

Correlation between Platelet Profile (Mean Platelet Volume, Platelet Volume Distribution Width and Plateletcrit) with Procalcitonin and C-reactive Protein in Critically Ill Children

Rina Amalia C. Saragih, Gema Nazri Yanni

Department of Paediatrics, Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia

Received January 26, 2022; Accepted April 11, 2022.

Key words: Platelet – Procalcitonin – MPV – PDW – PCT

Abstract: The early detection of sepsis can be highly beneficial for the treatment and prognosis of critically ill children. Bacterial culture is the gold standard of bacterial infection, but it takes considerable time to get the result. Some biomarkers had been used as infection markers in children, such as C-reactive protein (CRP), full blood count with differential count and procalcitonin level. Platelet profile had been linked to infection in many studies. Platelet profile consists of mean platelet volume, platelet volume distribution width and plateletcrit. Platelet profiles are relatively inexpensive and widely available examination. It is routinely measured by automated hematology analysers in routine full blood examination, but its clinical importance and application is still limited, especially in children. The aim of this study is to analyse the correlations between platelet profiles with procalcitonin and CRP in critically ill children. A cross sectional study was conducted at Haji Adam Malik Hospital Medan, Indonesia. Patients admitted to paediatric intensive care unit, aged 1 month to 18 years were recruited. Platelet profile, procalcitonin and CRP were measured within 24 hours after admission at PICU. The most common indication of PICU admissions were central nervous system (27.9%) and respiratory

This study is funded by Universitas Sumatera Utara. The fund is under the research grant Talenta USU of Year 2019 Contract Number: 4167/UN5.1.R/RPM/2019, date; 1st April 2019.

Mailing Address: Rina Amalia C. Saragih, MD., Department of Paediatrics, Faculty of Medicine, Universitas Sumatera Utara, Dr. Mansyur Street No. 5, Medan, North Sumatera 20155, Indonesia; Phone: +62 812 913 409 08; e-mail: rina.amalia.srgh@gmail.com

<https://doi.org/10.14712/23362936.2022.8>

© 2022 The Authors. This is an open-access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>).

(25.3%) disorders. Both MPV ($r=0.217$; $p=0.045$) and PDW ($r=0.23$; $p=0.033$) had statistically significant correlation with procalcitonin, while none of platelet indicators had significant correlation with CRP. PDW and MPV had statistically significant correlation with procalcitonin as a marker of bacterial infection, their roles as an initial marker of bacterial infection needs further research.

Introduction

The high mortality rate of critically ill children depends mainly on the presence of sepsis or organ failure. Therefore, early detection of sepsis will give advantage in the treatment and prognosis of critically ill children (Elmoneim et al., 2018). Bacterial culture is the gold standard of bacterial infection, but it takes long time to get the result. Research by Safdar et al. in 2017 and Kossiva et al. in 2014 showed some biomarkers to be used as infection markers in children, such as C-reactive protein (CRP), full blood count with differential and procalcitonin. Procalcitonin levels have been shown to distinguish between bacteremia and non-infectious inflammatory states accurately and quickly in critically ill patients (Charles et al., 2008).

Platelet profile consist of mean platelet volume (MPV), platelet volume distribution width (PDW) and plateletcrit (PCT). MPV is average size of the platelets in blood. Platelet distribution width is an indication of variation in platelet size, while PCT is a measure of total platelet mass (Baig, 2015). Of those major platelet indices, MPV had been the most common variable studied in association with infection. Although some studies have shown different result, most studies reported increased MPV in sepsis. Platelet profile was linked to infection and prognosis of septic patients in many studies (Sayed et al., 2020). Our previous studies reported that MPV had positive correlation with PELOD-2 score (PELOD – pediatric logistic organ dysfunction) on septic patients (Puspitasari et al., 2018) and the difference between MPV on days 1 and 3 (Δ MPV) significantly correlated with the change of PELOD-2 score on critically ill children (Yanni and Saragih, 2020). Platelet indices examination is relatively inexpensive and widely available. It is routinely measured by automated hematology analysers in routine full blood examination, but its clinical importance and application is still limited, especially in children.

The aim of this study is to analyse the correlations between platelet profiles with procalcitonin and C-reactive protein in critically ill children.

