

# The role of mean platelet volume (MPV) and platelet distribution width (PDW) pre-operating as sepsis indicators in laparotomy patients in Dr. Zainoel Abidin Hospital Banda Aceh, Indonesia



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## ABSTRACT

**Background:** Sepsis has become the most common postoperative complication caused by major surgery. Early diagnosis of sepsis is very important to know the patient's prognosis and survival. Changes in mean platelet volume (MPV) and platelet distribution width (PDW) were assessed to have a relationship with the incidence of sepsis. The use of MPV and PDW platelet preoperative indicators is expected to help predict sepsis so that appropriate interventions can be given immediately.

**Methods:** A total of 50 patients who met the inclusion criteria became the subjects of this study to determine the potential of MPV and PDW preoperative biomarkers for predicting sepsis in laparotomy patients. All blood tests for the diagnosis of sepsis were examined. Spearman's test and ROC curve were performed for statistical calculations to determine the cut-off point for MPV and PDW.

**Results:** Analysis of the relationship between PDW and MPV values as an indicator of sepsis using the Spearman test found a significant relationship between MPV and PDW on the incidence of sepsis ( $p < 0.05$ ). Furthermore, statistical tests using the ROC area under the curve (AUC) curve, MPV levels were 0.968, which indicates that if MPV were examined in 100 patients, it would predict sepsis in 96 patients. Meanwhile, the AUC of PDW is 0.770, which shows that if MPV examination is performed in 100 patients, it will predict sepsis in 77 patients. The best cut-off point that the researchers got in this study was MPV levels 9.8 fL (sensitivity 93.3% and specificity 85%) and PDW levels 9.45 fL (70% sensitivity and 70% specificity).

**Conclusion:** Preoperative MPV and PDW can be predictive indicators of sepsis in laparotomy surgery, with MPV sensitivity and specificity of 93.3% and 85% and sensitivity and specificity of PDW of 70% and 70%, respectively.

**Keywords:** sepsis, mean platelet volume (MPV), platelet distribution width (PDW), acute abdomen, laparotomy.

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## INTRODUCTION

Sepsis is a systemic inflammatory reaction caused by certain microbial components. This condition can be life-threatening and the immune system will respond to this infection. This condition affects more than 750,000 people each year with a prevalence of three cases per 1,000 people. Sepsis is responsible for 20% of all hospital deaths each year (210,000).<sup>1,2</sup>

The mean platelet volume (MPV) measures the average number of platelets in the blood. MPV will be high in destructive thrombocytopenia and low in hyperproliferative thrombocytopenia. Many reports have described the direct effect of altered platelet profiles in sepsis. Platelet volume indices, such as MPV or Platelet Distribution Width (PDW),

that were examined before surgery were associated with the incidence of sepsis.<sup>3</sup>

The platelet profile that also changes apart from MPV during sepsis is the platelet distribution width (PDW) which is an indicator of the morphology of the platelet shape. MPV and PDW were significantly altered by inflammation and coagulopathy. Patients with severe sepsis with a PDW level of more than 18% had a higher risk of death. Low platelet counts in patients with sepsis at the time of application and high PDW values are strongly associated with high mortality.<sup>4,5</sup>

Until now, the primary standard of diagnosis of sepsis was established by clinical findings, blood culture, elevated procalcitonin, C-Reactive Protein, and hematological profile. A platelet profile can be quickly and routinely performed

preoperatively and postoperatively. Using preoperative platelet indicators, MPV and PDW are expected to help predict sepsis so that appropriate interventions can be immediately given to reduce costs and poor patient outcomes.

The official report on using MPV and PDW in predicting preoperative sepsis in Indonesia, especially Aceh, has yet to be widely reported. Therefore, researchers are interested in assessing MPV and PDW's role in sepsis so they can be used as preoperative predictive indicators.

## METHODS

This study is a cross-sectional design. The study was conducted at the Regional General Hospital Dr. Zainoel Abidin Banda Aceh from July – October 2021.

The number of samples was calculated using the consecutive sampling method using the formula for the diagnostic test method. The number of samples required in this study is 50 samples.

Inclusion criteria in this study were (1) acute abdomen and peritonitis patients aged over 18 years who underwent exploratory laparotomy surgery, (2) patients with quick sequential organ failure assessment (SOFA) score > 2. Exclusion criteria were (1) patients with a history of hematological disorders, hematological malignancies, and acute bleeding; (2) does not have immunocompromised comorbidities such as diabetes, HIV, and post-chemo, which can interfere with hematological conditions and blood coagulation; (3) History of use of drugs that affect platelet damage, such as steroids; (4) History of chemotherapy or pre-operative chemoradiation.

