Original Article

MEDICINE PALLIATIVE CARE

DOI: 10.47582/jompac.1316995

J Med Palliat Care. 2023;4(4):288-295

Evaluation of pressure ulcer development and risk factors in COVID-19 patients followed in the ICU

Özlem Öner[1], Mehmet Çağatay Gürkok[2], Mehmet Nuri Yakar[1], Begüm Ergan[3], Erdem Yaka[4], Ali Necati Gökmen[1]

[1]Subdivision of Critical Care Medicine, Department of Anesthesiology and Reanimation, Faculty of Medicine, Dokuz Eylül University, İzmir, Turkey
[2]Subdivision of Critical Care Medicine, Department of General Surgery, Faculty of Medicine, Dokuz Eylül University, İzmir, Turkey
[3]Subdivision of Critical Care Medicine, Department of Pulmonary, Faculty of Medicine, Dokuz Eylül University, İzmir, Turkey
[4]Subdivision of Critical Care Medicine, Department of Neurology, Faculty of Medicine, Dokuz Eylül University, İzmir, Turkey

Cite this article as: Öner Ö, Gürkok MÇ, Yakar MN, Ergan B, Yaka E, Gökmen AN. Evaluation of pressure ulcer development and risk factors in COVID-19 patients followed in the ICU. *J Med Palliat Care*. 2023;4(4):288-295.

Received: 24.06.2023 ◆ **Accepted**: 31.07.2023 ◆ **Published**: 30.08.2023

ABSTRACT

Aims: In this study it was aimed to evaluate the causes of pressure ulcer development in COVID-19 patients followed in the intensive care unit (ICU).

Methods: Demographic data, comorbidities, laboratory parameters, treatment modalities and mortality rates of the patients were reviewed retrospectively from hospital records. In addition, Acute Physiology and Chronic Health Assessment (APACHE II), Sequential Organ Failure Assessment (SOFA), and modified NUTRIC scores were calculated. Braden scale was used for pressure ulcer evaluation.

Results: Eighty COVID-19 patients were included in the study. Pressure ulcers (PU) were detected in 29 (36.25%) of the cases, and no pressure ulcer was detected in 51 (63.75%) cases. 54 (69.7%) of the patients were male, 26 (32.5%) were female, and the mean age was 69 (61-77). The cases were divided into two groups according to the development of pressure ulcers. The APACHE II score was 24 (17-29) in the PU group and 18 (12-23) in the non-PU group (p=0.01), the mNUTRIC score was 4 (3-5) in the PU group and 3 (2-4) in the non-PU group.) (p=0.023), the Braden scale calculated at admission to the ICU was 11(10-13) in the PU group and 14(12-15) (p<0.001) in the non-PU group. A Braden scale score of <13 was found to be 22 (75.9) in the PU group and 14 (27.5) in the non-PU group, and 36 (45) patients in total (p<0.001).

Conclusion: The Braden Scale can be used in COVID-19 patients, since they are first admitted to the ICU, both for scoring the wound and predicting the (making a) prognosis quickly.

Keywords: COVID-19, pressure ulcer, ICU, Braden scale, mortality

INTRODUCTION

The viral outbreak caused by the novel coronavirus SARS-CoV-2 is responsible for the ongoing coronavirus (COVID-19) pandemic.[1] 30% of patients infected with COVID-19 are treated in the intensive care unit (ICU) for acute respiratory distress syndrome (ARDS), which requires emergency respiratory and hemodynamic support.[2] The mortality rate in COVID-19 patients followed with invasive mechanical ventilator therapy in the ICU is between 40-60%.[3] In addition to high mortality rates, the average duration of treatment for COVID-19 patients treated in the ICU is 9 (6-13) days.[4] In addition to the long duration of treatment, inactivity due to long-term follow-up on mechanical ventilators, advanced age, presence of various comorbidities, intense cytokine storm due to the nature of COVID-19 disease, prone position and use of various devices, excessive sedation, conditions such as lack of care and hygiene before and after the intensive care unit, changing positions less frequently than necessary in the ICU, malnutrition and deterioration of tissue perfusion may cause the development of pressure ulcers.[5]

The development of pressure ulcers (PU) is multifactorial and can occur in any part of the body, including the face, that is under pressure and if adequate precautions are not taken.[6] The consequences of pressure-induced skin and soft tissue injury ranges from unfading erythema of intact skin to deep ulcers extending to the bone.[7]

For optimal management of patients with pressure ulcers, it is necessary to identify simple prognostic predictors that will enable timely decisions to be made and cooperation between physician and nursing care.[12] One

Corresponding Author: Ozlemoner Öner, namdaroner@gmail.com

of the candidates with predictive potential for PU is the Braden scale.[13] The Braden scale (BS) is a commonly used indicator to predict the future of PU and its relationship with mortality rates.[14]

Our aim in this study is to investigate the causes of pressure ulcer development and possible risk factors in COVID-19 patients followed in the intensive care unit. In addition, our hypothesis is to investigate whether the Braden score can be used in COVID-19 patients who develop pressure ulcers.

