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ORIGINAL ARTICLE

Medicine Science International Medical Journal

Medicine Science 2023;12(4):1269-73

Association between mean platellet volume levels and mortality outcomes in geriatric patients in intensive care

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Received 28 August 2023; Accepted 26 September 2023
Available online 19.10.2023 with doi: 10.5455/medscience.2023.08.175

Abstract

To prospectively evaluate the relationship between Mean Platelet Volume (MPV) levels and short-term mortality outcomes in critically ill patients aged ≥85 years. We hypothesized that abnormal MPV levels could offer actionable insights for predicting mortality risk in this highly vulnerable group, thereby improving therapeutic decision-making processes in the ICU setting. This study included patients aged ≥85 years. The participants were categorized into two groups based on their MPV levels at admission: group 1 (MPV≤12.5, normal range) and group 2 (MPV>12.5, elevated).A comprehensive set of variables, including demographic information, clinical indices, biochemical parameters, and respiratory metrics, were recorded. In a cohort of 475 participants, patients were stratified into two distinct groups based on MPV values: group 1 (n=400, 84.2%) and group 2 (n=75, 15.8%). The mean age was 89 (SD=7.7) and 88 (SD=6.2) years for group 1 and group 2, respectively, with a statistically significant difference (p=0.035). Significant differences were found in key biochemical parameters such as urea (p=0.045) and sodium (p=0.005). The most profound disparity was observed in platelet counts, with a highly significant p-value <0.001. The clinical outcomes showed a substantial divergence in the 30-day mortality rates between the two MPV-based cohorts (p<0.001). Additionally, a higher incidence of sepsis was recorded in the Group 2 (p=0.024). MPV is a significant prognostic indicator for mortality, 30-day mortality, and sepsis incidence, advocating its inclusion in routine clinical assessments to optimize patient care. Routinely accessible platelet indices serve as robust indicators for assessing both morbidity and mortality in critically ill patients.

Keywords: Mean platelet volume, critical illness, morbidity, mortality risk, sepsis, systemic inflammatory response

Introduction

The demographic shift towards an increasingly older population is a significant global phenomenon. Long-term projections suggest that the proportion of the elderly population will escalate further, reaching 16.3% by 2040 and 22.6% by 2060 [1,2]. Importantly, individuals over the age of 85 years make up a critical 8% of the elderly population. As this group expands, it is imperative to elucidate the unique medical challenges and prognostic factors associated with it, especially for those requiring intensive care. This underscores the urgency for specialized research in this area to inform better healthcare strategies and clinical decision-making. Patients aged ≥85 years represent a subgroup with distinct clinical characteristics and often suffer from multiple comorbidities and frailty [3]. They are particularly vulnerable to adverse outcomes when subjected to critical illness. Their management in Intensive Care Units (ICUs) requires precise prognostic indicators to effectively guide therapeutic interventions. In recent years, the need to identify reliable predictive markers for critically ill elderly patients has gained substantial attention in academic circles, emphasizing the significance of fine-tuned age-specific healthcare models [4].

Mean Platelet Volume (MPV) is emerging as an essential marker in critical care and hematology [5,6]. Platelets, traditionally known for their roles in hemostasis and wound healing, are increasingly being recognized for their involvement in inflammatory pathways and immune responses [7,8]. Elevated MPV levels have been associated with various pathologies, including cardiovascular diseases [6]. Specifically, a higher MPV has been flagged as a red flag, particularly for conditions such as occlusive arterial disease. In the context of critical illness, prior studies have attempted to

CITATION
Akin Sen I, Turan Sonmez F. Association between mean platelet volume levels and mortality outcomes in geriatric patients in intensive care. Med Science. 2023;12(4):1269-73.

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DOI: 10.5455/medscience.2023.08.175

explore the relationship between MPV and prognostic indicators such as the Acute Physiology and Chronic Health Evaluation (APACHE) scores, with mixed results [7]. However, the role of MPV as a prognostic marker in critically ill patients aged >85 years remains largely unexplored [5].

The potential utility of MPV levels in predicting short-term mortality outcomes in this age-specific cohort is not clearly understood. This gap in current scientific understanding forms the basis of our study. Our research aimed to prospectively investigate the relationship between MPV levels and short-term mortality outcomes in critically ill patients aged ≥85 years, based on the methodology of existing studies. Moreover, we strive to contribute a nuanced perspective to the existing literature by focusing on a narrow age group within the elderly population and using a prospective cross-sectional study design. We hypothesized that abnormal MPV levels could serve as a useful prognostic indicator for mortality in this high-risk group, thereby offering actionable insights for ICU clinicians who cater to elderly patients.

