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CLINICAL STUDY

Relationship of intensive care scoring systems with neutrophil/lymphocyte ratio, platelet/lymphocyte ratio, and mean platelet volume values

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ABSTRACT

OBJECTIVE: We evaluated the relationship between NLR, PLR, and MPV values and scoring systems frequently used in intensive care units in our study.

METHODS: In our retrospective study, patients aged 18 years and over who received treatment in the intensive care unit for at least 48 hours were included. Demographic data, such as age, gender, APACHE II, SOFA and GCS scores, expected mortality, and 30-day and 1-year mortality rates were recorded.

RESULTS: There was a significant positive correlation between MPV values and APACHE, SOFA, and expected mortality rates, and a significant negative correlation between GCS values. It was also found to be significant that as the P/L ratio increased, APACHE, SOFA scores, and expected mortality rates decreased and GCS increased. In 30-day and 1-year mortalities, MPV values and CRP/albumin ratios were higher, and calcium values were significantly lower. The N/L ratios were also significantly higher in 1-year mortality.

CONCLUSION: In our study, a significant correlation was found between APACHE, GCS, SOFA, expected death rates and MPV and P/L rates. In conclusion, we suggest that in addition to intensive care scoring systems, the N/L ratio, P/L ratio, MPV, and CRP/albumin ratios can be used in the prognosis of patients *(Tab. 5, Fig. 2, Ref. 18)*. Text in PDF *www.elis.sk*

KEY WORDS: intensive care, neutrophil/lymphocyte ratio, platelet/lymphocyte ratio, mean platelet volume.

Introduction

Many scoring systems are used to evaluate the treatment processes of patients followed up in intensive care units and to predict morbidity and mortality rates. An ideal scoring system should be not only based on routine and easily identifiable variables but also have high sensitivity and specificity, be suitable for different patient populations, predict the post-discharge quality of life, and be universally usable (1, 2).

The main factor affecting the prognosis of patients in the intensive care unit is the level of inflammation due to causes such as infection and trauma and the development of immuno-inflammatory response (3). In scoring systems evaluating organ failure, such as Acute Physiology and Chronic Health Evaluation (APACHE), Multiple Organ Dysfunction Score (MODS), Logistic Organ Dysfunction Score (LODS), and Sequential Organ Failure Assessment Score (SOFA), laboratory measurements such as hematocrit (HTC), white blood cell (WBC) and platelet counts are used in addition to clinical changes (4–6). It has been shown in many studies that markers such as Neutrophil/Lymphocyte ratio (NLR), Platelet/Lymphocyte ratio (PLR), mean platelet volume (MPV), Monocyte/Lymphocyte ratio, obtained by utilizing the parameters in the routine complete blood count (CBC), can be used in the evaluation of inflammatory response (7–9).

In our study, we evaluated the relationship between APACHE II, SOFA, and Glasgow Coma Scale (GCS), which are among the scoring systems frequently used in intensive care units, and NLR, PLR, and MPV values. Thus, we aimed to evaluate the role of these parameters, which are easily measurable, inexpensive, and easily accessible, in predicting morbidity, and mortality of patients in the intensive care unit.

Materials and methods

Patients

Our retrospective study was conducted by reviewing the medical records of patients treated in the Tertiary Reanimation Intensive Care Unit of Giresun Research and Training Hospital between 01.10.2021–20.10.2022 after ethics committee approval and study permissions were obtained (Ethical Committee of Ordu University (No: 2022/256). Patients who received treatment in the intensive care unit for at least 48 hours and were 18 years of age or older were

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Tab. 1. Comparison of clinical variables, intensive care scores and laboratory values of patients according to their death status.

