J Surg Med. 2023;7(8):481-485.
DOI: 10.28982/josam.7829

Research article

Journal of Surgery and Medicine
e-ISSN: 2602-2079
https://jsurgmed.com/

The prognostic effect of lymphocyte, monocyte, and platelet counts, mean platelet volume, neutrophil-to-lymphocyte ratio, lymphocyte-to-monocyte ratio, and platelet-to-lymphocyte ratio on different stages of pressure ulcers

Leman Acun Delen [1], Mesut Öterkuş [2]

[1] Malatya Education and Research Hospital, Department of Anesthesiology and Reanimation, Malatya, Turkey
[2] Malatya Turgut Özal University, Faculty of Medicine, Department of Anesthesiology and Reanimation, Malatya, Turkey

ORCID ID of the author(s)

LAD: 0000-0001-9441-6979
MÖ: 0000-0003-1025-7662

Corresponding Author
Leman Acun Delen
Malatya Education and Research Hospital, Department of Anesthesiology and Reanimation, Post Code: 44100 Malatya, Turkey
E-mail: lmndelen@hotmail.com

Ethics Committee Approval
The study was approved by Malatya Turgut Özal University Clinical Research Ethics Committee (date: November 3, 2022, number: 2022/49). All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
No conflict of interest was declared by the authors.

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

Published
2023 August 23

Abstract

Background/Aim: Pressure ulcers (PU) pose a significant problem for patients in intensive care. Various factors contribute to the development of pressure sores. The primary focus of treatment is to implement measures that prevent factors such as nutrition and positioning, which can lead to PUs. Therefore, it is crucial to identify parameters that can serve as warning signals for the formation and progression of PU. This study investigates the potential use of hematological parameters as warning signals.
Methods: Demographic data, co-morbidities, PU stages, and laboratory parameters of 158 patients hospitalized in the intensive care unit who developed pressure ulcers during their hospital stay were recorded and analyzed.
Results: Among the 158 cases included in the study, PUs were more prevalent in patients of advanced age, those with pneumonia, chronic obstructive pulmonary disease (COPD), coronary diseases, and neurodegenerative diseases. Mean platelet volume (MPV) was significantly higher in PU stages 2 and 3 compared to stage 1. However, age, lymphocyte count, monocyte count, neutrophil-to-lymphocyte ratio (NLR), lymphocyte-to-monocyte ratio (LMR), and platelet-to-lymphocyte ratio (PLR) did not exhibit significant differences among the stages of PU (P<0.05).
Conclusion: Advanced age, pneumonia, COPD, coronary diseases, and neurodegenerative diseases are identified as risk factors for PU. Although MPV was initially considered a potential, stimulating parameter, the evidence was insufficient. Further research is required to explore this issue. The impact of parameters other than MPV did not show any excitatory signal in this study.

Keywords: pressure ulcer, pressure ulcer stage, hematological parameters, intensive care unit

How to cite: Delen LA, Öterkuş M. The prognostic effect of lymphocyte, monocyte, and platelet counts, mean platelet volume, neutrophil-to-lymphocyte ratio, lymphocyte-to-monocyte ratio, and platelet-to-lymphocyte ratio on different stages of pressure ulcers. J Surg Med. 2023;7(8):481-485.

Introduction

Thanks to advancements in technology and medicine and improvements in the standard of care provided in intensive care units (ICUs), patients' life expectancy has been steadily increasing. However, this prolonged life expectancy comes with certain challenges, including a rise in the number of days patients spend in intensive care, increased healthcare costs, and higher occupancy rates in ICUs. Despite implementing measures such as air beds and regular repositioning, pressure ulcers (PUs), commonly known as pressure sores, remain a significant issue during extended hospital stays, particularly among patients connected to mechanical ventilators. The incidence of PUs in ICUs ranges from 10% to 56% [1].

While PU can occur across all age groups, the risk is particularly elevated in geriatric patients. Aging is often accompanied by co-morbidities such as heart failure, coronary artery diseases, and neurodegenerative conditions like Alzheimer's disease and stroke. Furthermore, respiratory ailments stemming from smoking and a decline in respiratory capacity become more prevalent with advancing age. Geriatric patients also face additional factors such as incontinence, reduced subcutaneous adipose tissue, malnutrition, and dehydration, which can contribute to the development of PU, often exacerbated by prostate issues and Alzheimer's disease [2]. Therefore, accurate prediction of PUs, implementation of preventive measures, adequate pain management, and early treatment are vital for significantly enhancing the quality of life, particularly among these patient groups.