Material and Methods

A cross sectional study was conducted at Haji Adam Malik Hospital Medan, Indonesia on May to November 2019. Patients admitted to pediatric intensive care unit (PICU), aged 1 months–18 years old were recruited. Platelet indices (MPV, PDW and PCT), procalcitonin and CRP were measured within 24 hours of PICU admission. We also recorded PELOD-2 score on the admission day. Patient were excluded if their parents or guardian refused the blood examination. This study was approved by the Health Research Ethical Committee of Medical Faculty

of Universitas Sumatera Utara with the number 665/TGL/KEPK FK USU-RSUP HAM/2019.

Results

Among 86 subjects recruited, 51 (59.3%) children were boys. The most common indication of PICU admissions were central nervous system (27.9%) and respiratory disorders (25.3%). Characteristics of subjects were shown in Table 1.

We found that MPV ($r=0.217$; $p=0.045$) and PDW ($r=0.23$; $p=0.033$) had statistically significant correlation with procalcitonin (Table 2), while none of platelet indices correlated with CRP (Table 3). Scatter plot of correlation between platelet profile and procalcitonin are shown in Figure 1.

Discussion

Procalcitonin and CRP are well-known biomarker of sepsis. Serum procalcitonin levels are associated with blood culture positivity in patients with sepsis, and procalcitonin appears to have higher specificity and sensitivity for predicting bacterial infection than other markers (Irvem and Aksaray, 2018). The platelet profiles used in this study are PDW, MPV, and PCT which are simple and economical that is easy to interpret and are routinely measured in suspected infected patient. In addition, these results can also be obtained faster than culture which is the gold standard of bacterial infection (Erdogan et al., 2015).

MPV reflects the average size of platelets. Young platelets are larger than old platelets. Increased number of young platelets indicates increased platelet

Table 1 – Characteristic of subjects

Variable	n=86
Age (year), median (min–max)	3 (0.08–17.91)
Sex, n(%)	
– Boys	51 (59.3)
– Girls	35 (40.7)
Underlying disease, n(%)	
– Pneumonia	15 (17.4)
– Sepsis	19 (22.1)
– Central nervous system infection	16 (18.6)
– Congestive heart failure	3 (3.5)
– Chronic kidney disease	9 (10.5)
– Post surgical	14 (16.3)
– Others	10 (11.6)
PELOD-2 score, median (min–max)	8 (2–21)
≥ 10, n(%)	26 (30.2)
< 10, n(%)	60 (69.8)
Mortality, n(%)	43 (50)

Table 2 – Correlation between platelet profile and procalcitonin

	Platelet profile median (range)	Procalcitonin median (range)	p	R
MPV	9.85 (7.5–33.3)	6.36 (0.10–641.4)	0.045	0.217
PDW	9.70 (7.0–21.8)		0.033	0.230
PCT	263.15 (1.8–1706)		0.070	–1.960

MPV – mean platelet volume; PDW – platelet volume distribution width; PCT – plateletcrit

Table 3 – Correlation between platelet profile and CRP

	Platelet profile median (range)	CRP median (range)	p	R
MPV	9.85 (7.5–33.3)	1.9 (0–22.4)	0.149	0.157
PDW	9.70 (7.0–21.8)		0.242	0.128
PCT	263.15 (1.8–1706)		0.135	–0.162

CRP – C-reactive protein; MPV – mean platelet volume; PDW – platelet volume distribution width; PCT – plateletcrit