This study aimed to address the critical void in the literature regarding prognostic markers for short-term mortality in a uniquely vulnerable population of ICU-admitted patients aged 85 years and above. By focusing on the prognostic implications of MPV, our research aims to elucidate a potentially valuable metric in the complex calculus of geriatric critical care.

Material and Methods

Study design and ethical considerations

This is a retrospective, cross-sectional study conducted between January 1, 2015, and December 31, 2022. This study aimed to evaluate the relationship between the Mean Platelet Volume (MPV) and short-term mortality outcomes in critically ill patients aged ≥85 years. This study was approved by the Mersin University Clinical Research Ethics Committee (approval number: 2023/67, dated February 1, 2023). All the procedures adhered to the principles outlined in the Declaration of Helsinki.

Participant selection

Patients aged ≥85 years, with no known malignancies or hematologic diseases, and under intensive care during the study period were eligible for inclusion. Patients with known malignancies, hematological disorders, or those receiving anticoagulant or antiplatelet therapy were excluded.

Grouping and variables

Participants were categorized into two groups based on their MPV levels upon admission to the intensive care unit (ICU): Group 1 comprised patients with MPV levels≤12.5, and Group 2 consisted of patients with MPV levels>12.5. For each participant, the following variables were recorded: demographics (age and sex), Clinical Variables (Comorbidities, APACHE and GCS scores, ICU length of stay (ICU LOS), survival status (alive or deceased)), and Biochemical Parameters (metabolic markers, hematological indices, and markers of inflammation).

Data collection and measurements

Data were collected both at the time of admission and during discharge, including one-year follow-up for each patient. This included the measurement of key biochemical and hematological parameters using standardized diagnostic kits and procedures. Patient survival was evaluated over a short term (1-month after post-admission).

Statistical analysis

Statistical analyses were performed using SPSS software version 29.0.0. Continuous variables were evaluated for normal distribution using the Shapiro-Wilk test. The relationships between categorical variables were assessed using the chi-square test. Statistical significance was set at $P<0.05$.

Results

Sample demographics and comorbidities

The study consisted of a total of 475 participants, with 400 participants (84.2%) in Group 1, and 75 participants (15.8%) in Group 2.

The mean age for the Group 1 was 89 years, whereas the mean age for the Group 2 was 88 years with a standard deviation of 6.2 years, and a statistically significant difference was observed between the two groups (p=0.035). The gender and demographic features are presented in Tale 1 in details.

Table 1. Demographic and clinical characteristics of participants stratified by mean platelet volume (MPV) levels

Variable	MPV≤12.5	MPV>12.5	p-value
N	400	75	
Age (mean±SD)	89±7.7	88±6.2	0.035
Male (n, %)	158 (39.5%)	29 (38.7%)	0.892
Female (n, %)	242 (60.5%)	46 (61.3%)	
Additional illness (n, %)	35 (8.8%)	4 (5.3%)	0.323

SD: standard deviation, n: number of participants, %: percentage, *t-test

Biochemical parameter variation relative to mean platelet volume

The subsequent phase of the investigation was dedicated to the analysis of the key biochemical parameters. Among the biochemical markers, urea showed a statistically significant difference between the two groups, it was significantly high in the Group 2 (p=0.045). In terms of the electrolytes, Sodium (Na) demonstrated a remarkable disparity, it was higher in the Group 2 (p=0.005). The comparison between the two cohorts, classified based on their MPV levels (MPV≤12.5, MPV>12.5), is comprehensively compiled in Table 2.

DOI: 10.5455/medscience.2023.08.175

Table 2. Comparative analysis of biochemical parameters between groups based on MPV levels

Biochemical parameter	MPV≤12.5 (min-max or mean±SD)	MPV>12.5 (min-max or mean±SD)	p-value
Glucose	155 (100-197)	145 (113-202)	0.385
Urea	111 (99-179)	132 (108-228)	**0.045**
Creatine	1.6 (1-2.8)	1.7 (1-2.5)	0.378
Sodium (Na)	138.8±14.3	145.7±13.6	**0.005**
Potassium (K)	4.57±0.42	4.48±0.72	0.130
Calcium (Ca)	8.2±0.68	8.1±0.85	0.198
Phosphorus (P)	3.6±0.39	3.97±0.47	0.071
Magnesium (Mg)	2.02±0.63	2.06±0.62	0.245
AST	49 (13-76)	78 (15-145)	0.061
ALT	26 (10-42)	32 (18-51)	0.233
LDH	320 (197-453)	353 (205-578)	0.072
Total protein	5.59±1.12	5.29±1.52	0.125
Albumin	2.75±0.71	2.62±0.55	0.059
Total bilirubin	0.77 (0.54-1.89)	1.34 (0.9-2.41)	**0.009**
Direct bilirubin	0.33 (0.14-0.79)	0.68 (0.39-1.02)	**0.006**
CRP	90 (36-193)	112 (46-203)	0.172
Procalcitonin	2.5 (1.6-8)	3.3 (1.9-9)	0.651
Parathormone	162 (72-386)	173 (86-413)	0.218
Vitamin D	13 (7-22)	13 (7-25)	0.924
Troponin	86 (23-214)	92 (22-236)	0.179