Studies have demonstrated that in addition to age and co-morbidities, certain parameters derived from complete blood counts, such as the neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and lymphocyte-to-monocyte ratio (LMR), can serve as valuable predictors of PU formation and wound healing. Therefore, this study also examines the potential of these parameters [3]. PUs give rise to significant issues, including infection, pain, and increased healthcare costs. Hence, our study aims to guide for predicting PUs, implementing preventive measures, and determining appropriate treatment strategies.

In this study, we investigated the impact of hematological changes, hospitalization diagnoses, and co-morbidities on the development of PUs and their progression across different stages.

Materials and methods

This retrospective cohort study was conducted in compliance with the Declaration of Helsinki and STROBE guidelines, following approval from Malatya Turgut Özal University Clinical Research Ethics Committee (date: November 3, 2022, number: 2022/49). The minimum required sample size for the study was determined as 150 patients, based on similar studies, with an alpha error of 0.05 and a beta error of 0.8. The study was carried out from January 1, 2022, to September 30, 2022. All participants were informed about the study, and written consent was obtained from them and/or their legal guardians.

Initially, a total of 180 patients with PUs who were hospitalized in the tertiary ICU were included for analysis. However, 22 patients were excluded due to their refusal to participate or the unavailability of their medical data. Consequently, the study continued with a final sample of 158 patients aged between 18 and 100 years. Exclusion criteria included patients who developed PUs before ICU admission, those with a history of diabetes or sepsis, individuals with peripheral arterial disease, patients requiring inotropic support, those unwilling to participate in the research, individuals with short postoperative hospital stays, and pediatric patients. Furthermore, patients who had PUs during hospitalization or had previously undergone plastic surgery or PU surgery were not included to optimize the study.

In our hospital's intensive care unit, all patient beds are equipped with air mattresses, and patients were regularly repositioned. To address the nutritional factor, each patient received enteral or oral feeding tailored to their specific caloric, protein, and electrolyte requirements. Patient data, including age, gender, hospitalization diagnoses, co-morbidities, laboratory results, and PU stages, were retrieved from the hospital's automation system. The study aimed to analyze the effects of these parameters on PU formation and staging.

PU stages were evaluated as: Stage 1, redness on intact skin that does not fade with pressure; Stage 2, partial thickness skin loss with exposed dermis; Stage 3, full-thickness skin loss; and stage 4, full-thickness skin and tissue loss.

Statistical analysis

Data analysis was performed using SPSS 22 (Statistical Package for Social Sciences; SPSS Inc., Chicago, IL) software. Descriptive statistics were presented as n and % values for categorical variables, while continuous variables were expressed as mean (standard deviation [SD]) or median with interquartile range (IQR) (25th–75th percentiles). The Pearson chi-square test was employed to compare categorical variables between groups. The normal distribution of continuous variables was assessed using the Kolmogorov-Smirnov test. The Kruskal-Wallis test was utilized for comparisons involving more than two variables. A statistical significance level of P-value <0.05 was considered in the analysis of continuous variables.

Results

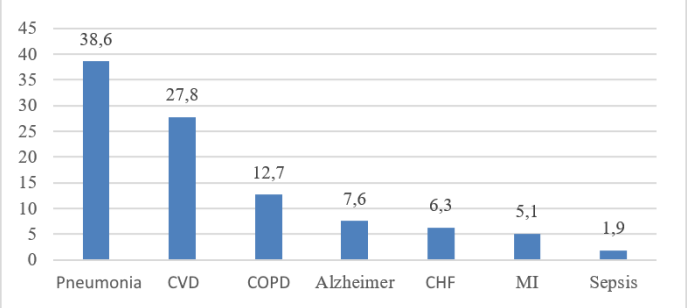
Of the 158 cases included in the search, 84 (53.2%) patients were males. The mean age of the cases was 73.9 (13.5) years, and 100 (63.3%) had co-morbidities. The PU stages of the patients were as follows: Stage 1 in 95 (60.1%) patients, stage 2 in 37 (23.4%) patients, and stage 3 in 26 (16.5%) patients. The demographic characteristics, blood, and laboratory data of the patients are demonstrated in Table 1. The diagnoses of the cases were as follows: pneumonia in 61 (38.6%) patients, cerebrovascular diseases (CVD) in 44 (27.8%) patients, chronic obstructive pulmonary disease (COPD) in 20 (12.7%) patients, Alzheimer's disease in 12 patients, heart failure (HF) in 10 (6.3%) patients, myocardial infarction (MI) in 8 (5.1%) patients, and sepsis in 3 (1.9%) patients (Figure 1).

