ERCİYES ÜNİVERSİTESİ VETERİNER FAKÜLTESİ DERGİSİ
Journal of Faculty of Veterinary Medicine, Erciyes University
Research Article / Araştırma Makalesi
21(3), 194-201, 2024
DOI: 10.32707/ercivet.1592078

Diagnostic Significance of Mean Platelet Volume and Erythrocyte Distribution Width in Calves with Sepsis

Murat UZTİMÜR[1,a]

[1]Bingöl University, Faculty of Veterinary Medicine, Department of Internal Medicine, Bingöl-TÜRKIYE
ORCID No: [a]0000-0001-9294-1825

Corresponding author; Murat UZTİMÜR, E-mail: muratuztimur@yahoo.com
How to cite: Diagnostic significance of mean platelet volume and erythrocyte distribution volume in calves with sepsis. Erciyes Univ Vet Fak Derg 2024; 21(3):194-201

Abstract: Medical studies conducted on humans have revealed significant changes in hematological parameters during sepsis and used these changes for diagnostic and prognostic purposes. However, there are very few studies on the diagnostic and prognostic utility of hematological parameters in the field of veterinary medicine. The objective of this study was to assess whether the parameters mean platelet volume (MPV), erythrocyte distribution width standard deviation/coefficient of variation (RDW-SD/CV), platelet distribution width (PDW) and plateletcrit (PCT) hold diagnostic significance in identifying sepsis in calves, while also investigating the interrelationships of these parameters within these sepsis group. The study included 45 calves diagnosed with sepsis and healthy 15 calves as control group. In calves with sepsis, MPV, PCT, RDW-SD, RDW-CV and total leukocyte count were found to be significantly higher than the control group. In their analysis for the diagnosis of sepsis in calves, the sensitivity of MPV was 86.67, the specificity was 84.44, the area under the curve (AUC) was 0.91, and the cut-off point value was 5.95 fL. In addition, the AUC values for other parameters were found as PCT 0.79 (P=0.009), RDW-SD 0.68, RDW-CV 0.75 and WBC 0.80, respectively. In the correlation analysis between MPV and other parameters, it was determined that there was a significant relationship between PCT 0.630, PDW 0.310, WBC 0.271, RDW-SD 0.383 and RDW-CV 0.-643. In conclusion, MPV may be a useful biomarker in calves with sepsis due to its favorable diagnostic performance in the early detection of sepsis in new born calves with diarrhea. In order to determine the effects of the results in this study on sepsis very well, it is necessary to work with populations with large sample numbers in the future.
Keywords: Calf, diarrhea, MPV, RDW, sepsis

Sepsisli Buzağılarda Ortalama Trombosit Hacmi ve Eritrosit Dağılım Hacminin Diyagnostik Önemi

Öz: İnsanlarda yapılan tıbbi çalışmalarda sepsis sırasında hematolojik parametrelerde anlamlı değişiklikler ortaya konmuş ve bu değişiklikler tanı ve prognoz amaçlı kullanılmıştır. Ancak veteriner hekimliği alanında hematolojik parametrelerin tanı ve prognozdaki faydasına ilişkin çok az çalışma bulunmaktadır. Bu çalışmanın amacı buzağılarda sepsisin belirlenmesinde ortalama trombosit hacmi (MPV), eritrosit dağılım genişliği-standart sapma/varyasyon katsayısı (RDW-SD/CV), trombosit dağılım genişliği (PDW) ve plateletkrit (PCT) parametrelerinin tanısal önem taşıyıp taşımadığını değerlendirmek ve ayrıca sepsis grubunda bu parametrelerin birbirleriyle olan ilişkilerini araştırmaktır. Çalışmaya sepsis tanısı konulan 45 buzağı dahil edildi. Sağlıklı olduğu belirlenen 15 buzağı kontrol grubunu oluşturdu. Sepsisli buzağılarda MPV, trombosit sayısı, RDW-SD, RDW-CV ve toplam lökosit sayısının kontrol grubuna göre anlamlı derecede yüksek olduğu bulundu. Buzağılarda sepsis tanısı için yapılan ROC analizinde MPV'nin duyarlılığı 86.67, özgüllüğü 84.44, eğri altında kalan alan 0.91 ve kesme noktası değeri 5.95 fL olarak bulundu. Ayrıca diğer parametreler için AUC değerleri sırasıyla PCT 0.79 (P=0.009), RDW-SD 0.68, RDW-CV 0.75 ve WBC 0.80 olarak bulundu. MPV ile diğer parametreler arasındaki korelasyon analizinde PCT 0.630, PDW 0.310, WBC 0.271, RDW-SD 0.383 ve RDW-CV 0.-643 arasında anlamlı ilişki olduğu belirlendi. Sonuç olarak MPV, ishalli yenidoğan buzağılarda sepsisin erken tespitinde iyi tanı performansı nedeniyle sepsisli buzağılarda yararlı bir biyobelirteç olabilir. Bu çalışmadaki sonuçların sepsis üzerine etkilerinin çok iyi belirlenebilmesi için gelecekte geniş örneklem sayılarına sahip popülasyonlarla çalışılması gerekmektedir.
Anahtar kelimeler: Buzağı, ishal, MPV, RDW, sepsis