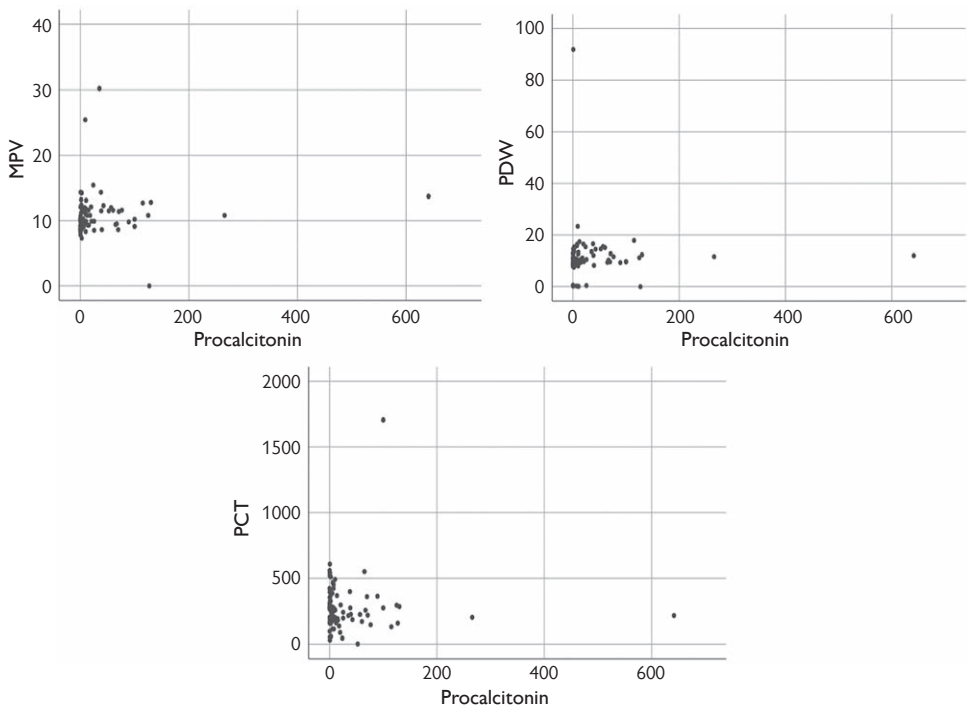


Figure 1 – Scatter plot of correlation between mean platelet volume (MPV) (A), platelet volume distribution width (PDW) (B), plateletcrit (PCT) (C) and procalcitonin levels.

production due to overconsumption induced by inflammation. Larger platelets are functionally, metabolically, and enzymatically more active than smaller ones. They contain more intracellular thromboxane A₂ and increased expression of procoagulant surface proteins such as p-selectin and glycoprotein IIIa, causing greater prothrombotic potential. Moreover, platelet-neutrophil interactions and platelet-endothelial interactions facilitate a variety of immune activation instances. Systematic review and meta-analysis on critically ill adult patients conclude that initial high MPV might not be used as a prognostic marker, while subsequent MPV changes might be meaningful (Tajarenmuang et al., 2016).

This study showed a significant correlation between MPV and PDW with procalcitonin level changes. The PDW shares similar behaviour to MPV during acute severe infection, it increases in platelet depletion when turnover is accelerated. PDW is an indicator of the heterogeneity in platelet size. A high value of PDW suggests a large range of platelet size due to swelling, destruction, and immaturity (Gao et al., 2014). We have not found any statistically significant correlation between plateletcrit and procalcitonin in this study. There were not many studies about plateletcrit, especially in critically ill children. Previous study on adults showed significant differences of plateletcrit when compared between groups based on their procalcitonin levels. Plateletcrit reflects the total mass of platelet in circulation within 1 unit of blood volume and it is said to be relevant to hematocrit towards erythrocyte (Djuang et al., 2018).

While procalcitonin has been considered a reliable biomarker for differentiating sepsis from non-infectious systemic inflammatory response syndrome (SIRS), C-reactive protein is a non-specific, acute-phase protein that increases after exposure to an inflammatory trigger. (Lanziotti et al., 2016). This study shows that platelet profile represents bacterial infection rather than inflammation since no significant correlation was found between platelet profile and CRP.

Mortality in this study was relatively high. Many factors can be related to mortality in critically ill children. The severity of disease on admission could be one possible explanation of high mortality in this study. Median value of PELOD-2 score on admission in this study was 8 (2–21), and 30.2% of subjects had PELOD-2 score ≥ 10 . Previous study reported that a PELOD-2 score > 10 is valid for predicting life-threatening organ dysfunction in pediatric patients with sepsis, with 75% sensitivity and 72% specificity (Suari et al., 2021), while other study in pediatric intensive care unit reported that the odds ratio for mortality with PELOD-2 score of ≥ 9 was 1.5 (95% CI 1.4–1.7) as compared to the score < 9 (El-Nawawy et al., 2017).

Conclusion

Our study concludes that PDW and MPV had statistically significant correlation with procalcitonin level as a marker of bacterial infection, their roles as an initial marker of bacterial infection needs further research.