Table 1: Demographic, clinical, and laboratory characteristics of the patients.

Parameter		Value
Gender (Male)		84 (53.2)
Co-morbidity		100 (63.3)
Stage	Stage 1	95 (60.1)
	Stage 2	37 (23.4)
	Stage 3	26 (16.5)
Age, (year)		75.0 (65-85)
Neutrophil ($10^3\mu L^{-1}$)		10.39 (0.69-14.21)
Lymphocyte ($10^3\mu L^{-1}$)		0.78 (0.54-1.15)
Monocyte ($10^3\mu L^{-1}$)		0.66 (0.57-0.86)
Platelet ($10^3\mu L^{-1}$)		270 (230-450)
MPV (fL)		12.8 (9.9-13.8)
NLR		11.8 (7.1-21.7)
PLR		0.4 (0.2-0.6)
LMR		1.2 (0.7-2.1)

MVP: Mean Platelet Volume, NRL: Neutrophil-to-Lymphocyte Ratio, LMR: Lymphocyte-to-Monocyte Ratio, PLR: Platelet-To-Lymphocyte Ratio. Gender, comorbid diseases, and pressure ulcer stages are given as n (%). Other values are given as median (interquartile range) + (minimum-maximum)

Figure 1: Distribution of patients according to their diagnoses



CVD: Cerebrovascular Disease, COPD: Chronic Obstructive Pulmonary Disease, CHF: Chronic Heart Failure, MI: Myocardial Infarction

Among men, 58.3% were at stage 1, 22.6% were at stage 2, and 19% were at stage 3. For women, 62.2% were at stage 1, 24.3% were at stage 2, and 13.5% were at stage 3. The distribution of PU stages did not show a significant difference by gender (P=0.645). Among patients with co-morbidities, 55% were at stage 1, 25% were at stage 2, and 20% were at stage 3. The PU stages did not differ significantly based on the presence of co-morbidities (P=0.169).

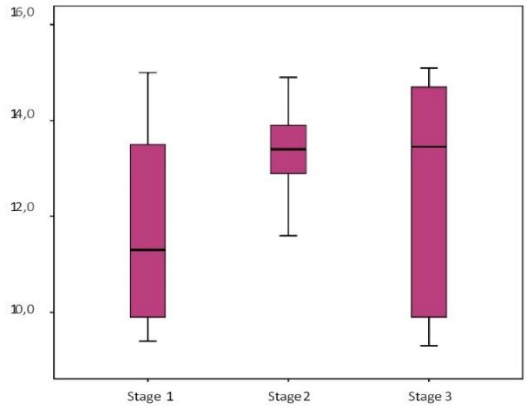
There was a significant difference in mean platelet volume (MPV) between the stages (P<0.001). This difference was primarily observed between stage 1 and the other two stages, with the MPV value of stage 1 being lower than the other two stages. No significant differences were found between the stages in terms of age, neutrophils, lymphocytes, monocytes, platelets, NLR, PLR, and LMR (P=0.156, P=0.613, P=0.593, P=0.667, P=0.360, P=0.602, and P=0.569, respectively) (Table 2). The relationship between MPV and the pressure stages of the patients is illustrated in Figure 2.