		All patients (n=330)	Survivors (n=151)	Nonsurvivors (n=179)	p
Age (years)		70.70 (±17.88)	64.99 (18.61)	75.51 (±15.75)	0.000*
Sex (n/%)	Female	137 (41.50%)	60 (43.80%)	77 (56.20%)	0.547
	Male	193 (58.50%)	91 (47.20%)	102 (52.80%)	
Duration of mv		11.94±22.44	3.38±9.33	19.16±27.25	0.000*
Duration of icu		19.05±22.46	12.54±11.88	24.55±27.33	0.000*
Duration of hospitalisation		22.22±22.43	18.64±13.58	25.23±27.47	0.754
APACHE-II		15.04±9.60	12.78±9.08	16.94±9.64	0.000*
SOFA		6.27±2.83	4.98±2.28	7.35±2.80	0.000*
GCS		11.28±4.27	12.43±3.55	10.32±4.59	0.000*
Expected mortality rate		26.14±24.41	20.56±22.07	30.84±25.34	0.000*
Procalcitonin		5.01±15.17	3.18±9.38	6.56±18.61	0.002*
Lactate		2.15±1.94	1.76±1.44	2.47±2.23	0.000*
Albumin		31.45±5.99	33.22±5.57	29.96±5.94	0.000*
Calcium		8.34±0.79	8.44±0.80	8.25±0.77	0.030*
CRP		99.56±103.55	95.50±108.82	102.98±99.08	0.046*
MPV		9.44±1.17	9.23±1.02	9.62±1.26	0.002*
N/L rate		15.04±11.69	13.69±11.32	16.17±11.91	0.005*
P/L rate		328.78±261.22	312.77±238.84	342.30±278.66	0.319
CRP/albumin rate		3.51±4.09	3.20±4.05	3.77±4.11	0.010*

*p<0.05 statistically significant

included in the study. Pregnant patients, patients with hematologic malignancies such as leukemia and lymphoma, patients with liver failure, patients receiving chemotherapy, and immunosuppressive patients (AIDS, etc.) were excluded from the study.

Clinical findings and laboratory data

Patients' age, gender, comorbidities, the reason for intensive care admission, the reason for intensive care admission, the status and duration of mechanical ventilation, the duration of intensive care and hospitalization, expected mortality, and 30-day and 1-year mortality rates were noted. APACHE II, SOFA, and GCS scores from intensive care scoring systems were also evaluated at the first hospitalization. Laboratory data that were recorded included WBC, erythrocyte, lymphocyte, monocyte, neutrophil, platelet, MPV, hemoglobin, hematocrit, C-reactive protein (CRP), procalcitonin, lactate, glucose, albumin, and calcium values were recorded. Neutrophil/lymphocyte ratio, platelet/lymphocyte ratio, and CRP/albumin ratio were calculated based on the hemogram values.

Statistical analysis

IBM SPSS Statistics 20.0 (IBM SPSS, Chicago, USA) program was used for statistical analyses. The conformity of the variables to normal distribution was evaluated by Shapiro–Wilks test. During the evaluation of the study data, as well as descriptive statistical methods (mean, standard deviation, frequency), the Student T-test was used for the comparisons of variables with normal distribution between 2 groups, and Mann–Whitney U test was used for the comparisons of variables without normal distribution in the evaluation of quantitative data. The Chi-square test and Fisher's chi-square test were used to compare the qualitative data. Pearson correlation analysis was used to evaluate the correlation between the data in cases with normal distribution, and Spearman Rho correlation analysis was used in cases without normal distribution. The significance level was set at p<0.05.

Tab. 2. Evaluation of the relationship between patients' APACHE II, SOFA, GCS, and expected death rates, and mpv, calcium, N/L ratio, CRP/albumin ratio, and P/L ratios.

		APACHE	GKS	SOFA	Expected mortality rate
MPV	r	.132*	-.148*	.192*	.128*
	p	.016	.007	.000	.020
Calcium	r	-.095	.142*	-.293*	-.107
	p	.085	.010	.000	.052
N/L ratio	r	-.074	-.007	.008	-.067
	p	.180	.906	.881	.227
CRP/albumin ratio	r	.025	.100	.093	.043
	p	.654	.070	.093	.439
P/L ratio	r	-.181*	.154*	-.159*	-.174*
	p	.001	.005	.004	.002

*p<0.05 statistically significant

Results

A total of 330 patients were included in the study by retrospectively reviewing the medical records of the patients who were followed up in the intensive care unit within a period of one year. The mean age of females and males was 73.44 and 67.64 years, respectively. 83.9% of the patients were hospitalized from the emergency department to the intensive care unit. When the indications for hospitalization were analyzed, 33.0% were due to COVID, 26.3% were renal, 26.3% were respiratory, 9.0% were neurological, and 8.7% were multi-traumatic. Regarding comorbidities, 48.4% had hypertension, 21.2% had DM, 16.6% had COPD, 9% had Alzheimer's disease, 8.7% had coronary artery disease, and 16% did not have any diagnosis.