METHODS

The study was carried out with the permission of Dokuz Eylül University Non-interventional Researches Ethics Committee (Date:25.08.2021, Decision No:2021/24-02). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Eighty patients who were diagnosed with polymerase chain reaction (PCR) test and admitted to the intensive care unit between April and October 2020 were included in the study. Patients younger than 18 years of age, those who were in the intensive care unit for less than 24 hours, and those with insufficient medical knowledge and anamnesis were excluded from the study. Pregnant and lactating patients were also excluded from the study. Demographic data, medical histories, comorbidities, laboratory parameters, major events and treatment modalities, nutritional status, respiratory support and method, and mortality rates were reviewed retrospectively from hospital records.

Disease severity within the first 24 hours after each patient's admission to the ICU was calculated according to the relevant scoring criteria of the Acute Physiology and Chronic Health Assessment (APACHE II) and Sequential Organ Failure Assessment (SOFA).[15,16] Nutritional risk for each patient was assessed at ICU admission using the mNUTRIC score. The score, calculated by subtracting IL-6 values, consisted of five variables: age, APACHE II score, and SOFA score at admission, patient comorbidity, and length of hospital stay before the intensive care unit.[17] It has been reported that a modified NUTRIC score of 5 and above indicates that the patient has a high risk in terms of nutrition.[17] PU is divided into 4 grades by the European Pressure Ulcer Advisory Panel (EPUAP).[18] These stages are important in the detection and treatment of ulcers.

Stage 1: There is a spotless rash in a localized area, usually over bony prominences.

Stage 2: A scaleless red-pink sore, partial thickness loss of dermis presenting as an open ulcer. Bullas may develop.

Stage 3: Full thickness tissue loss. Subcutaneous fat may be visible, but bones, tendons, or muscles are not exposed. Dead skin may be present but does not hide the depth of tissue loss.

Stage 4: There is full-thickness tissue loss with exposed bone, tendon, or muscle.

There may be abrasions or crusts in some parts of the wound.

The Braden scale values of the patients were obtained from the nursing care records included in the patient observations.

The Braden scale includes six risk factors: sensory perception, moisture, activity, mobility, nutrition, and irritation / friction. Except for friction and irritation, each variable is scored between 1-4.[19] The total score of the scale is obtained by calculating the sum of the scores obtained from each of the sub-dimensions of the scale. The total score of the scale is obtained by summing the scores obtained from each of the sub-dimensions of the scale. The total score varies between 6-23. As the scores obtained from the scale decrease, the risk of pressure ulcer development increases.

Individuals with a scale score of 9 and below are considered to be at very high risk for the development of pressure ulcers, those of 10-12 are considered to be high-risk, those of 13-14 are considered to be medium risk, those of 15-18 are considered to be at low risk, and those above 18 are considered to be at no risk.[20]

As recommended by the American Society for Parenteral and Enteral Nutrition (ASPEN) and the European Society for Parenteral and Enteral Nutrition (ESPEN);[21,22] The daily caloric intake of the patients was planned as 14 kcal/kg/day for patients with a body mass index (BMI) above 30 kg/m², and as 25 kcal/kg/day for patients with a body mass index below 30 kg/m². From patient observations, the planned calories and the day the target calories were reached during the first 14 days were recorded. Inaddition, the diet of the patients, the reasons for the interruption, whether they received additional vitamin support or not were recorded.

Statistical Analysis and Calculations of Sample Size

To define the retrospective power of the observed effect based on the sample size, we performed a post-hoc power analysis using G*Power 3.1.9.7 software. Participants were divided into two groups: Pressure Ulcer (n=29) and No-Pressure Ulcer (n=51). We used an alpha (α) error probability rate of 0.05 with an 0.80 effect size, and the power (1- β error probability) was 0.924.

All continuous variables were presented as mean standard deviation [SD] or median (IQR), and categorical variables were presented as numbers and percentage (%). Descriptive statistics for all variables were calculated with Student's t-test, Mann Whitney U-Test 2 or Fisher's Exact Test. Multivariate logistic regression analysis was

performed to investigate pressure ulcer risk factors. A p value of <0.05 was considered statistically significant. SPSS 26.0 Statistical Package was used for all analyses.

RESULTS.