Table 2: Comparison of patient characteristics according to the pressure ulcer stages

	Stage 1 (n=95)	Stage 2 (n=37)	Stage 3 (n=26)	*P*-value
Gender (male)	49 (58.3)	19 (22.6)	16 (19)	0.645*
Co-morbidity	55 (55)	25 (25)	20 (20)	0.169*
Age (year)	77(65-85)	76.0 (69-86)	70 (65-81)	0.300**
Neutrophil ($10^3\mu L^{-1}$)	10.43 (0.64-14.07)	12.14(8.2-15.34)	8.39 (6.83-13.37)	0.156**
Lymphocyte ($10^3\mu L^{-1}$)	0.77 (0.51-1.15)	0.86 (0.62-1.10)	0.74 (0.56-1.43)	0.613**
Monocyte ($10^3\mu L^{-1}$)	0.67 (0.59-0,85)	0.62 (0.59-0.82)	0.63(0.43-0,90)	0.593**
Platelet ($10^3\mu L^{-1}$)	275 (235-425)	365 (189-463)	242.0 (236-463)	0.667**
MPV (fL)	1.3 (9.9-13.5) [a]	13.4 (12.9-13.9)[b]	13.5 (9.9-14.7)[b]	<0.001**
NLR	11.7 (7.1-22.1)	13.6 (8.4-21.4)	11.1 (4.3-19.6)	0.360**
PLR	0.4 (0.2-0.5)	0.4 (0.2-0.6)	0.3 (0.2-0.6)	0.602**
LMR	1.2 (0.7-2.1)	1.3 (1.0-1.7)	1.3 (0.8-2.7)	0.569**

MVP: Mean Platelet Volume, NRL: Neutrophil-to-Lymphocyte Ratio, LMR: Lymphocyte-to-Monocyte Ratio, PLR: Platelet-To-Lymphocyte Ratio, *Chi-squared test **Kruskal-Wallis test. a, b give the groups with difference. Gender, and comorbid diseases are given as n (%). Other values are given as median (interquartile range) (minimum-maximum). P<0.05 was considered statistically significant.

Figure 2: Comparison of MPV values according to the compression stage



Discussion

The development of PU poses numerous challenges, particularly in intensive care and palliative care centers, including worsened clinical conditions, prolonged hospitalization, and increased treatment costs. Therefore, various scales such as the Braden Risk Assessment Scale, Norton Risk Assessment Scale, and Waterlow Risk Assessment Scale are employed to assess multiple risk factors such as physical activity, mental state, incontinence, and skin condition [1]. In this study, we aimed to investigate the impact of hematological parameters on the formation and stages of PUs. Our findings revealed that MPV was lower in stage 1 compared to stages 2 and 3. However, demographic data, hemogram parameters, and values of NLR, PLR, and LMR did not show significant differences among different stages of PUs.

Our study exhibited similarities in terms of age, gender, and co-morbidities compared to previous studies. Adıyeke E and Adıyeke L [3] reported demographic data of patients with and without PUs that aligned with our study. In a 2017 article by Jaul et al. [2], it was stated that the likelihood of PU development is higher in geriatric patient groups due to factors such as diabetes, HF, increased neurodegenerative diseases, immobility, nutritional deficiency, incontinence, and peripheral vascular diseases. Given that our study population consisted of geriatric patients with an average age of 75 years, our findings could not be evaluated based on different age groups.

In our study, 53.2% of the patients were male. Consistent with our findings, the literature does not report a significant gender-related difference in PUs. Shi et al., in their meta-analysis of 65 articles, found that 53% of PU patients were female [4]. Similarly, Dinçer et al. [5] reported that 44.8% of patients with PUs in the palliative unit were female.

In the present study, the most common diagnoses at hospitalization for patients who developed PUs were pneumonia, CVD, and COPD. However, the diagnoses at hospitalization did not significantly impact the stage of PUs. Tissue hypoxia is a major concern in PUs. It is widely recognized that, in addition to pressure, comorbid factors that impede perfusion and oxygenation can predispose individuals to PUs and hinder wound healing under conditions of tissue hypoxia. Our study revealed that pneumonia and COPD, which affect the respiratory system, were significant co-morbidities. As this patient group primarily consisted of geriatric patients, they often require mechanical ventilation support due to impaired oxygenation, tissue hypoxia,

and reduced lung capacity associated with advanced age. The need for mechanical ventilation support results in patient immobilization and prolonged ICU stays. Manzano et al. [6] documented the impact of mechanical ventilation support on PU formation. In a multicenter study involving 13,254 patients, Labeau et al. [7] identified COPD as a risk factor for PUs.