SD: standard deviation, n: number of participants, %: percentage, *Independent t-tests

Comparative assessment of complete blood count and coagulation parameters in relation to mean platelet volume

Among the evaluated parameters, the most striking difference was observed in platelet counts. The difference was highly significant, with a p-value<0.001, suggesting an exceptionally substantial variance between the two group; The platellet count was significantly high int the Group 1. Table 3 shows a meticulous comparison of complete blood count (CBC) and coagulation markers between patients with MPV≤12.5 and those with MPV>12.5.

Table 3. Comparative examination of complete blood count and coagulation parameters across MPV categories

Parameter	MPV≤12.5	MPV>12.5	p-value
Hemoglobin	11.05±3.6	10.74±3.2	0.367
Leukocyte	11.5 (8.1-15.2)	12.1 (9-15.3)	0.365
Platelet	250 (162-365)	148 (124-183)	**<0.001**
RDW	17.6±4.22	18±5.23	0.220
NLO	8 (6-13)	8 (5-13)	0.619
Fibrinogen	362.1±171.3	331.2±165.9	0.384
INR	1.5 (1.2-1.8)	1.5 (1.21-1.8)	0.217
aPTT	25.6±7.2	25.3±8.9	0.796

MPV: mean platelet volume, RDW: red cell distribution width, NLO: neutrophil-to-lymphocyte ratio, INR: international normalized ratio, aPTT: activated partial thromboplastin time, SD: standard deviation, n: number of participants, %: percentage, *Independent t-tests

Clinical and mortality outcomes

A significant difference was observed in the exitus rates between the two groups, with a higher incidence in the MPV>12.5 group (238 patients (%59.5)) compared to the MPV≤12.5 group.

A significant disparity was noted in 30-day mortality rates. The exitus rate was considerably higher in the MPV>12.5 group (58 patients (77.3%)) compared than in the MPV≤12.5 group (215 patients (53.8%)), (p<0.001).

The incidence of sepsis was higher in the MPV>12.5 group (10 patients (13.3%)) compared than in the MPV≤12.5 group (24 patients (6%)). The p value for this comparison was 0.024, indicating statistical significance. In Table 4, we present a comprehensive comparative evaluation of clinical outcomes and associated variables between the two distinct patient groups categorized by their MPV levels.

Table 4. Comparative analysis of clinical outcomes and associated variables in patient groups with different MPV levels

	Variable/outcome	MPV≤12.5	MPV>12.5	p-value
Overall clinical outcomes	Mortality (exitus)	238 (59.5%)	61 (81.3%)	**0.003**
	Surviving	162 (40.5%)	14 (18.7%)	
	APACHE Score	20 (13-29)	20 (12-29)	0.908
	GKS	12 (3-14)	12 (3-14)	0.662
Hopitalisation	LOS in ICU	6 (3-12)	6 (3-12)	0.476
	Overall, LOS	6 (3-12)	6 (3-12)	0.957
30-day mortality	Exitus	215 (53.8%)	58 (77.3%)	**<0.001**
	Surviving	185 (46.2%)	17 (22.7%)	
Resubmission	Yes	21 (5.3%)	4 (5.3%)	0.976
	No	379 (94.7%)	71 (94.7%)	
Sepsis	Yes	24 (6%)	10 (13.3%)	**0.024**
	No	376 (94%)	65 (86.7%)	

MPV: mean platelet volume, APACHE: acute physiology and chronic health evaluation, GKS: Glasgow Coma scale, LOS: length of stay, SD: standard deviation, n: number of participants, %: percentage, *Independent t-tests

Discussion

The present study comprehensively investigated the relationship between the mean platelet volume (MPV) and an array of clinical and biochemical parameters, including demographic characteristics, comorbidities, and outcomes such as mortality.

The first striking observation was the statistically significant difference in age between the MPV≤12.5 and MPV>12.5 groups (p=0.035). Although the age gap is modest, this aligns with the study by Wacka et al., which indicated that aging populations may experience alterations in hematological parameters, including MPV, which could be indicative of systemic changes in health status [9]. Our study did not indicate a significant gender disparity between the two MPV groups (p=0.892), which is consistent with the findings of Juster et al. [10]. With regard to comorbidities, we found no statistically significant difference in the presence of additional illnesses between the two groups

DOI: 10.5455/medscience.2023.08.175

(p=0.323). This is in contrast to research by Lee [11], who argued that a high MPV might be associated with a higher prevalence of comorbid conditions.