Of the 109 COVID-19 patients admitted to the intensive care unit, 80 patients were included in the study. Patient selection is shown in the flow-chart (**Figure 1**). While pressure ulcers were detected in 29 (36.25%) of the cases, no pressure ulcer was detected in 51 (63.75%) cases. 54 (69.7%) of the patients were male, 26 (32.5%) were female, and the mean age was 69 (61-77). Patients included in the study were divided into two groups (PU and non-PU) according to the development of pressure ulcers. The mean age of the PU group was 78 (71-84), and the non-PU group was 65 (59-70) years old (p<0.001) (**Table 1**).

When the cases are evaluated in terms of disease scores, nutrition and wound site scores; the APACHE II score was 24 (17-29) in the PU group and 18 (12-23) in the non-PU group (p=0.01), the mNUTRIC score was 4 (3-5) in the PU group and 3 (2-4) in the non-PU group (p=0.023), the Braden scale calculated at admission to ICU was 11(10-13) in the PU group and 14(12-15) (p<0.001) in the non-PU group and those with a Braden scale <13 were found to occur in 22 (75.9) patients in the PU group and 14 (27.5) patients in the non-PU group, and 36 (45) patients in total (p<0.001) (**Table 1**).

Table 1. Demographic data, comorbidities and clinical outcomes of the patients

	All Patients (n=80)	Pressure Ulcer (PU)		p Value
		PU (n=29)	Non-PU (n=51)	
Age	69 (61-77)	78 (71-84)	65 (59-71)	< 0.001
Gender male	54 (66.7)	19 (65.5)	35 (68.6)	0.81
BMI, kg/m²	27.0 (24.0-32.0)	25.0 (22.5-31.0)	27.0 (25.0-33.0)	0.07
APACHE II score	20 (14-27)	24 (17-29)	18 (12-23)	0.010
SOFA score*	8 (6-11)	8 (8-11)	8 (4-10)	0.10
GCS (admission to ICU)	13 (7-15)	10 (7-14)	15 (7-15)	0.08
NUTRIC score	3 (2-4)	4 (3-5)	3 (2-4)	0.023
Braden scale (admission to ICU)	13 (10-15)	11 (10-13)	14 (12-15)	< 0.001
Braden scale <13	36 (45)	22 (75.9)	14 (27.5)	< 0.001
Comorbidities	72 (90)	27 (93.1)	45 (88.2)	0.70
Hypertension	50 (61.7)	19 (65.5)	31 (60.8)	0.81
Diabetes Mellitus	32 (39.5)	14 (48.3)	18 (35.3)	0.34
COPD	16 (19.8)	5 (17.2)	11 (21.6)	0.78
Congestive Heart Failure	13 (16.0)	6 (20.7)	7 (13.7)	0.53
Chronic Liver Failure	13 (16.0)	5 (17.2)	8 (15.7)	1.00
Atrial Fibrillation	11 (13.6)	7 (24.1)	4 (7.8)	0.09
Chronic Renal Failure	9 (11.1)	3 (10.3)	6 (11.8)	1.00
Cerebrovascular Disease	8 (9.9)	2 (6.9)	6 (11.8)	0.70
Malignancy	8 (9.9)	7 (24.1)	1 (2.0)	0.003
Dementia	6 (7.4)	5 (17.2)	1 (2.0)	0.022
Parkinson's Disease	2 (2.5)	1 (3.4)	1 (2.0)	1.00
Duration of Stay (days)				
Hospital Stay	17 (10-24)	16 (8-26)	17 (10-23)	0.78
ICU Stay	10 (5-14)	8 (3-14)	10 (6-14)	0.19
Pressure Ulcer Features				
Location				
Sakral	22 (27.5)	22 (75.9)	N/A	N/A
Gluteal	4 (5.0)	4 (13.8)	N/A	N/A
Back	1 (1.3)	1 (3.4)	N/A	N/A
Other	2 (2.5)	2 (6.9)	N/A	N/A
Stage				
Stage I	23 (28.8)	23 (79.3)	N/A	N/A
Stage II	5 (6.3)	5 (17.2)	N/A	N/A
Stage III	1 (1.3)	1 (3.4)	N/A	N/A
Measure				
Size ≤ 5 cm²	7 (8.8)	7 (24.1)	N/A	N/A
5 cm² <Dimension≤ 10 cm²	14 (17.5)	14 (48.3)	N/A	N/A
10 cm² <Dimension ≤ 15 cm²	6 (7.5)	6 (20.7)	N/A	N/A
Size > 15 cm²	2 (2.5)	2 (6.9)	N/A	N/A
Mortality				
Hospital	58 (71.6)	25 (86.2)	33 (64.7)	0.042
ICU	56 (69.1)	24 (82.8)	32 (62.7)	0.08

All values were expressed as n (%) or median (IQR). PU: Pressure Ulcer; BMI: Body Mass Index; APACHE II Score: Acute Physiology and Chronic Health Assessment Score; SOFA Score: Sequential Organ Failure Assessment Score; GCS: Glasgow Coma Scale; NUTRIC Score: Critical Patient Nutritional Risk Score; COPD: Chronic Obstructive Pulmonary Disease; N/A, Not Valid; ICU: Intensive Care Unit., *Calculated on the Day of Admission to the ICU.