In our study, co-morbidities such as cardiogenic diseases, including heart failure (HF) and MI, played a significant role in forming PUs. Conditions like low cardiac output, hypotension, and rhythm disorders contribute to the development of PUs by reducing tissue perfusion pressure [8]. In a 2017 article by Cox, it was mentioned that inadequate tissue perfusion is a notable risk factor for PUs in MI patients with left ventricular failure caused by reduced ejection fraction (EF) and subsequent decreased cardiac output [9]. HF increases the risk of PU development due to factors such as dehydration (resulting from diuretic use, for example), edema, and decreased cardiac output [10]. While we considered decreased arterial blood flow in the affected extremity due to peripheral arterial diseases as an exclusion criterion in our study, it remains an inevitable risk factor that predisposes individuals to PUs. Lopatina et al. [11] identified diabetes and hypertension as risk factors for post-surgical PUs in patients with cardiogenic diseases. They also demonstrated a significant increase in the likelihood of developing PUs in patients with a high ASA score.

CVDs are another significant factor contributing to the development of PUs. Given that most PU patients are geriatric, the incidence of neurodegenerative diseases such as Alzheimer's tends to be higher. Particularly in the advanced stages of the disease, factors like immobility and malnutrition emerge as risk factors for PU development in these patients. In our study, Alzheimer's disease was observed as a co-morbidity in 12 (6.3%) patients.

Our literature search revealed a scarcity of publications regarding hemogram values, as well as parameters such as NLR, PLR, and LMR, in relation to PUs. The NLR ratio is commonly utilized to assess inflammation and mortality. Therefore, it was expected that the NLR ratio would be higher, particularly in stage 3 and stage 4 PUs. However, our study had no patients with stage 4 PUs. Our investigation solely involved a retrospective review of patients who developed PUs. Consequently, we could not ascertain the difference in NLR between patients with and without PUs. Nonetheless, our findings indicated that NLR did not impact the stage of PUs.

Similar to NLR, MPV is frequently used to indicate inflammation and mortality. Platelets play a crucial role in maintaining a balance between inflammation and hemostasis in patients with PUs. They enhance the efficacy of leukocytes and contribute to wound healing [12]. As the wound site and stage progress, inflammation intensifies, leading to increased production of new platelets to compensate for platelet consumption. Younger platelets are expected to be larger in size. In line with this expectation, our study observed that MPV was higher in stage 2 and stage 3 PUs compared to stage 1, indicating that MPV can serve as an important parameter for evaluating the follow-up and treatment outcomes of PUs.

Adıyake E and Adıyake L [3] conducted a study evaluating PUs and hematological parameters. They found that the NLR was higher in patients with PUs than those without. Additionally, they observed higher MPV values in patients with PUs. Their findings regarding MPV align with our study results. Kutlu et al. examined blood values in bedridden patients, a primary population susceptible to PUs, and demonstrated a significant decrease in MPV values following exercise [13]. This decrease could be attributed to a partial relief of compression in the pressure area and a reduction in tissue hypoxia in parallel with increased blood circulation due to exercise.

Numerous studies have examined whether lymphocyte and monocyte counts, as well as LMR and PLR, can serve as indicators of inflammation and mortality. For instance, Durmuşoğlu et al. [14] conducted studies on ovarian cancers and found that LMR, NLR, and PLR did not impact mortality. Conversely, in his specialized thesis, Dede [15] determined that although LMR is a poor prognostic indicator in COVID-19, it is not effective in predicting mortality. There are limited studies in the literature investigating the effects of LMR and PLR on PUs and their stages. While these studies may have demonstrated an association between these parameters and PUs due to their involvement in inflammation, we lacked data on this matter since our study exclusively focused on patients who developed PUs. Consequently, we could not arrive at a definitive conclusion regarding the staging and/or prognosis of PUs in our study.

Limitations

Our study had certain limitations. First, we solely focused on patients who developed PUs, which prevented us from comparing them with patients who did not develop PUs. Second, the study was conducted at a single center, which may limit the generalizability of the findings. Additionally, the small number of patients included in the study is another limitation that should be taken into consideration.