References

- Baig, M. A. (2015) Platelet indices – Evaluation of their diagnostic role in pediatric thrombocytopenias (one year study). *Int. J. Res. Med. Sci.* **3(9)**, 2284–2289.
- Charles, P. E., Ladoire, S., Aho, S., Quenot, J., Doise, J., Prin, S., Olsson, N. O., Blettery, B. (2008) Serum procalcitonin in critically ill patients at the onset of bacteremia caused by either Gram negative or Gram positive bacteria. *BMC Infect. Dis.* **8**, 38.
- Djuang, M. H., Ginting, F., Hariman, H. (2018) Platelet indexes for bacterial sepsis severity assessment. *IJCPML* **24(3)**, 210–213.
- Elmoneim, A. A., Alhojaili, A. R., Banjer, N. R., Zolaly, M., El-Moneim, E. S. A. (2018) Changes in mean platelet volume in critically ill children and its relation to other clinical and laboratory findings. *Biomedical Research* **29(5)**, 882–888.
- El-Nawawy, A., Mohsen, A. A., Abdel-Malik, M., Taman, S. O. (2017) Performance of the pediatric logistic organ dysfunction (PELOD) and (PELOD-2) scores in a pediatric intensive care unit of a developing country. *Eur. J. Pediatr.* **176**, 849–855.
- Erdogan, S., Oto, A., Bosnak, M. (2015) The relation between mean platelet volume and mortality in critical pediatric patients. *Turk. J. Pediatr.* **57**, 605–610.
- Gao, Y., Li, Y., Yu, X., Guo, S., Ji, X., Sun, T., Lan, C., Lavergne, V., Ghannoum, M., Li, L. (2014) The impact of various platelet indices as prognostic markers of septic shock. *PLoS One* **9(8)**, e103761.
- Irvem, A., Aksaray, S. (2018) Procalcitonin, C-reactive protein, leukocyte, mean platelet volume levels in bloodstream infections. *J. Clin. Anal. Med.* **9(5)**, 391–395.
- Kossiva, L., Gourgiotis, D. I., Douna, B., Marmarinos, A., Sdogou, T., Tsentidis, C. (2014) Composite bacterial infection index in the evaluation of bacterial versus viral infections in children: A single centre study. *Pediatr. Therapeut.* **4**, 203.
- Lanziotti, V. S., Povoia, P., Soares, M., Silva, J. R. L., Barbosa, A. P., Salluh, J. I. F. (2016) Use of biomarkers in pediatric sepsis: Literature review. *Rev. Bras. Ter. Intensiva* **28(4)**, 472–482.
- Puspitasari, R., Saragih, R. A. C., Mutiara, E., Lubis, M. (2018) Correlation of mean platelet volume with PELOD-2 score as a prognostic factor of sepsis in children. *Pediatr. Crit. Care Med.* **19(6S)**, 36.
- Safdar, O. Y., Felemban, O. M., Alghamdi, A. A., Jastaniyyah, D. F., Abdouh, D. O., Alkindi, F. L., Saeedi, K. A., Barhameen, H. M., Al Turkistani, E. L., Bashammakh, D. S., Daali, S. M., Almsoudi, A. M., Sukkar, S. A., Al-Amoudi, S. O., Rayyis, L. A., Hadadi, A. A., Ibrahim, B. M. (2017) Serum procalcitonin as a diagnostic biomarker for bacterial infection in febrile children. *J. Med. Diagn. Meth.* **6**, 1.
- Sayed, S. Z., Mahmoud, M. M., Moness, H. M., Mousa, S. O. (2020) Admission platelet count and indices as predictors of outcome in children with severe sepsis: A prospective hospital-based study. *BMC Pediatr.* **20**, 387.
- Suari, N. R. M., Latief, A., Pudjadi, A. H. (2021) New PELOD-2 cut-off score for predicting death in children with sepsis. *Paediatrica Indonesiana* **61**, 39–45.
- Tajarernmuang, P., Phrommintikul, A., Limsukon, A., Pothirat, C., Chittawatanarat, K. (2016) The role of mean platelet volume as a predictor of mortality in critically ill patients: A systematic review and meta-analysis. *Crit. Care Res. Pract.* **2016**, 4370834.
- Yanni, G. N., Saragih, R. A. C. (2020) Platelet profile as prognostic factor in critically ill children. *Open Access Maced. J. Med. Sci.* **8(B)**, 966–968.