When evaluated in terms of laboratory data the statistical significance was determined as follows ; hemoglobin (g/dL) was 11.3 (9.7-13.2) in the PU group and 12.8 (11.5-14) in the non-PU group (p=0.006), BUN (mg/dL) was 52 (29.5-92) in the PU group and in the non-PU group 27 (21-43) (p<0.001) in the group, creatinine (mg/dL) was 1.81 (0.83-3.61) in the PU group, and 0.85 (0.75-1.41) (p=0.016) in the non-PU group, HS troponin I (ng/mL) 64 (14-503) in the PU group and 18 (11-59) in the non-PU group (p=0.004), D-dimer (µg/mL) 3.60 (1.91-5.82) in the PU group and 3.60 (1.91-5.82) in the non-PU group 1.10 (0.80-2.50) (p<0.001) and procalcitonin (ng/mL) in the PU group 1.29 (0.33-4.01) in the PU group and 0.27 (0.11-0.87) in the non-PU group (p<0.001) (Table 2).

When the nutritional status of the patients is evaluated; target calories were calculated as 1350 (1270-1475) in the PU group and 1420 (1330-1530) in the non-PU group (p=0.048). In terms of reaching the target calories, on the 1st day of admission to the ICU, it was 800 (425-1200) in the PU group, 1200 (800-1400) (p=0.024) in the non-PU group, and in the 5th, day was 1200 (960-1440) in the PU group, 1400 (1200-1500) (p=0.025) in the non-PU group, and were found to be statistically significant (Table 3). When multivariate regression analysis of independent risk factors related to pressure ulcer developing in COVID-19 patients followed in the ICU was performed; Braden scale to be <12 7.60 (1.94-29.75) (p=0.004) and D-dimer to be >1.72 µg/mL 6.59 (1.66-26.20) (p=0.007) OR (95% CI) were found to be statistically significant (Table 4).

Table 4. Analysis of independent risk factors for pressure ulcers in critically ill patients with COVID-19

	OR (95% CI)	p Value
Braden scale ≤12	7.60 (1.94-29.75)	0.004
APACHE II score	1.04 (0.97-1.13)	0.28
D-dimer> 1.72 µg/Ml	6.59 (1.66-26.20)	0.007
Malignancy	11.72 (0.99-138.99)	0.05
Flux	3.71 (0.94-14.73)	0.06
Supplemental protein supplement	0.39 (0.06-2.44)	0.32

OR, odds ratio; CI, confidence interval;

Table 2. Laboratory data of the patients on the day of admission to the intensive care unit

Laboratory Values*	All Patients (n=80)	Pressure Ulcer (PU)		p Value
		PU (n=29)	Non-PU (n=51)	
WBC, ×10³/µL	11.95 (9.28-16.10)	14.10 (10.10-18.95)	11.70 (8.90-15.60)	0.28
Neutrophil ×10³/µL	9.60 (8.20-13.68)	10.80 (7.70-14.40)	9.45 (8.20-13.10)	0.66
Hemoglobin, g/dL	12.4 (10.9-13.5)	11.3 (9.7-13.2)	12.8 (11.5-14.0)	0.006
Lymphocyte ×10³/µL	0.5 (0.3-0.8)	0.5 (0.3-1.0)	0.5 (0.4-0.7)	0.59
Platelet, ×10³/µL	271.0 (200.5-372.5)	288.0 (190.5-370.5)	268.0 (211.0-385.0)	0.60
BUN, mg/dL	33.0 (23.3-58.0)	52.0 (29.5-92.0)	27.0 (21.0-43.0)	< 0.001
Creatinine, mg/dL	1.00 (0.75-2.03)	1.81 (0.83-3.61)	0.85 (0.75-1.41)	0.016
Total Bilirubin, mg/dL	0.90 (0.62-1.10)	0.83 (0.58-1.07)	0.91 (0.64-1.10)	0.68
CRP, mg/L	150.5 (74.3-202.3)	157.0 (97.0-233.5)	147.0 (71.0-197.0)	0.44
AST, U/L	48 (33-75)	42 (31-96)	49 (34-73)	0.77
LOWER, U/L	33 (23-65)	30 (19-66)	36 (24-64)	0.28
LDH, U/L	564 (406-710)	570 (312-675)	559 (450-742)	0.53
Albumin, g/dL	3.06 (2.72-3.23)	3.00 (2.53-3.19)	3.07 (2.80-3.28)	0.11
Ferritin, ng/mL	463 (301-924)	426 (261-737)	554 (332-1124)	0.12
HS Troponin I, ng/L	25 (11-86)	64 (14-503)	18 (11-59)	0.004
D-Dimer, µg/mL	1.72 (0.94-4.40)	3.60 (1.91-5.82)	1.10 (0.80-2.50)	< 0.001
D-Dimer> 1.72 µg/mL	40 (50)	23 (79.3)	17 (33.3)	< 0.001
Procalcitonin, ng/mL	0.52 (0.15-2.39)	1.29 (0.33-4.01)	0.27 (0.11-0.87)	0.007