Introduction

Sepsis arising from neonatal calf diarrhea elicits a substantial burden of morbidity and mortality (Panda et al., 2022; Milas et al., 2022). Moreover, sepsis engenders noteworthy economic ramifications for corporate entities. Analogous to numerous maladies, the early and precise diagnosis of sepsis assumes paramount significance for the efficacy of treatment protocols and the principles of preventive medical practice. Blood culture stands as the definitive criterion for sepsis diagnosis. Nevertheless, the necessity for novel biomarkers is underscored by reasons such

Geliş Tarihi/Submission Date : 02.08.2024
Kabul Tarihi/Accepted Date : 10.10.2024

as the extended duration requisite for blood culture application-typically spanning 48-72 hours-coupled with its susceptibility to yielding false positive outcomes and demonstrating reduced sensitivity (Pugni et al., 2015; Sağıroğlu et al., 2023). Despite the emergence of novel therapeutic interventions and early diagnostic methodologies in the domain of veterinary medicine in recent years, sepsis continues to uphold its clinical significance as a pivotal cause of mortality (Llewellyn et al., 2017). Automated hematology analyzers scrutinize indices associated with erythrocytes and platelets, encompassing metrics like erythrocyte distribution width standard deviation/ coefficient of variation (RDW-SD/VC), platelet count, platelet distribution width (PDW), plateletcrit (PCT), and mean platelet volume (MPV). Evaluation of these indices related to erythrocytes and platelets bestows clinicians with the capacity to proffer observations concerning the processes of production and activities pertaining to these cellular elements (Phillips et al., 2022). MPV constitutes a parameter amenable to straightforward analysis through a complete blood count, revealing the platelet volume, while also demonstrating a substantial increase concomitant with the release of immature PLTs from the bone marrow (Goddard et al., 2015). It also serves as a reliable indicator of platelet production and thrombopoesis (Korniluk et al., 2019). PCT expresses the ratio of platelet volume to total blood volume as a percentage value. It is also calculated using PCT count, MPV, and platelet count (Goddard et al., 2015). A multitude of studies have attested to the diagnostic significance of the platelet index in sepsis within the realm of human medicine (Panda et al., 2022; Milas et al., 2022; Mangalesh et al., 2021). Furthermore, demonstrative evidence reveals that the platelet index undergoes significant alteration in dogs afflicted by sepsis, septic peritonitis, and systemic inflammation (Bommer et al., 2008; Pierini et al., 2020; Llewellyn et al., 2017). The causative factor behind the heightened platelet index during sepsis resides in the escalated turnover of platelets originating from the bone marrow and the subsequent release of nascent platelets into the circulation. Consequently, this intricate interplay gives rise to pathological modifications in the parameters encompassed within the platelet index (Korniluk et al., 2019).

RDW quantifies the coefficient of variation in the dimensions of erythrocytes within circulation, revealing the presence of anisocytosis within these red blood cells (Scalco et al., 2022). RDW holds significance across both human and veterinary medical domains for regenerative anemias. Additionally, within human medicine, it emerges as a biomarker with applicability in the identification of various conditions, including sepsis (Scalco et al., 2022; Hodeib et al., 2022), cardiovascular ailments (Chen et al., 2010; Förhécz., 2009), and critical illnesses (Bazick et al., 2011).