Our study showed that urea (p=0.045) and sodium (p=0.005) levels were notably different between the MPV groups. This is particularly intriguing, as elevated urea levels are often implicated in renal dysfunction, whereas abnormal sodium levels may reflect an underlying electrolyte imbalance. These biochemical differences underscore the importance of considering MPV as a potential marker for broad systemic changes, aligning with the assertion of Efe et al. [12].

Certainly. The expansion of the section in question necessitates a nuanced understanding of each of the three principal observations: platelet counts as correlated with mean platelet volume (MPV), 30-day mortality rate between the two MPV groups, and incidence of sepsis among patients with elevated MPV. The following is a more detailed and comprehensive version of this section.

Augmented platelet count variability

The most salient and striking observation to emerge from our study was the notable divergence in platelet counts between the MPV≤12.5 and MPV>12.5, substantiated by a highly significant p-value of less than 0.001. This finding lends strong credence to the hypothesis that MPV may serve as an indispensable biomarker for thrombotic events. The value of MPV in this context is further substantiated by seminal research that articulates the utility of MPV as an efficacious marker for diagnosing coagulopathies in patients presenting with acute medical conditions [5,7]. Notably, elevated MPV levels have been associated with a prothrombotic state, which may contribute to the development of cardiovascular events, deep vein thrombosis, and other coagulation-related complications. This is a paramount consideration for physicians, suggesting that elevated MPV could necessitate targeted anticoagulant therapies or further diagnostic tests, such as D-dimer levels and ultrasound imaging for deep vein thrombosis.

30-day mortality rate: a cautionary indicator

A second pivotal observation in our research is the marked discrepancy in the 30-day mortality rates between the two MPV groups, as evidenced by a p-value of less than 0.001. These data are indicative of a heightened risk for unfavorable outcomes, particularly mortality, among patients exhibiting elevated MPV levels. This observation is in agreement with a study by Tajarernmuang et al. [13], which also asserted that a higher MPV serves as a reliable predictor of mortality in critical care settings. Also, Kim et al. MPV increase during the first 72 h of hospitalization is an independent risk factor for 28-day mortality [14]. These data suggest that elevated MPV could be reflective of the underlying pathophysiological processes that exacerbate patient outcomes. Therefore, it is not merely a passive marker, but potentially an active participant in clinical cascades leading to mortality, calling for more aggressive intervention strategies for patients within this category.

Incidence of sepsis: Implications for systemic inflammatory response

Lastly, the incidence of sepsis showed a significantly higher frequency within MPV>12.5, corroborated by a p-value of 0.024. This observation emphasizes the role of MPV as a critical indicator of systemic inflammatory response. This is particularly true given the findings of previous studies, which posited that elevated MPV levels are indicative of increased inflammatory activity within the body [7,15,16]. Similarly, Kim et al. reported that an elevation in MPV observed within the initial 72-hour window following hospital admission is a statistically robust, independent risk determinant for adverse clinical trajectories, including organ dysfunction and complications. Moreover, this increase in MPV serves as an autonomous prognostic indicator of the 28-day mortality rates. Consequently, persistent surveillance of MPV metrics is of critical importance and could facilitate risk stratification for mortality in patients with severe sepsis and/or septic shock [14].

Sepsis is a state of systemic inflammation, and its higher occurrence in patients with elevated MPV underscores the need for rigorous monitoring and the early initiation of anti-inflammatory or antibiotic therapies in this patient cohort.

By delving deeper into these facets, it becomes evident that MPV could serve multiple rolesas a marker for thrombotic risk, an indicator of heightened mortality, and a signal for increased susceptibility to systemic inflammatory conditions such as sepsis. These nuanced roles make MPV an invaluable tool in predictive medicine, necessitating its incorporation into routine clinical assessment [17-20].

Conclusion

MPV is not merely a one-dimensional hematological parameter but also a clinical nexus that interacts with various aspects of patient care, from diagnostics to prognosis and treatment planning. Its significant correlation with platelet count variance, mortality risk, and sepsis incidence lends weight to the argument for its mandatory inclusion in routine clinical assessments of high-risk patients.

The potent implications of these findings contribute substantively to the burgeoning realm of predictive and personalized medicine, offering clinicians a robust multipurpose tool for enhancing patient care.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
This study was approved by the Mersin University Clinical Research Ethics Committee (approval number: 2023/67, dated February 1, 2023). All the procedures adhered to the principles outlined in the Declaration of Helsinki.

DOI: 10.5455/medscience.2023.08.175

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