All values were expressed as n (%) or median (IQR). PU: Pressure Ulcer; WBC:Leukocyte; BUN, Blood Urea Nitrogen; CRP, C-Reactive Protein; AST: Aspartate Transaminase; ALT: Alanine Transaminase; LDH: Lactate Dehydrogenase; HS Troponin I: High Sensitivity troponin I. *Calculated on the day of admission to ICU.

Tablo 3. Major events and treatment modalities

	All Patients (n=80)	Pressure Ulcer		p value
		PU (n=29)	Non-PU (n=)	
Respiratory support time				
HFNO, days	1 (0-3)	0 (0-2)	2 (0-4)	0.015
NIMV, days	0 (0-1)	0 (0-2)	0 (0-1)	0.67
IMV, days	3 (0-10)	3 (1-12)	3 (0-9)	0.35
Termination of respiratory support	60 (75.0)	24 (82.8)	36 (70.6)	0.17
Treatment modalities				
FLUX	36 (45.0)	19 (65.5)	17 (33.3)	0.010
RRT	24 (30.0)	11 (37.9)	13 (25.5)	0.31
Sedation	60 (75.0)	24 (82.8)	36 (70.6)	0.29
Vasopressor need	58 (72.5)	24 (82.8)	34 (66.7)	0.11
Corticosteroid therapy	68 (85.0)	22 (75.9)	46 (90.2)	0.11
Pulse corticosteroid therapy	32 (40.0)	7 (24.1)	25 (49.0)	0.035
Tocilizumab	7 (8.8)	0 (0.0)	7 (13.7)	0.045
Tracheostomy	1 (1.3)	1 (3.4)	0 (0.0)	0.36
Prone position	38 (47.5)	7 (24.1)	31 (60.8)	0.002
Nutritional properties				
Nutritional route, enteral	80 (100.0)	29 (100.0)	51 (100.0)	N/A
Additional protein support	22 (27.5)	2 (6.9)	20 (39.2)	0.002
Additional vitamin support	70 (87.5)	24 (82.8)	46 (90.2)	0.48
Target calories, kcal	1400 (1300-1520)	1350 (1270-1475)	1420 (1330-1530)	0.048
Continuation and Cessation of Feeding				
Planned	16 (20.0)	7 (24.1)	9 (17.6)	0.57
Vomiting	9 (11.3)	6 (20.7)	3 (5.9)	0.07
Bleeding	7 (8.8)	4 (13.8)	3 (5.9)	0.25
Abdominal distention	3 (3.8)	1 (3.4)	2 (3.9)	1.00
to continue uninterrupted	50 (62.5)	14 (48.3)	36 (70.6)	0.06
Nutritional support, kcal				
1st day of admission to ICU	1200 (600-1375)	800 (425-1200)	1200 (800-1400)	0.024
2nd day of admission to ICU	1300 (1000-1485)	1200 (875-1400)	1400 (1200-1500)	0.003
3rd day of admission to ICU	1400 (1150-1500)	1300 (980-1440)	1400 (1200-1500)	0.05
4th day of admission to ICU	1400 (1100-1500)	1300 (960-1440)	1400 (1225-1500)	0.18
5th day of admission to ICU	1400 (1000-1500)	1200 (960-1440)	1400 (1200-1500)	0.025
7th day of admission to ICU	1400 (1000-1440)	1250 (960-1440)	1400 (1200-1500)	0.31
10th day of admission to ICU	1400 (1000-1440)	1200 (1000-1400)	1400 (1000-1500)	0.07
14th day of admission to ICU	1200 (1000-1430)	1000 (1000-1500)	1200 (800-1420)	0.77
The number of the days achieved the target calorie	2 (2-3)	3 (2-3)	2 (2-3)	0.56

All values are expressed as n (%) or median (IQR). PU: Pressure Ulcer; HFNO, High-flow nasal oxygen; NIMV, Non-invasive mechanical ventilation; IMV, Invasive mechanical ventilation; AKI, Acute Kidney Injury; RRT, Renal Replacement Therapy; N/A, not valid; ICU: Intensive Care Unit

DISCUSSION

In this study, pressure ulcers were detected in 29 (36.25%) of 80 critically ill patients with COVID-19 treated in the ICU, and the mean age of this group was found to be high (78 years old) (71-84). In the PU group, while the mNUTRIC score of 4 (3-5) and the APACHE II score of 24 (17-29) in the first 24 hours were high, the Braden score 12 (11-13) was low. When the independent risk factors for the development of PU were analyzed, it was found statistically significant that the Braden score was <12 and the D-dimer value was >1.72 µg/ml.