Conclusion

Our search revealed that age, pneumonia, COPD, coronary artery diseases, and neurodegenerative diseases, as well as MPV, may influence the risk of development and stage of PU. While we initially hypothesized that MPV could be a contributing factor, we lacked sufficient evidence to support this claim. Further research is needed to explore the role of MPV in PU. Other parameters, apart from MPV, did not demonstrate a significant association with PU. Alongside preventive measures such as proper nutrition, early mobilization, and the use of air mattresses, early treatment of PUs and addressing the underlying factors are crucial in preventing the formation of PUs and potential complications.

References

1. Firat Kiliç H, Sucudag G. The scales frequently used in patients with the Assessment of Pressure Sores. G.O.P. Taksim E.A.H. JAREN. 2017;3(1):49-54.
2. Jaul E, Barron J, Rosenzweig JP, Menczel J. An overview of co-morbidities and the development of pressure ulcers among older adults. BMC Geriatr. 2018;18(1):305.
3. Adıyeke E, Adıyeke L. Neutrophil to lymphocyte ratio and mean platelet volume may predict the development of the pressure ulcers. J Surg Med. 2020;4(7):578-81.
4. Shi C, Dumville JC, Cullum N. Support surfaces for pressure ulcer prevention: A network meta-analysis. Plos One. 2018;13(2):e0192707.
5. Dincer M, Doger C, Tas SS, Karakaya D. An analysis of patients in palliative care with pressure injuries. Niger J Clin Pract. 2018;21:484-91.
6. Manzano F, Perez-Perez AM, Martinez-Ruiz S, Garrido-Colmenero C, Roldan D, Jiménez-Quintana Mdel M, et al. Hospital-acquired pressure ulcers and risk of hospital mortality in intensive care patients on mechanical ventilation. J Eval Clin Pract. 2014;20:362-8.
7. Labeau SO, Afonso E, Benbenishty J, Blackwood B, Boulanger C, Brett SJ, 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):160-9.
8. Kaitani T, Tokunaga K, Matsui N, Sanada H. Risk factors related to the development of pressure ulcers in the critical care setting. J Clin Nurs. 2010;19(3–4):414–21.

9. Cox J. Pressure Injury Risk Factors in Adult Critical Care Patients: A Review of the Literature. Ostomy Wound Manage. 2017;63(11):30–43.
10. Aloweni F, Ang SY, Fook-Chong S, Agus N, Yong P, Goh MM, et al. A prediction tool for hospital-acquired pressure ulcers among surgical patients: Surgical pressure ulcer risk score. Int Wound J. 2019;16(1):164-75.
11. Lopatina T, Bruno S, Tetta C, Kalinina N, Porta M, Camussi G. Platelet-derived growth factor regulates the secretion of extracellular vesicles by adipose mesenchymal stem cells and enhances their angiogenic potential. Cell Communication and Signaling. 2014;12(1):26–38.
12. Korniluk A, Koper-Lenkiewicz OM, Kamińska J, Kemona H, Dymicka-Piekarska V. Mean Platelet Volume (MPV): New Perspectives for an Old Marker in the Course and Prognosis of Inflammatory Conditions. Mediators Inflamm. 2019;17;2019:9213074.
13. Koca Kutlu A, Diramalı A, Temiz C, Onur E, Miskioğlu M. Effect of exercise on blood values and vital findings in bed-connected patients. Journal Of Ege University Faculty of Nursing. 2011;27(1):25-36.
14. Erben Durmusoglu S, Kiliç F, Unsal M, Aytekin O, Kimyon Comert G, Karalok A, et al. Preoperative neutrophil/lymphocyte, lymphocyte/monocyte and platelet/lymphocyte ratios serous ovarian cancer survival Balikesir Medical Journal. 2021;5(1):43-53.
15. Dede S. In Critical Patients Diagnosed Wıth Covid-19, Platelet Lymphocyte Rate, Monocyte Lymphocyte Rate And Some Others Effect Of Hematological Values On Prognosis. (Master thesis in medicine), Konya, Necmettin Erbakan University 2021.