cohort was 74.7 (± 13.2) years, and 76 patients (52%) were males. Demographics (age and gender), nursing assessments (BS, BMI, and Barthel scale), and clinical characteristics (myocardial infarction, stroke, diabetes mellitus, cancer, lung disease, chronic kidney disease, dialysis, atrial fibrillation, and hypertension) of the study population are shown in Table 1. The admission BS score ranged from 9 to 23, with a median value of 18. The lowest quartile is a value of 15 (interquartile range, 6). One hundred patients had an admission BS > 15, and 46 patients had an admission BS ≤ 15. Compared to patients with an admission BS > 15, patients with an admission BS ≤ 15 were significantly older ($p < .001$), had a lower BMI ($p = .042$) and Barthel scale score ($p < .001$), and were more frequently affected by myocardial infarction ($p = .034$), atrial fibrillation ($p = .008$) and hypertension ($p = .002$; Table 1).

Overall, 37 (25.3%) of 146 patients died during the hospitalization. Of these, 21 (56.8%) had an admission BS ≤ 15, and 16 (43.2%) had an admission BS > 15. The mortality rate of patients with BS ≤ 15 was significantly higher than that observed in patients with BS > 15 (45.7% vs. 16%, $p < .001$; Table 2).

The AUC for the BS for the prediction of death was 0.75 (95% CI [0.68, 0.82]; Figure 1). Using the cutoff of 15, the sensitivity was 0.85, and the specificity was 0.57.

Age ($p < .001$), admission BS ($p < .001$), Barthel scale ($p = .001$), the presence of chronic kidney disease ($p = .009$), atrial fibrillation ($p = .009$), and hypertension ($p = .020$)

Table 1. Baseline Characteristics of the Study Population, Patients With Admission BS > 15, and Patients With Admission Braden Scale (BS) ≤ 15 (Corresponding to the Lowest Quartile Of Admission BS)

Variables	Study population	Admission BS ≤ 15	Admission BS > 15	*p* value (BS ≤ 15 vs. BS > 15)
Patients, number	146	46	100	
Age, years, mean (*SD*)	74.7 (± 13.2)	84 (± 7)	70 (± 13)	<.001
Female, number (%)	70 (47.9%)	26 (56.5%)	44 (44%)	.159
BMI, mean (*SD*)	26.3 (± 4.6)	25.2 (± 4.1)	26.8 (± 4.7)	.042
Barthel scale, mean (*SD*)	6.8 (± 4.5)	2.1 (± 2.5)	9.1 (± 3.4)	<.001
Myocardial infarction, number (%)	19 (13%)	2 (4.3%)	17 (17%)	.034
Stroke, number (%)	15 (10.2%)	7 (15.2%)	8 (8%)	.182
Diabetes mellitus, number (%)	32 (21.9%)	9 (19.5%)	23 (23%)	.641
Cancer, number (%)	16 (10.9%)	5 (10.8%)	11 (11%)	.981
Lung disease, number (%)	22 (15%)	8 (17.3%)	14 (14%)	.594
Chronic kidney disease, number (%)	20 (13.6%)	8 (17.3%)	12 (12%)	.378
Dialysis, number (%)	5 (3.4%)	1 (2.1%)	4 (4%)	.573
Atrial fibrillation, number (%)	29 (19.8%)	15 (32.6%)	14 (14%)	.008
Hypertension, number (%)	78 (53.4%)	33 (71.7%)	45 (45%)	.002

Note. BS = Braden Scale.

Table 2. In-Hospital Mortality and Baseline Characteristics of Deceased Patients

Variables	Study population	Admission BS ≤ 15	Admission BS > 15	*p* value (BS ≤ 15 vs. BS > 15)
Deaths, number (%)	37/146 (25.3%)	21/46 (45.7%)	16/100 (16%)	<.001
Age, years, mean (*SD*)	82.7 (± 8.1)	85.3 (± 6.5)	79.3 (± 9.1)	.027
Female, number (%)	15 (40.5%)	9 (42.8%)	6 (37.5%)	.742
BMI, mean (*SD*)	25.3 (± 4.4)	24.4 (± 4.3)	26.4 (± 4.5)	.190
Barthel scale, mean (*SD*)	4.7 (± 4.1)	2.1 (± 2.5)	8 (± 3.4)	<.001
Myocardial infarction, number (%)	7 (18.9%)	2 (9.5%)	5 (31.2%)	.202
Stroke, number (%)	6 (16.2%)	4 (19%)	2 (12.5%)	.679
Diabetes mellitus, number (%)	11 (29.7%)	4 (19%)	7 (43.7%)	.151
Cancer, number (%)	6 (16.2%)	2 (9.5%)	4 (25%)	.370
Lung disease, number (%)	7 (18.9%)	5 (23.8%)	2 (12.5%)	.674
Chronic kidney disease, number (%)	10 (27%)	5 (23.8%)	5 (31.2%)	.613
Dialysis, number (%)	3 (8.1%)	0 (0%)	3 (18.7%)	.072
Atrial fibrillation, number (%)	13 (35.1%)	9 (42.8%)	4 (25%)	.314
Hypertension, number (%)	26 (70.2%)	16 (76.1%)	10 (62.5%)	.366

Note. BS = Braden Scale.