Numerous studies have documented substantial alterations in hematological parameters among septic calves, underscoring the relevance of these changes in the disease's progression (Naseri et al., 2018; Naseri et al., 2019). In parallel, human medical studies have similarly illuminated significant shifts in hematological parameters during sepsis, harnessing these changes for diagnostic and prognostic purposes (Hodeib et al., 2022). However, within the sphere of veterinary medicine, explorations into the diagnostic and prognostic utility of hematological parameters have primarily centered on felines (Gori et al., 2021), canines (Phillips et al., 2022; Pierini et al., 2020), and equine neonates (Scalco et al., 2022). Thus far, no study has been identified that delves into platelet and erythrocyte indices' determination and their diagnostic significance among septic calves. This study's objectives encompass: (i) ascertaining whether platelet and erythrocyte indices bear diagnostic relevance in both sepsis and healthy neonatal calves; (ii) elucidating the associations between these indices and sepsis; and (iii) unveiling novel avenues for the application of these traditional hematological parameters, widely entrenched within clinical practice.

Materials and Methods

Before the commencement of the study, ethical clearance was secured from the Bingöl University Animal Experiments Local Ethics Committee (B.U. AELEC Meeting Number: 2023/04 Decision No: 04/04).

Animals and etiological diagnosis

The study included a total of 60 calves of different breeds and gender and aged 1-28 days. Of these, the sepsis group included 45 calves with diarrhea whose, their etiological diagnosis [Rotavirus, Coronavirus*, Cryptosporidium parvum (C. parvum),* and *Giardia lamblia*] was based on the utilization of immuno chromatographic rapid test kits (Anigen Rapid BoviD-5 Ag Test Kit, Bionote, Inc. Korea). Within the sepsis group, calves manifesting clinical sign other than diarrhea (such as prematurity, pneumonia, omphalitis, arthritis, congenital anomalies, immunosuppressive drug administration, or antibiotic usage) were excluded from the study. The remaining 15 healthy calves served as control group. These calves were clinically healthy and were negative for any infectious agents of concern on the immunochromatographic rapid test kits.

Sepsis criteria and analyses

The calves included in the study underwent an initial physical examination, encompassing assessments of respiratory rate per minute, body temperature in degrees Celsius, and heart rate per minute. Criteria for diagnosis of SIRS in calves were as follow;

-body temperature was more than 39.5 °C or less

than 38.5 °C,

- heart rate was more than 160/min or less than 100/ min,

-respiratory rate was more than 36/min,

- total leukocyte count was more than 12,000/mm3 or less than 4000/mm3 (Fectau et al., 1997; Fectau et al., 2009).

The presence of at least two of the aforementioned criteria defines SIRS, and when coupled with an infection or suspicion of infection, it characterizes sepsis (Fectau, 2009). To assess the erythrocyte and platelet indices in all calves, 2 ml blood samples were collected from the jugular vein into K3-EDTA-containing anticoagulant tubes (BD Vacutainer®, Plymouth, UK). For the determination of the total leukocyte (WBC), MPV, RDW-CV, RDW-SD, PDW, and PCT counts for each calf, the blood samples in the anticoagulant tubes were gently mixed and read on a 3-part hematology device (Benesphera H-31, India) within a maximum of 5 minutes. Prior to analysis, the hematology analyzer was calibrated in accordance with the manufacturer's protocol, and the blood samples were processed. Samples with inappropriate PLT or RBC histogram indices were excluded from the study. Blood smears were checked for the presence of PLT aggregates and calf with abnormal feature were excluded from the study.

Statistical analysis

Data were analyzed using software [SPSS 26 (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.) and Graph Pad Prism (Prism 9 for Windows, version 9)]. The data were presented in the form of descriptive statistics, including mean ± standard deviation, median, minimum, and maximum values. To assess the normal distribution of the data, the Shapiro-Wilk test was employed. When analyzing the distinctions between the sepsis and control group calves, the Mann-Whitney U test was utilized for data that did not meet the criteria for normal distribution. Conversely, the Independent Sample T test was applied to data that exhibited a normal distribution. The correlation between variables was examined through Spearman's rank correlation test. For the assessment of the diagnostic value of erythrocyte and platelet indices in calves with sepsis, sensitivity, specificity, AUC, and the cut off value were determined using ROC analysis. The interpretation of the AUC values was as follows: AUC>0.90 indicated high accuracy, AUC between 0.70 and 0.90 denoted moderate accuracy, AUC between 0.5 and 0.7 indicated low accuracy, and AUC<0.5 was considered a failure. The statistical significance between groups was determined as P<0.05.