All samples with a quick SOFA score > 2 will be subjected to preoperative blood tests, including all indicators to establish sepsis based on the SOFA score. Patients with a diagnosis of sepsis based on the SOFA score will be tested for Spearman's correlation between MPV and PDW values. The correlation value is considered significant if the p-value < 0.05, then continued with Receiver Operating characteristic (ROC) analysis to determine the cut-off point. The statistical test will use a software program based on the computer operating system.

## RESULTS

There are 50 patients with a quick sofa score > 2; 60% are male. After obtaining all laboratory results, only 30 patients with SOFA scores of 5 were declared sepsis (Table 1). Spearman's correlation test found that MPV and PDW were significantly related as a determinant of preoperative sepsis with  $p < 0.05$  (Table 2).

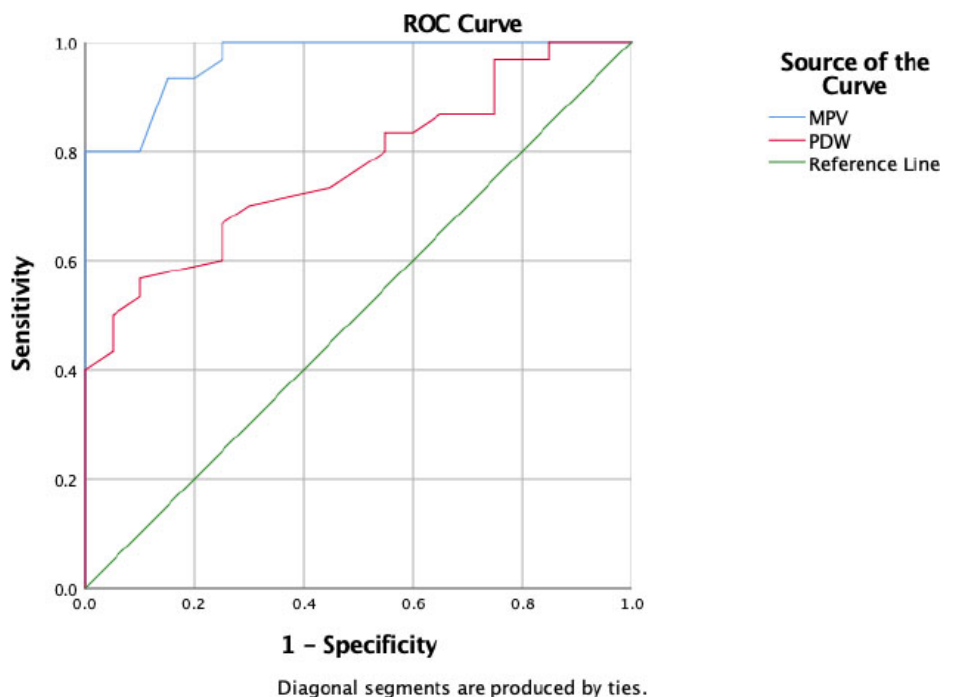
Based on statistical tests using the ROC area under the curve (AUC) curve, MPV levels were 0.968, which indicates that if MPV were examined in 100 patients, it would predict sepsis in 96 patients. Meanwhile, the AUC of PDW is 0.770, which shows that if MPV examination is performed in 100 patients, it will predict sepsis in 77 patients (Figure 1). The best cut-off values that the researchers got

**Table 1.** Characteristics of patients.

Variable	Total	Percentage (%)
<b>Sex</b>		
Male	30	60.0
Female	20	40.0
<b>Age (years)</b>		
<25	1	2.0
26-44	8	16.0
45-59	21	42.0
60-74	19	38.0
>74	1	2.0
<b>SOFA score</b>		
Male	11	36.67
Female	19	63.33

**Table 2.** MPV and PDW statistical analysis using Spearman's correlation test.

Variable	Sepsis	No sepsis	r (correlation coefficient)	p-value
MPV	11.50 ( $\pm 1.66$ )	8.89 ( $\pm 0.84$ )	1.000	<0.001
PDW	10.67 ( $\pm 1.96$ )	8.56 ( $\pm 0.86$ )	0.592	0.001



**Figure 1.** ROC curve of MPV and PDW.

**Table 3.** The area under the curve (AUC), cutoff value, sensitivity, specificity of MPV and PDW.

Parameter	AUC	95% CI	Cut off value	Sensitivity	Specificity	p-value
MPV	0.968	0.98 – 1.00	9.8 fL	93.3	85	<0.001
PDW	0.770	0.642-0.898	9.45 fL	70	70	0.01

in this study were MPV levels 9.8 fL (sensitivity 93.3% and specificity 85%) and PDW levels 9.45 fL (70% sensitivity and 70% specificity) (Table 3).