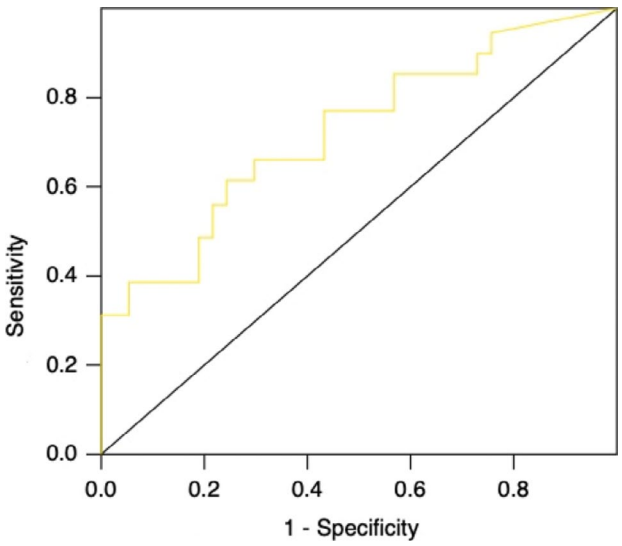

Figure 1. Receiver operating characteristic (ROC) curve for the Braden Scale

were related to a higher probability of death on univariable analysis (Table 3). In the multivariable regression analysis, admission BS, age, and chronic kidney disease remained associated with the risk of hospital mortality (BS: adjusted OR = 0.76; 95% CI [0.60, 0.96]; $p = .020$; age: adjusted OR = 1.07; 95% CI [1.01, 1.13]; $p = .018$; chronic kidney disease: adjusted OR = 3.84; 95% CI [1.26, 12.50]; $p = .018$; Table 4).

DISCUSSION

The results of the present study indicate the usefulness of the BS for risk stratification at hospital admission in patients with COVID-19. BS has proven to be a simple and quick bedside assessment tool capable of assessing skin integrity as well as elements of frailty syndrome. This nursing assessment seems very relevant for predicting COVID-19 patients' outcomes. In this COVID-19 cohort, a lower BS at the time of hospital admission was indicative of an increased risk of hospital mortality.

Although the association between age and comorbidities and the prognosis of COVID-19 infected patients appears obvious, our data support the hypothesis that BS may be an additional relevant determinant of adverse outcomes. Furthermore, our findings highlight that it may not simply be the age that determines a more severe course of COVID-19 infection but rather frailty before hospitalization.

A BS less than or equal to 15 (the lowest quartile) is indicative of higher hospital mortality. The mortality risk assessment can be improved by using the BS, which explores more aspects of a patient's clinical status than those examined by other existing risk assessment tools (Jentzer et al., 2019). The results obtained also highlight the importance of frailty in defining outcomes in COVID-19 patients,

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Table 3. Predictors of Hospital Mortality-Univariable Analysis

Variables	Unit OR	95% CI	*p* value
Age, years*	1.09	1.04–1.13	<.001
Male sex (vs. female)	1.49	0.70–3.18	.298
BMI	0.92	0.84–1.02	.106
Admission BS*	0.78	0.70–0.88	<.001
Barthel scale*	0.86	0.79–0.94	.001
Myocardial infarction	1.88	0.68–5.22	.222
Stroke	2.15	0.71–6.51	.176
Diabetes mellitus	1.77	0.75–4.15	.187
Cancer	1.91	0.64–5.70	.242
Lung disease	1.46	0.54–3.92	.450
Chronic kidney disease	3.66	1.38–9.71	.009
Dialysis	4.72	0.75–29.43	.097
Atrial fibrillation	3.14	1.33–7.42	.009
Hypertension	2.59	1.16–5.76	.020

Note. * = per 1-unit increase; BMI = body mass index; BS = Braden Scale.