Results

Basic characteristics of the calves in the study

The numerical distribution of etiological factors is shown in Table 1. Etiological agents identified in calves were rotavirus (n=18), coronavirus (n=10), *C. parvum* (n=4), *Giardia lamblia* (n=4), and mixed infections [Rotavirus + Coronavirus (n=3), Coronavirus + *C. parvum* + *Giardia lamblia* (n=1)]. The breed distribution of calves with sepsis were Simmental (n=32) and were Holstein calves (n=13). All controls were Simmental breed. The study population consisted of 40 male and 20 female calves.

Table 1. Numerical distribution of etiological factors

Etiological Factors	Number
Rotavirus	18
Coronavirus	10
C. parvum	4
Giardia lamblia	4
Rotavirus+Coronavirus	3
Coronavirus+*C.parvum*+*Giardia lamblia*	1

Comparison of hematological variables between study groups

Table 2, 3 and Figure 1 present the descriptive statistics of MPV, RDW-SD, RDW-CV, PDW, PCT, WBC, body temperature, heart rate, and respiratory rate for calves with sepsis and calves in the control group. Statistically significant differences were observed between the sepsis and control groups. Specifically, in calves with sepsis, MPV (P<0.001), WBC (P<0.001), PCT (P<0.001), RDW-SD (P<0.034), and respiratory rate (P<0.025) were significantly higher compared to the control group. Conversely, RDW-CV was notably lower in calves with sepsis compared to the control group (P<0.004). While PDW and heart rate showed higher values in calves with sepsis, these differences were not statistically significant (PDW: P>0.061; heart rate: P>0.972).

Table 2. MPV, RDW-SD, RDW-CV, PLT, PDW, PCT, WBC, mean±standard deviation, median, minimum and maximum values of calves with sepsis and those in the control group

	Sepsis Group	**Control Group**	
Variables	**Mean±SDMean±SD Median (IQR)**	**Median (IQR)**	**P value**
MPV (fL)	12.96±4.42[a] 15 (4.40-17.90)	5.26±0.50[b] 5.10 (4.6-6)	0.001
RDW-SD (fL)	42.30±10.55[a] 44.4 (12.80-73)	40.92±4.20[b] 40.5 (33.3-49.70)	0.034
RDW-CV (%)	22.14±5.19[a] 24.1 (7.60-27.20)	30.39±8.23[b] 32.8 (16-44.60)	0.004
PDW (fL)	13.66±6.63 18.3 (1.8-20.70)	11.09±4.69 14.1 (4.2-14.5)	0.061
PCT (%)	5.51±2.86[a] 6.38 (0.05-9.79)	3.04±2.2[b] 3.64 (0.19-5.43)	0.001
WBC (x10^9)	18.52±11.66[a] 16.61 (2.5-55)	9.52±2.86[b] 8.64 (6.94-18.7)	0.001

RDW-SD/VC: Erythrocyte distribution width standard deviation/coefficient of variation; PDW: platelet distribution width; PCT: plateletcrit; MPV: Mean platelet volume; WBC: White blood cell. Statistical significance differences between groups P<0.05.

Table 3. Body temperature, heart and respiratory frequency values of calves with sepsis and those in the control group

Variables	**Sepsis Group mean±SD min-max**	**Control Group mean±SD min-max**	**P value**
Heart Frequency (min)	124.89±34.7 35-200	121.87±20.12 68-140	0.972
Respiratory Frequency (min)	38.96±14.5[a] 12-80	30.13±4.64[b] 20-40	0.025
Body Temperature (°C)	37.95±1.47 35-40.3	38.07±2.25 30-39.2	0.476

Statistical significance differences between groups P<0.05.

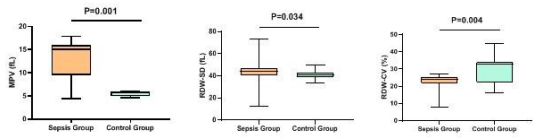

Figure 1. Box plots show MPV, RDW-SD and RDW-CV values of calves with sepsis and control group calves. Statistical significance differences between groups P<0.05. MPV: mean platelet volume; RDW-SD: erythrocyte distribution width standard deviation; RDW-CV, erythrocyte distribution width coefficient of variation.