In two different studies conducted in Turkey, in-hospital PU rates were found to be 5.8% and 10.4%.[8] Pressure ulcers are one of the common complications of hospital care, and their incidence rates in intensive care patients varies between 1.6% and 26.8% in prevalence studies.[9]

This situation, which has a high incidence, may contribute negatively to the existing morbidity and high mortality rates, especially in COVID-19 patients followed in the ICU. In addition, PU, which is completely preventable with appropriate measures, is difficult to treat and is a serious financial burden in the healthcare system.[10] Gencer et al.[11] reported in a study they conducted that PU may develop in 308,796 patients annually in our country and the annual care cost of these patients may be 1 billion 425 million dollars.

There are publications implies that advanced age and male gender are important risk factors for the development of PU.[23] Patients over the age of 60 are prone to develop pressure injuries due to decreased skin elasticity, insufficient hydration, and changes in sensitivity.[24] In a study conducted by Kurtulus et al.[25] it was determined that the development of pressure injuries was higher in male patients aged 65 and over, but this result was not statistically significant. Similarly, the mean age of the PU group was found to be statistically significantly higher in our study; however, being male was not found to be statistically significant, although PU was more common in male gender as clinical observation.

In a meta-analysis study, which researching COVID-19 patients treated in the ICU and their risk factors, the mortality rate was found to be 41.6%, while in our study the mortality rate was found to be 62.7%.[26] The fact that patients admitted to the ICU are critically ill is consistent with high APACHE II and mNUTRIC scores and low BS, as we found in our study. Previous studies which conducted in different populations, it was found that a BS ≤15 may be associated with short-term mortality.[14]

In another cohort study of COVID-19 in the literature, lower BS at admission was found to be consistent with increased in-hospital mortality.[27] In the independent risk analysis for PU in our study, BS <12 was found to be statistically significant (p <0.004). According to the results of the current study, it has been proven that BS can be used as a mortality predictor as well as being a simple, rapid and bedside nursing assessment tool that can evaluate skin integrity.[27]

Risk factors for PU includes cerebrovascular disease, cardiovascular disease, recent lower extremity fractures, incontinence, and diabetes.[28] However, it is not clear whether these are independent risk factors or merely reflect the high prevalence of inactivity in fragile, older adult patients.[28]

In our study, the presence of malignancy and dementia, which are among the comorbidities, were prominent. It can be thought that the common point may be nutritional deficit, insufficient self-care and inactivity. Immobility is the most important host factor contributing to the development of pressure-related skin and soft tissue injury.[29] Immobility may be an important problem in COVID-19 patients followed in the ICU, especially in patients who are oversedated and followed up on mechanical ventilators. Unfortunately, it is not easy to measure the level of inactivity clinically.[29] The best solution for inactivity due to the existing comorbid disease or the treatment modalities applied is an effective physiotherapy and staff-nurse active cooperation with position change in a short time.[29]

A hemoglobin level below 12 g/dl, which is among the risk factors, increases the risk of pressure ulcers by decreasing the tissue resistance and O_2 carrying capacity of the blood.[30] In our study, in accordance with the literature, mean hemoglobin levels were found to be low in the PU group. Since anemia impairs tissue resistance and nutrition, it affects injury negatively.[30] In the independent risk analysis for PU formation, a D-dimer level of >1.72 µg/ml showed that COVID-19 disease is a prothrombotic disease.[31] In a systematic review, vascular endothelial abnormalities, disruption of the coagulation cascade, thromboembolic events, tissue circulation, and decreased oxygen delivery have been found.[31] This situation explains the D-dimer elevation in patients with PU. Corticosteroids were thought to have a role in the treatment of COVID-19 patients with elevated inflammatory parameters, and it was one of the first drugs that were shown to reduce mortality as a result of studies.[32]

In our study, it was found that the use of pulse corticosteroid and tocilizumab was high in the group without PU. This shows that COVID-19 is at the

forefront in the treatment of patients in the non-PU group and that secondary infection does not develop. Since the septic process did not develop in patients who did not develop secondary infection, tissue circulation did not deteriorate, and PU did not develop.[33] Nutritional deficiency is one of the important factors affecting the development of PU.[34]