The mean age, duration of follow-up on a mechanical ventilator, and duration of hospitalization in the intensive care unit were found to be statistically significantly higher in patients who died (p = 0.000) (Tab. 1). In the study, the mean APACHE II, SOFA, GCS scores, and expected mortality rates of patients who died in the intensive care unit were significantly higher than those of patients who did not die.

The mean values of lymphocytes, monocytes, platelets, albumin, and calcium in patients who died were significantly lower. Procalcitonin, lactate, glucose, and CRP values were significantly higher than in non-exitus patients. In addition, the MPV, N/L ratio,

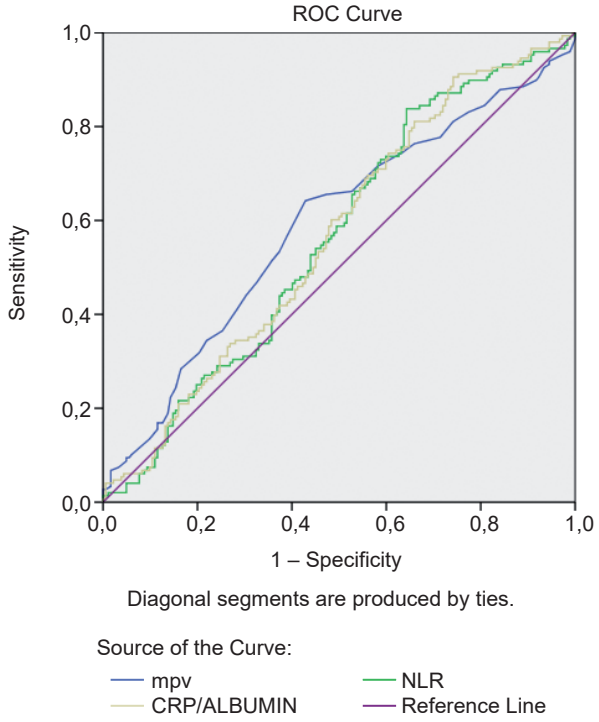

Fig. 1. Receiver operating characteristic curves of MPV, NLR and Crp/Alb values for 30 days mortality.

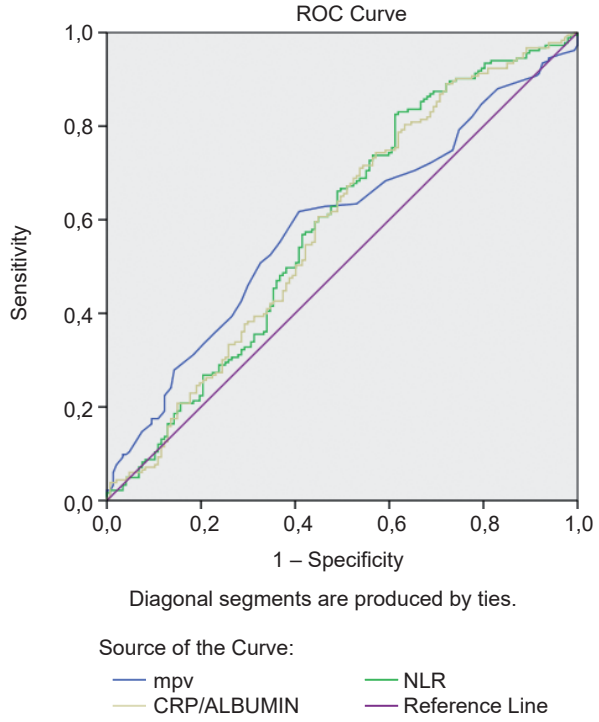

Fig. 2. Receiver operating characteristic curves of MPV, NLR and Crp/Alb values for 1 year mortality.

and CRP/albumin ratios of patients who died were found to be significantly higher than those who did not die (Tab. 1).

A positive significant relationship was found between the MPV values of the patients and APACHE, SOFA, and expected mortality rates. Moreover, a negative significant relationship was found between the MPV values and the GCS values of the patients, and it was observed that as the MPV values increased, the GCS values decreased. It was also found that there was a significant positive correlation between calcium values and the GCS scores and a significant negative correlation between SOFA values (Tab. 2).