The Value of hematological variables in the diagnosis of sepsis

Table 4 and Figure 2 present the sensitivity, specificity, AUC, and cut-off point values for the parameters MPV, RDW-SD, RDW-CV, and PCT in the context of diagnosing sepsis using the ROC curve. For the diagnosis of sepsis, the MPV parameter exhibited a sensitivity of 86.67% and specificity of 84.44%. The AUC was determined to be 0.91, with a cut-off point value of less than 5.95. Similarly, the PCT parameter displayed a sensitivity of 73.33% and specificity of 68.89%, yielding an AUC of 0.79. The corresponding cut-off point value was less than 4.91. Regarding RDW-SD, its sensitivity was calculated as 73.33% and specificity as 73.33%, resulting in an AUC of 0.68. The cut-off point value was determined to be less than 41.65. On the other hand, RDW-CV showed a sensitivity of 66.67% and specificity of 66.67%, with an AUC of 0.75. The optimal cut-off point value was greater than 24.85.

Table 4. Sensitivity, specificity, AUC and cut-off point values of variables in the diagnosis of sepsis in calves

Variables	Sensitivity	Specificity	AUC	Cutt-off	P value
MPV (fL)	86.67	84.44	0.91	>5.95	0.001
RDW-SD (fL)	73.33	73.33	0.68	>41.65	0.034
RDW-CV (%)	66.67	66.67	0.75	<24.85	0.003
PCT (%)	66.67	68.89	0.79	>4.91	0.009
WBC (x10^9)	80	80	0.80	>9.68	0.006

AUC: area under the curve; RDW-SD/VC: Erythrocyte distribution width standard deviation/coefficient of variation; PDW: platelet distribution width; PCT: plateletcrit, MPV: Mean platelet volume; WBC: White blood cell. Statistical significance differences between groups P<0.05

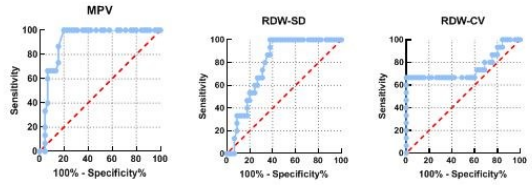

Figure 2. Receiver operating characteristic curves of MPV, RDW-SD and RDW-CV values of calves with sepsis. MPV: mean platelet volume; RDW-SD: erythrocyte distribution width standard deviation; RDW-CV: erythrocyte distribution width coefficient of variation.

Relationship between hematological variables in sepsis

Correlation analysis was performed between MPV value and PLT, PCT, RDW-SD, PDW and WBC values in calves diagnosed with sepsis. In the septic calves, a statistically significant positive correlation was determined between MPV and PCT (r=0.630, P=0.005), MPV and RDW-SD (r=0.383, P=0.001), MPV and PDW (r=0.310, P=0.005) and MPV and WBC (r=0.271, P=0.001).

Discussion

The primary hypothesis of this study asserts that the erythrocyte and platelet indices measured by accessible, cost-effective, user-friendly hematology analyzers, which require minimal labor and technical expertise and are readily available in most clinical settings, can serve as potential biomarkers for diagnosing sepsis in calves. As such, the objective of this study was to assess whether the parameters MPV, RDW-SD, RDW-CV, PDW, and PCT hold diagnostic significance in identifying sepsis in calves, while also investigating the interrelationships of these parameters within the sepsis group. The findings indicated statistically significant elevations in MPV, WBC, PCT, RDW-CV, and RDW-SD levels among septic calves compared to the control group. The sensitivity, specificity, AUC (0.91), and cut off point (>5.95) for MPV were 86.67%, 84.44%, and 0.91, respectively. Furthermore, this study unveiled significant alterations in platelet activation and production within calves experiencing sepsis triggered by diarrhea. This underscores the potential utility of MPV as a valuable biomarker for sepsis diagnosis.

Timely recognition of sepsis-related problems in calves, prior to developing into irreversible condition is a critical in calf survival as it is of utmost importance in minimizing sepsis-related mortality. Consequently, the necessity for diagnostic biomarkers exhibiting high sensitivity and specificity is evident (Pugni et al., 2015; Schwartz et al., 2014; Uztimür et al., 2024). Novel diagnostic biomarkers can significantly contribute to the early identification and prognosis monitoring of infected newborns, ultimately reducing both morbidity and mortality rates, and preventing the progression towards septic shock (Pierini et al., 2020; Scalco et al., 2022).