## DISCUSSION

Sepsis is an infection associated with systemic inflammatory manifestations and has been the most common complication in the perioperative period caused by major

surgery.<sup>6</sup> Sepsis is typically associated with coagulation disorders, especially prothrombotic states.<sup>7</sup> Platelets induce endothelial adhesion and the development of sepsis through their involvement in inflammation and thrombosis.<sup>8</sup> Platelets are the first blood cells to accumulate at the site of damage, where they are deformed and exhibit pseudopodia formation, local release of cytoplasmic granular content, and aggregation when activated by classical agonists such as adenosine diphosphate (ADP), thromboxane A2 (TXA2), Platelet Activating Factor (PAF), and inflammatory cytokines such as interleukin-1 (IL-1), IL-6, and tumor necrosis factor alpha (TNF- $\alpha$ ). Thus the process of fibrosis and inflammation will begin.<sup>9</sup>

The involvement of platelets in this process can result in changes in number and morphology. Platelets' increased volume and size reflect the presence of a thrombotic and inflammatory environment. During coagulation, the platelet count may decrease due to overutilization of platelets, whereas activation of megakaryocytes by pro-inflammatory cytokines can lead to increased production and release of platelets. The basic platelet parameters that are assessed during routine blood morphology tests and can provide valuable information about the blood platelet count are mean platelet volume (MPV) and platelet distribution width (PDW).<sup>9,10</sup>

A significant relationship between MPV levels and post-laparotomy sepsis was found in this study. This shows that there is a relationship between preoperative MPV levels and post-laparotomy sepsis. A study by Li et al. showed that elevated MPV levels were associated with postoperative sepsis in colorectal cancer patients.<sup>3</sup> The mechanism underlying this is still unknown, but an increase in MPV is involved in the mechanism of platelet activation. During the period of infection, MPV levels and platelet consumption increase.<sup>3,4,11</sup>

Chan et al. mentioned that in their research there was a relationship between an increase in MPV and PDW values on the occurrence of sepsis this was associated with an increase in the value of kidney function that played a role.<sup>10</sup> However, research by Qayyum et al. showed that

only PDW played a significant role independently as a predictor of mortality. Meanwhile, MPV and platelet count did not play a significant role as predictors of mortality in septic patients.<sup>11,12</sup>

A significant relationship between PDW levels and post-laparotomy sepsis was found ( $p=0.001$ ). This indicates a statistically significant relationship between preoperative PDW levels with sepsis. An increase in preoperative PDW is often associated with the presence of sepsis, malnutrition, cardiovascular disorders or malignancy. May contribute to an increase in mortality.<sup>13,14</sup>

Preoperative MPV and PDW have high sensitivity and specificity in determining sepsis after laparotomy. The best cut-off values that the researchers got in this study were MPV levels 9.8 fL (sensitivity 93.3% and specificity 85%) and PDW levels 9.45 fL (70% sensitivity and 70% specificity). The cut-off of 9.8 fL in MPV has a sensitivity value of 93.3%, indicating that MPV levels greater than 9.8 fL have a probability of detecting 93.3% of post-laparotomy sepsis patients, and a specificity of 85% indicating that probability of 85% of patients having MPV value more than equal to 9.8 fL indicates a state of sepsis after laparotomy surgery. This principle applies equally to the sensitivity and specificity of PDW.

Yanxia et al. stated that MPV has good sensitivity and specificity values, namely 81.82% and 85.71% with a cut-off value of 10.5 fl which is associated with damage to the size and shape of platelets.<sup>14</sup> Guclu et al. support the use of the platelet indicator as an indicator of the diagnosis of sepsis, this is indicated by the MPV and PDW values, where in this study the cut-off value of MPV and PDW respectively was 8 fl (sensitivity: 53.47%, specificity: 87.41%, AUC: 0.752) and 17.9 (sensitivity: 59.31%, specificity: 76.22%, AUC: 0.733).<sup>5</sup> This study supports that MPV and PDW are effective predictors of mortality in patients with septic shock.<sup>15</sup> In Indonesia, previous studies stated that the best prognostic value in patients with septic shock was MPV where with a cut-off of 10.5 fl obtained an AUC of 0.81.<sup>16</sup>

A limitation of this study is that we did not determine the onset of acute abdomen/peritonitis and the range of age in study subjects that will affect the inflammatory

response and the difference in the quick SOFA score when the patient comes to the emergency unit and the determination of sepsis based on the SOFA score.

## CONCLUSION

Preoperative MPV and PDW can be predictive indicators of sepsis in laparotomy surgery with MPV sensitivity and specificity of 93.3% and 85% and sensitivity and specificity of PDW 70% and 70%, respectively.

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## DISCLOSURE

The author reports no conflicts of interest in this work.

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None.

## ETHICAL CONSIDERATION

Ethical Committee Faculty of Medicine has approved this study, Universitas Syiah Kuala, Bana Aceh, Indonesia with Ethical Clearance reference number 412/EA/FK-RSUDZA/2021.

## AUTHOR CONTRIBUTION

All authors had contributed to manuscript writing and agreed for final version of manuscript for publication.

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