In the evaluation of the relationship between P/L ratios and intensive care scoring systems in our study, it was found to be statistically significant that as the P/L ratio increased, APACHE II, SOFA scores, and expected mortality rates decreased, and the GCS scores increased.

MPV values and CRP/albumin ratios were higher, and calcium values were significantly lower in patients who died within 30 days, compared to patients who survived. Similarly, the same result was found in 1-year mortality. Furthermore, N/L ratios were significantly higher in patients who died within 1 year (Tab. 3).

In the ROC analysis for the 30-day mortality of the patients, cut-off values of 9.35 for MPV and 1.90 for crp/alb were determined (Tab. 4, Fig. 1). In 1-year mortality, cut-off values are; 9.25 for MPV, 11.70 for NLR, 1.71 for crp/alb (Tab. 5, Fig. 2).

Discussion

Scoring systems based on clinical findings and laboratory values are used to evaluate the treatment processes of patients in intensive care units. This provides insight for estimating the prognosis and mortality of patients. In the studies conducted, the performances of APACHE, SAPS II, and MPM II scoring systems were found to be close to each other, and the fact that microbiologic data were not included in the calculation was

Tab. 3. Evaluation of the relationship between the patients' 30-day and 1-year mortality rates and MPV, calcium, N/L ratio, CRP/albumin ratio and P/L ratios.

	30- day mortality			1- year mortality		
	Yes (n=148)	No (n=182)	p	Yes (n=183)	No (n=147)	p
MPV	9.63±1.26	9.29±1.08	0.005*	9.60±1.26	9.25±1.02	0.006*
Calcium	8.24±0.77	8.42±0.80	0.030*	8.23±0.76	8.46±0.80	0.010*
N/L ratio	15.71±11.38	14.49±11.95	0.053	16.04±11.77	13.79±11.51	0.006*
CRP/albumin ratio	3.81±4.24	3.27±3.95	0.040*	3.81±4.14	3.14±4.00	0.008*
P/L ratio	319.61±223.77	336.24±288.52	0.766	331.18±243 32	325.80±282.75	0.412

*p<0.05 statistically significant

Tab. 4. Receiver operating characteristic curves of MPV, NLR and Crp/Alb values for 30 days mortality.

	mpv	NLR	CRP/ALBUMIN
AUC	0.58 (0.52–0.65)	0.56 (0.50–0.62)	0.56 (0.50–0.62)
p	0.005	0.053	0.040
Cut-off	9.35	12.07	1.90
Sensitivity	56.76 (48.37–64.87)	54.05 (45.68–62.27)	53.38 (45.01–61.61)
Specificity	60.99 (53.5–68.12)	54.95 (47.41–62.31)	54.4 (46.86–61.78)
Positive predictive value	54.19 (48.46–59.82)	49.38 (43.95–54.83)	48.77 (43.34–54.22)
Negative predictive value	63.43 (58.24–68.32)	59.52 (54.16–64.67)	58.93 (53.58–64.08)
True	59.09 (53.57–64.44)	54.55 (49–60.01)	53.94 (48.39–59.41)

Tab. 5. Receiver operating characteristic curves of MPV, NLR and Crp/Alb values for 1 year mortality.

	mpv	NLR	CRP/ALBUMIN
AUC	0.58 (0.52–0.64)	0.58 (0.52–0.65)	0.58 (0.52–0.64)
p	0.006	0.006	0.008
Cut-off	9.25	11.70	1.71
Sensitivity	61.75 (54.29–68.82)	57.38 (49.87–64.64)	59.56 (52.07–66.74)
Specificity	59.18 (50.78–67.21)	57.82 (49.41–65.91)	55.78 (47.37–63.96)
Positive predictive value	65.32 (60.05–70.24)	62.87 (57.45–68)	62.64 (57.44–67.57)
Negative predictive value	55.41 (49.74–60.95)	52.15 (46.72–57.53)	52.56 (46.89–58.17)
True	60.61 (55.11–65.91)	57.58 (52.04–62.97)	57.88 (52.35–63.27)

shown to be the reason why they were not sufficient in determining mortality (10). Considering that sepsis patients constitute the vast majority of cases in the intensive care unit, these results are not unexpected.