Notable studies on MPV, a pivotal parameter of platelet index, have disclosed a significant increase in its value among dogs infected with canine parvovirus compared to control groups (Engelbrecht et al., 2021). Correspondingly, investigations conducted by Bommer et al. (2008), Schwartz et al. (2014), and Moritz et al. (2005), involving dogs afflicted by inflammatory thrombocytopenia, have reported considerable MPV elevation vis-à-vis healthy cohorts. This phenomenon of MPV increase has been attributed to the presence of larger, immature platelets resultant from regenerative processes (Bommer et al., 2008; Schwartz et al., 2014; Moritz et al., 2005). In parallel, studies have noted elevated MPV in dogs with sepsis (Pierini et al., 2020) and septic peritonitis (Llewellyn et al., 2017), underscoring its diagnostic potential. Consistent with these findings, Panda et al. (2022) observed a substantial MPV elevation in 43 neonates with sepsis. The recorded MPV sensitivity was 63.4%, specificity was 53.8%, and the cut-off point value was ≥9 fL, all indicating its utility in sepsis diagnosis. A meta-analysis by Milas et al. (2022) concurred that MPV has diagnostic significance in neonatal sepsis. Its sensitivity and specificity were reported as 0.675 and 0.733, respectively, with a cut-off point value of 9.28 fL. Another study concerning neonates with sepsis demonstrated MPV sensitivity of 93.9%, specificity of 60.9%, an AUC of 0.825, and a cut-off point >10.25 fL (Mangalesh et al., 2021). Consistent with prior studies, our study found a significant

elevation in MPV (12.96±4.42 fL) among septic calves compared to controls (5.26±0.50 fL). The ROC analysis yielded an AUC of 0.91, sensitivity of 86.67%, specificity of 84.44%, and a cut-off point value exceeding 5.95 fL, all reflecting robust diagnostic capability for sepsis. The upsurge in MPV during sepsis is attributed to the presence of larger, immature platelets and augmented activation, aggregation, and adhesion due to platelet regeneration (Khadka et al., 2022; Bommer et al., 2008).

PCT, an integral component of the platelet index, emerges as a parameter significantly impacted by sepsis (Khadka et al., 2022; Phillips et al., 2022). Two distinct studies involving neonates with sepsis disclosed marked increases in PCT values relative to healthy subjects, with this parameter exhibiting substantial correlation with disease severity (Zhang et al., 2015; Khadka et al., 2022). The ensuing ROC analysis for early sepsis prediction yielded a sensitivity of 75.9%, specificity of 67.6%, and a cut-off point exceeding 0.19%. Correspondingly, Phillips et al. (2022) observed a significant increase in PCT values within a study involving dogs with hematological neoplasia. In the present study, PCT levels were notably higher in calves afflicted with neonatal sepsis compared to the control group. Furthermore, the diagnostic capacity of PCT in sepsis was established with a sensitivity of 73.33%, specificity of 68.89%, AUC of 0.79, and a cut-off point exceeding 4.98%. These findings resonate with the outcomes of aforementioned studies.

RDW is a parameter inherent to the whole blood profile, illustrating the variance and heterogeneity among erythrocytes (Kim et al., 2020). Recent years have witnessed an expanded recognition of RDW beyond its traditional role in anemia, emphasizing its significance as a biomarker in conditions involving respiratory, cardiovascular diseases, inflammation, infection, and sepsis-related contexts (Lippi et al., 2009; Hodeib et al., 2022). Empirical studies on dogs with heartworm disease (Kim et al., 2020) and pulmonary hypertension (Swann et al., 2014), encompassing 86 and 44 subjects respectively, unveiled substantial elevations in RDW count. This led to suggestions that RDW serves as a crucial parameter for disease monitoring. These observations underline the importance of RDW in determining disease prognosis. In sepsis, profound alterations transpire within the hematopoietic system. Among these changes, the presence of pro-inflammatory cytokines inhibits erythrocyte maturation, contributing to heightened erythrocyte heterogeneity and, consequently, elevated RDW values (Pierce et al., 2005; Tóth et al., 2017). For sepsis diagnosis, RDW-SD demonstrated a sensitivity of 73.33%, specificity of 73.33%, AUC of 0.68, and a cut-off point exceeding 41.65 fL. Conversely, RDW-CV value (22.14±5.19%) was lower in septic calves than the control group (30.39±8.23%). The sensitivity and specificity of RDW-CV in sepsis diagnosis were 66.67% each, with an AUC of 0.75, and a cut-off point below 24.85. The elevation of RDW might be attributed to heightened inflammatory reactions in sepsis, impacting bone marrow and iron metabolism (Förhécz et al., 2009). Additionally, endocrine and neuro-hormonal factors stimulate erythrocyte proliferation, thereby enhancing erythropoietin production and consequently elevating RDW (Chen et al., 2010).