Table 4. Predictors of Hospital Mortality – Multivariable Analysis (Logistic Regression Model)

Variables	Unit OR	95% CI	*p* value
Age, years*	1.07	1.01–1.13	.018
Admission BS*	0.76	0.60–0.96	.020
Barthel scale*	1.17	0.96–1.42	.128
Chronic kidney disease	3.84	1.26–12.50	.018
Atrial fibrillation	1.66	0.63–4.34	.302
Hypertension	1.20	0.46–3.12	.700

Note. * = per 1-unit increase; BS = Braden Scale.

as the BS investigates some typical components of frailty, such as mobility and nutritional status.

Previous studies have considered BS as a predictor of hospital mortality risk in other patient cohorts (Bandle et al., 2017; Rothman et al., 2012; Sundaram et al., 2017). Rothman et al. (2012) found that in a large cohort of hospitalized patients there was an association between mortality and reduced skin integrity (defined by a BS ≤ 15).

The study by Bandle et al. (2017) found that out of 642 hospitalized patients with heart failure, BS predicted mortality at 30 days (OR 0.81) and home discharge (OR 1.66) after adjusting for other variables. In a study by Sundaram et al. (2017) including 341 liver transplant patients, patients with hospitalized BS less than or equal to 15 had higher rates of short-term mortality, non-ambulatory status, and discharge to a rehabilitation facility. The recent Jentzer et al. (2019) study found that an admission BS ≤ 15 was associated with an increased risk of hospital mortality among patients with acute coronary syndromes (19.8% vs. 3.0%; OR = 8.02; 95% CI [6.20, 10.39]; $p < .001$) or heart failure (21.4% vs. 6.2%; OR = 4.10; 95% CI [3.32, 5.07]; $p < .001$).

The BS has undergone the most extensive psychometric testing of all pressure ulcer risk tools, proving to be a highly reliable and repeatable assessment method (Bolton, 2007; Pancorbo-Hidalgo, Garcia-Fernandez, Lopez-Medina, & Alvarez-Nieto, 2006). Initial reliability studies, conducted in skilled nursing facilities, yielded interrater reliability coefficients (r) ranging from 0.83 to 0.99 ($p < .001$). In the critical care population, an interrater reliability of 0.89 ($p < .001$) was recorded (Bergstrom, Demuth, et al., 1987).

The current investigation emphasizes the relevance of nursing assessments such as BS for predicting outcomes in COVID-19 patients. As a potential indicator of frailty by acquiring prognostically relevant components, the BS can naturally integrate both acute disease severity and chronic health status to identify the patient's overall clinical status in a way that complements age. Unlike many other frailty measures, the BS requires neither laboratory data nor specialized clinical evaluations that may not be available at hospital admission. Consequently, the BS appears to be a simple bedside tool for nurses and physicians that can quickly inform COVID-19 patient prognosis, favoring an appropriate clinical management. In particular, the BS could be used to enhance the predictive risk of mortality provided by age, as patients of the same age may have different levels of frailty. Patients with a low BS upon admission should be considered as high risk for deterioration and should receive close monitoring and increased intensity of care. Indeed, the presence of a low

BS score in association with an advanced age or other risk factors for poor prognosis could be used to establish a treatment limitation decision and shift the patient to palliative treatment.

Severe COVID-19 is characterized by respiratory failure and is often accompanied by prolonged immobilization, which can cause reduction in muscle function. Moreover, COVID-19 patients present with a high risk of malnutrition related to chronic comorbidities and reduction of food intake caused by dyspnea, nausea, and loss of appetite (Brugliera et al., 2020). A repeated assessment of the BS during the hospital stay would allow clinicians to evaluate and monitor these aspects of COVID-19. Implementation of comprehensive interventions primarily aimed at improving the BS score such as functional exercise, early mobilization, compliance with drugs, nutrition intake, and adequate diet could even improve the prognosis of frail patients with COVID-19.

Our study has several limitations that have to be acknowledged. First, our investigation was retrospective and subject to the biases inherent to this study design. However, we tried to minimize bias by evaluating objectively verifiable variables. Moreover, the BS assessments were completed by frontline nursing staff in the course of routine clinical care in all patients, and we observed no missing data. Second, the validity and interrater reliability of these assessments have not been confirmed. Third, we reported data from a relatively small number of patients from a single center. Therefore, we do not know if our data can be generalized to wards in other hospitals and in other geographic areas.

LINKING EVIDENCE TO ACTION

- Admission BS could be used as a simple bedside predictive tool able to early identify non-ICU COVID-19 patients with poor prognosis who might benefit from specific and timely interventions, such as care intensity elevation or palliative treatment initiation.
- Prospective studies are needed to confirm these findings and explain how the information provided by the BS can be used to improve COVID-19 patient care.

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