In severe infections such as COVID-19, cytokine storm induces hypercatabolism, secondary hypermetabolism and insufficient energy intake cause delay in wound healing.[34] The American National Pressure Ulcer Long-Term Care Working Group (NUPAP) defined inadequate diet and malnutrition as risk factors for PU.[30] Berlowitz et al.[31] identified pre-existing malnutrition and/or weight loss as a positive predictive variable for PU. Similarly, in our study, it was determined that the targeted calorie amount in the PU group was lower than the group without PU, but despite this the targeted calorie amount in the PU group could not be reached. This situation can be explained by the calculation of the target calorie, which calculated as 25 kcal/kg/day in accordance with the ESPEN recommendations,[22] and as the lower amounts due to the lower average BMI in the PU group. In the group that did not develop pressure ulcers, the target calories were reached. It has also been determined that additional protein supplementation contributes to the prevention of pressure ulcer development. Protein loss causes negative nitrogen balance, and the risk of pressure injury increases with subcutaneous tissue loss.[34] In our study, the percentage of following the prone position was higher in the group without PU. In the patients followed in the prone position, simple mild abrasions and erythema that did not require treatment were found on the face, but lesions that did not reach the size to be included in any grading. However, no pressure ulcers were observed. Although severe ARDS patients due to COVID-19 were followed in the prone position for 12-16 hours, as suggested by the relevant guidelines, PU related with this position was not observed.[35]

Limitations

We could not use any anthropometric measurements for nutritional assessment in this study because these data were not available in our medical records. Secondly, 80 patients who met the inclusion criteria were included, and studies with larger sample sizes may be useful in this regard. In our study, although independent risk factor analysis was performed, root analysis was not performed for pressure ulcers. Doing so could help us better understand the causes of pressure ulcer development. Finally, randomized and controlled studies are needed because of the limitations inherent in retrospective observational studies.

CONCLUSION

There are many factors that affect the development of pressure ulcers in COVID-19 patients followed in the intensive care unit. Pressure ulcers can cause serious morbidity and mortality. This situation, which has a serious financial burden, can be prevented with effective follow-up and treatment. We think that the Braden Scale should be followed by doctors as well as a nurse follow-up tool, since it predicts both the wound score and prognosis of COVID-19 patients from the first admission to the ICU.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Dokuz Eylül University Non-interventional Researches Ethics Committee (Date:25.08.2021, Decision No:2021/24-02).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. WHO. Q&A on coronaviruses (COVID-19). Accessed july 6, 2020. https://who.int/news-room/q-a-detail/q-a-coronaviruses
2. Sun P, Qie S, Liu Z, Ren J, Xi J. Clinical characteristics of 50466 patients with 2019-nCoV infection. *MedRxiv*. 2020.
3. Montenegro F, Unigarro L, Paredes G, et al. Acute respiratory distress syndrome (ARDS) caused by the novel coronavirus disease (COVID-19): a practical comprehensive literature review. *Exp Rev Respir Med*. 2021;15(2):183-195.
4. Grasselli G, Greco M, Zanella A, et al. Risk Factors Associated With Mortality Among Patients With COVID-19 in Intensive Care Units in Lombardy, Italy. JAMA Intern Med. 2020;180(10):1345-1355. doi:10.1001/jamainternmed.2020.3539
5. WHO. Coronaviruses disease 2019 (COVID-19). 2019; https://www.who.int/emergencies/diseases/novel-coronavirus-2019
6. Pancorbo-Hidalgo PL, Garcia-Fernandez FP, Lopez-Medina IM, Alvarez-Nieto C. Risk assessment scales for pressure ulcer prevention: a systematic review. *J Adv Nurs*. 2006;54(1):94-110. doi:10.1111/j.1365-2648.2006.03794.x
7. Beers MH, Berkow R. The Merck Manual of Geriatrics. Merck & Co. Inc Whitehouse Station, NJ. 2000;
8. Kıraner E, Hülya K. COVID-19 Tanısı ile yoğun bakımda yatan hastalarda basınç yaralanmalarının ve risk faktörlerinin retrospektif analizi. *Yoğun Bakım Hemşireliği Derg*. 2021;25(3):139-151.
9. Karahan A, AAbbasoğlu A, Işık SA, et al. Factors Affecting Wound Healing in Individuals With Pressure Ulcers: A Retrospective Study. *Ostomy/Wound Manage*. 2018;64(2):32-39.