In conclusion, the acquired values of MPV, RDW-SD, RDW-CV, PDW, and PCT from automated hematology analyzers, readily accessible in nearly all clinical settings, requiring minimal additional labor and technical expertise, and offering cost-effective and swift results, hold potential for deployment in the diagnosis of sepsis in calves. In this study, discernible elevations were observed in MPV, RDW-SD, RDW-CV, PDW, PCT, and WBC counts among calves afflicted with sepsis in comparison to the control group. Notably, MPV, RDW, PLT, and PCT levels in calves exhibited diagnostic significance for sepsis, with an evident interrelation between these indices. The findings of this study firmly establish the diagnostic utility of MPV values as a viable biomarker for sepsis diagnosis.

REFERENCE

Bazick HS, Chang D, Mahadevappa K, Gibbons FK, Christopher KB. Red cell distribution width and all-cause mortality in critically ill patients. Crit Care Med 2011; 39(8): 1913-21.

Bommer NX, Shaw DJ, Milne EM, Ridyard, AE. Platelet distribution width and mean platelet volume in the interpretation of thrombocytopenia in dogs. J Small Anim Pract 2008; 49(10): 518-24.

Chen PC, Sung FC, Chien KL, Hsu HC, Su TC, Lee YT. Red blood cell distribution width and risk of cardiovascular events and mortality in a community cohort in Taiwan. Am J Epidemiol 2010; 171(2):214-20.

Engelbrecht M, Atkinson B, Goddard A, Pazzi P, Mcclure V. Mean platelet volume and platelet volume distribution width in canine parvoviral enteritis. Front Vet Sci 2021; 8: 722280.

Fecteau G, Pare J, Van Metre DC, Smith BP, Holmberg CA, GuterbockW, Jang S. Use of a clinical sepsis score for predicting bacteremia in neonatal dairy calves on a calf rearing farm. Can Vet J 1997; 38(2): 101.

Fecteau G, Smith BP, George, LW. Septicemia and meningitis in the newborn calf. Vet Clin North Am Food Anim 2009; 25(1): 195-208.

Förhécz Z, Gombos T, Borgulya G, Pozsonyi Z, Prohaszka Z, Janoskuti L. Red cell distribution width in heart failure: prediction of clinical events and relationship with markers of in effective erythropoiesis, inflammation, renal function, and nutritional state. Am Heart J 2009; 158(4): 659-66.

Goddard A, Leisewitz AL, Kristensen AT, Schoeman JP. Platelet indices in dogs with Babesia rossi infection. Vet Clin Pathol 2015; 44(4): 493-7.

Gori E, Pierini A, Lippi I, Lubas G, Marchetti V. Leukocytes ratios in feline systemic inflammatory response syndrome and sepsis: A retrospective analysis of 209 cases. Animals 2021; 11(6): 1644.

Hodeib M, Morgan D, Hedaya A, Waked N. A study of elevated red cell distribution width (RDW) in early -onset neonatal sepsis. Gaz Egypt Paediatr Assoc 2022; 70(1): 1-6.

Khadka P, Maharjan G, Chapagain G, Paudyal P. Economic and diagnostic biomarker tests of neonatal sepsis: A prospective study from a tertiary care hospital in a low-income country. Biomed Res Int 2022; 2022: 5166380.

Kim SJ, Suh SI, Hyun C. Evaluation of red blood cell profiles in dogs with heartworm disease. Can J Vet Res 2020; 84(4): 265-71.

Korniluk A, Koper-Lenkiewicz OM, Kamińska J, Kemona H, Piekarska VD. Mean platelet volume (MPV): new perspectives for an old marker in the course and prognosis of inflammatory conditions. Mediators Inflamm 2019;17(2019): 921307.