The aim of this study was to investigate the efficacy of scoring systems used in intensive care units and easily accessible laboratory parameters that help us to monitor the inflammatory process in determining 30-day and 1-year mortality. In our study, we used APACHE II and GCS as prognostic scoring systems and SOFA as organ failure scoring systems in the follow-up of patients in our intensive care unit. We also evaluated the NLR, PLR, and MPV data obtained from hemograms, which have been shown to be used as markers of systemic and local inflammation (3, 9). We investigated the relationship between these parameters and intensive care scoring systems.

MPV reflects platelet size and is an indicator of increased MPV platelet activation. Studies have shown that MPV is a marker of inflammation, increases in patients with malignant tumors compared to healthy individuals, and is associated with atherosclerosis-related cardiovascular diseases (3). It has also been shown that it is associated with mortality and can be used as a prognostic marker when these aspects are considered in critically ill patients (3, 11). In our study, mortality was evaluated separately as 30-day and 1-year, and similarly, MPV was found to be associated with increased 30-day and 1-year mortality in intensive care unit patients. A statistically significant positive correlation was also found between APACHE, SOFA, and expected mortality rates when compared with the scoring systems in intensive care patients, which were not evaluated in these studies. It was also shown in our study that as the MPV increases, the GCS decreases statistically significantly. These findings may indicate the necessity of using new scoring systems, including hemogram findings in intensive care units in the future.

NLR has been shown as a mortality marker in cardiovascular diseases (12, 13). It has also been shown to predict mortality-related outcomes in cancer patients (14). Increased neutrophil levels and lymphopenia in the presence of systemic inflammation may be attributed to stress-induced elevated cortisol levels. There are different approaches to its use as a prognostic marker in sepsis patients (7, 8). This can be explained by neutropenia in severe sepsis. In this study, we observed that NLR increased in patients with exitus status; however, there was no significant association with 30-day mortality. Nevertheless, NLR was found to be significantly higher in 1-year mortality. No significant relationship was found between NLR and intensive care scoring systems (APACHE, SOFA, and expected mortality). We presume that the results in our study are attributable to our diagnostic classification of the patients and the fact that sepsis patients are a significant part of the patient population in the intensive care unit.

In studies, PLR has been associated with increased mortality in diseases such as coronary artery disease, liver and kidney diseases, and malignancies (15, 16). Kundi et al. found an association between increased PLR and mortality in patients with acute pulmonary embolism (17). However, no association was found between PLR and mortality in intensive care unit patients. In our study, no significant relationship was found between PLR and mortality in the evaluation of 30-day and 1-year mortality in intensive care unit patients. This was consistent with previous studies on intensive care unit patients.

As in previous studies, procalcitonin, CRP, lactate, and glucose values were significantly higher in patients with exitus status in our study. Some studies show that high CRP/albumin values are accurate indicators of the severity of inflammation and may be a useful parameter in predicting mortality. Evaluation of CRP and albumin values together may provide an insight into the severity of inflammation and the occurrence of malnutrition, and the prognosis of inflammation may be better predicted (18). Also in our study, CRP/albumin ratios were found to be significantly higher in the patients who died. In addition, these ratios were significantly higher in patients with 30-day and 1-year mortality. These results suggest that high CRP/albumin values may be associated with increased mortality risk.

Conclusion

In our study, it was observed that increased P/L ratio, N/L ratio, and MPV, all of which can be easily calculated with routine

hemogram parameters, were significantly associated with mortality. Besides, a significant correlation was found between APACHE, GCS, SOFA, and expected mortality rates with MPV and P/L ratios. In conclusion, we suggest that besides intensive care scoring systems, N/L ratio, P/L ratio, MPV, and CRP/albumin ratios can be used to monitor the prognosis of patients.

In our literature review, we could not find any studies showing the relationship between the scoring systems used in the intensive care unit and the mpv, nlr, plr values obtained easily and cheaply from the hemogram. In this study, the relationship between these parameters and scoring systems was examined. We thought that it would be beneficial to add these parameters to the scoring systems used to predict mortality and morbidity with these and similar studies with significant results.

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