10. de Araújo TM, de Araújo MFM, Barros LM, de Oliveira FJG, da Silva LA, Caetano JÁ. Educational intervention to assess the knowledge of intensive care nurses about pressure injury. *Rev Rene*. 2019;(20):42.
11. Gencer ZE, Erdinç Ü, Özkan Ö. Basınç ülserleri tedavi maliyetleri etkililik analizi; konvansiyonel ve modern yara bakım tedavi maliyetlerinin karşılaştırılması. *Akdeniz Tıp Derg*. 2019;5(2):201-208.
12. Tanrikulu F, Dikmen Y. Yoğun bakım hastalarında basınç yaraları: risk faktörleri ve önlemler. *J Hum Rhythm*. 2017;3(4):177-182.
13. Lovicu E, Faraone A, Fortini A. Admission braden scale score as an early independent predictor of in-hospital mortality among inpatients with COVID-19: a retrospective cohort study. *Worldviews Evid Based Nurs*. 2021;18(5):247-253.
14. Bandle B, Ward K, Min SJ, et al. Can Braden score predict outcomes for hospitalized heart failure patients? *J Am Geriatr Soc*. 2017;65(6):1328-1332.
15. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. *Crit Care Med*. 1985;13(10):818-829.
16. Vincent J-L, Moreno R, Takala J, et al. The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/ failure. Springer-Verlag; 1996.
17. Zhang P, He Z, Yu G, et al. The modified NUTRIC score can be used for nutritional risk assessment as well as prognosis prediction in critically ill COVID-19 patients. *Clin Nutr*. 2021;40(2):534-541.
18. Defloor T, Schoonhoven L, Fletcher J, et al. Statement of the European Pressure Ulcer Advisory Panel--pressure ulcer classification: differentiation between pressure ulcers and moisture lesions. *J Wound Ostomy Continence Nurs*. 2005;32(5):302-306. doi:10.1097/00152192-200509000-00006
19. Cox J. Predictors of pressure ulcers in adult critical care patients. *Am J Crit Care*. 2011;20(5):364-375.
20. Bergstrom N, Demuth PJ, Braden B. A clinical trial of the Braden Scale for predicting pressure sore risk. *Nurs Clin North Am*. 1987;22(2):417-428.
21. Singer P, Blaser AR, Berger MM, et al. ESPEN guideline on clinical nutrition in the intensive care unit. *Clin Nutr*. 2019;38(1):48-79. doi:10.1016/j.clnu.2018.08.037
22. Mechanick JI, Carbone S, Dickerson RN, et al. Clinical nutrition research and the COVID-19 pandemic: a scoping review of the ASPEN COVID-19 task force on nutrition research. *JPEN J Parenter Enteral Nutr*. 2021;45(1):13-31.
23. Reuler JB, Cooney TG. The pressure sore: pathophysiology and principles of management. *Ann Intern Med*. 1981;94(5):661-666.
24. Lyder CH. Pressure ulcer prevention and management. *JAMA*. 2003;289(2):223-226.
25. Kurtuluş Z. Braden skalası ile belirlenen yüksek riskli hasta grubunda albümin düzeyleri ile bası yaraları arasındaki ilişki. Marmara Universitesi (Turkey); 2003.
26. Armstrong R, Kane A, Kursumovic E, Oglesby F, Cook TM. Mortality in patients admitted to intensive care with COVID-19: an updated systematic review and meta-analysis of observational studies. *Anaesthesia*. 2021;76(4):537-548.
27. Cooper KL. Evidence-based prevention of pressure ulcers in the intensive care unit. *Crit Care Nurse*. 2013;33(6):57-66.
28. Coleman S, Nixon J, Keen J, et al. A new pressure ulcer conceptual framework. *J Adv Nurs*. 2014;70(10):2222-2234.
29. Haisley M, Sørensen J, Sollie M. Postoperative pressure injuries in adults having surgery under general anaesthesia: systematic review of perioperative risk factors. *J Br Surg*. 2020;107(4):338-347.
30. NPUAP. 2014; Available at: https://www.epuap.org/wp-content/uploads/2010/10/NPUAP-EPUAP-PPPIA-Quick-Reference-Guide-2014-DIGITAL.pdf
31. Berlowitz DR, Brandeis GH, Morris JN, et al. Deriving a risk-adjustment model for pressure ulcer development using the minimum data set. *J Am Geriatr Soc*. 2001;49(7):866-871.
32. Rostami M, Mansouritorghabeh H. D-dimer level in COVID-19 infection: a systematic review. *Exp Rev Hematol*. 2020;13(11):1265-1275.
33. Bluestein D, Javaheri A. Pressure ulcers: prevention, evaluation, and management. *Am Fam Physician*. 2008;78(10):1186-1194.
34. Borghardt AT, Prado TN, Bicudo SD, Castro DS, Bringuente ME. Pressure ulcers in critically ill patients: incidence and associated factors. Úlcera por pressão em pacientes críticos: incidência e fatores associados. *Rev Bras Enferm*. 2016;69(3):460-467. doi:10.1590/0034-7167.2016690307i
35. Alhazzani W, Møller MH, Arabi YM, et al. Surviving Sepsis Campaign: guidelines on the management of critically ill adults with Coronavirus Disease 2019 (COVID-19). *Intensive Care Med*. 2020;46(5):854-887. doi:10.1007/s00134-020-06022-5