Llewellyn EA, Todd JM, Sharkey LC, Rendahl A. A pilot study evaluating the prognostic utility of platelet indices in dogs with septic peritonitis. J Vet Emerg Crit Care 2017; 27(5): 569-78.

Lippi G, Targher G, Montagnana M, Salvagno GL, Zoppini G, Guidi GC. Relation between red blood cell distribution width and inflammatory biomarkers in a large cohort of unselected outpatients. Arch Path Lab 2009; 133(4): 628-32.

Mangalesh S, Dudani S, Malik A. Platelet indices and their kinetics predict mortality in patients of sepsis. Indian J Hematol Blood Transfus 2021; 37(4): 600-8.

Milas GP, Karageorgiou V, Bellos I. Mean platelet volume and neonatal sepsis: a systematic review and meta-analysis of diagnostic accuracy. J Matern Fetal Neonatal Med 2022; 35(25): 5324-36.

Moritz A, Walcheck BK, Weiss DJ. Evaluation of flow cytometric and automated methods for detection of activated platelets in dogs with inflammatory disease. Am J Vet Res 2005; 66(2): 325-9.

Naseri A, Sen I, Turgut K, Guzelbektes H, Constable PD. Echocardiographic assessment of left ventricular systolic function in neonatal calves with naturally occurring sepsis or septic shock due to diarrhea. Res Vet Sci 2019; 126: 103-12.

Naseri A, Turgut K, Sen I, Ider M, Akar A. Myocardial depression in a calf with septic shock. Vet Rec Case Rep 2018;6(1): e000513.

Panda SK, Nayak MK, Thangaraj J, Das P, Pugalia R. Platelet parameters as a diagnostic marker in early diagnosis of neonatal sepsis-seeking newer answers for older problems. Fam Med Prim Care Rev 2022; 11(5): 1748.

Phillips C, Naskou MC, Spangler E. Investigation of platelet measurands in dogs with hematologic neoplasia. Vet Clin Pathol 2022; 51(2): 216-24.

Pierce CN, Larson DF. Inflammatory cytokine inhibition of erythropoiesis in patients implanted with a mechanical circulatory assist device. Perfusion 2005; 20(2): 83-90.

Pierini A, Gori E, Lippi I, Lubas G, Marchetti V. Are leukocyte and platelet abnormalities and complete blood count ratios potential prognostic markers in canine sepsis? Front Vet Sci 2020; 7: 578846.

Pugni L, Pietrasanta C, Milani S, Vener C, Ronchi A, Falbo M, Arghittu M, Mosca F. Presepsin (soluble CD14 subtype): reference ranges of a new sepsis marker in term and preterm neonates. PloS one 2015; 10(12): e0146020.

Sağıroğlu M, Uztimur M, Kızıl Ö. Sepsisli buzağılarda serum heparan sülfat, sürfaktant protein-D ve sRAGE düzeylerinin diyagnostik önemi. FÜ Sağ Bil Vet Derg 2023; 37(2): 122-6.

Scalco R, Aleman M, Nogueira CE, Freitas N, Curcio BR. Red cell distribution width values and red cell distribution width-to-platelet ratio in Thoroughbred foals in the first 24 hours of life. J Vet Emerg Crit Care 2022; 1-6.

Schwartz D, Sharkey L, Armstrong PJ, Knudson C, Kelley J. Platelet volume and plateletcrit in dogs with presumed primary immune-mediated thrombocytopenia. J Vet Intern Med 2014; 28(5): 1575-79.

Swann JW, Sudunagunta S, Covey HL, English K, Hendricks A, Connolly DJ. Evaluation of red cell distribution width in dogs with pulmonary hypertension. J Vet Cardiol 2014; 16(4): 227-35.

Tóth J, Debreceni IB, Berhés M, Hajdú E, Deák Á, Pető K, Kappelmayer J. Red blood cell and platelet parameters are sepsis predictors in an Escherichia coli induced lethal porcine model. Clin Hemorheol Microcirc 2017; 66(3): 249-59.

Uztimür M, Kizil Ö, Akbulut HH. Immunophenotyping of peripheral circulating lymphocytes and serum selenium levels in calves with neonatal diarrhea. Vet Immunol Immunopathol 2024; 269: 110728.

Zhang S, Cui YL, Diao MY, Chen DC, Lin ZF. Use of platelet indices for determining illness severity and predicting prognosis in critically ill patients. Chin Med J 2015; 128: 2012-2018.