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Red Cell Distribution Width on First Day Intensive Care Unit Admission in Paediatrics

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Abstract: Red distribution width (RDW) has recently been acclaimed as prognostic marker for mortality in critically-ill patients. However, this claim is still unclear and reports are still inadequate for the association between RDW and mortality in critically-ill paediatric patients. This research assessed the correlation between RDW within 24 hours of PICU (paediatric intensive care unit) admission and PELOD-2 score. A cross-sectional study was carried out involving 59 pediatric patients admitted to the PICU Haji Adam Malik Hospital, Medan, Indonesia, from May to July 2019. The association between RDW and PELOD-2 score was assessed by using Spearman correlation test. The RDW level of paediatric patients in the PICU on the first 24 hours was elevated (median 14.7%, range 11.4–31.2%). The median of PELOD-2 score assessment was 8 (range 2–21). There was no significant correlation between RDW and PELOD-2 in this research (r=0.187, p=0.156).

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Introduction

Red distribution width (RDW) is recently acclaimed as prognostic marker for mortality in critically-ill patients (Bazick et al., 2011). It is also reported to be significantly related to ventilator requirement, postoperative outcome, and intensive care unit care outcome (Said et al., 2017; Fernandez et al., 2018). However, most of the available reports were involving adult patients. The role of RDW as prognostic factor in paediatric patients still remains unclear. Yanni et al. (2019) conducted a study to paediatric patients with sepsis and reported no significant correlation between the increase in RDW and severity of diseases or mortality. On the contrary, Sachdev et al. (2018) reported that high RDW at admission and the persistent high levels were associated with high mortality and longer PICU (paediatric intensive care unit) stay.

This study aims to assess the correlation between RDW and PELOD-2 score, specifically on the first day of PICU admission. We compared RDW level and PELOD-2 score on the first day of PICU admission.

Methods

This research was a cross-sectional design study conducted at Haji Adam Malik Hospital, Medan, Indonesia from May to July 2019. The research subjects were paediatric patients aged between 1 month old and 18 years old admitted to the paediatric intensive care unit. RDW was measured within 24 hours of PICU admission. RDW level normal range was 11.5–14.5%, and the level above 14.5% was considered elevated. The patients who refused to do blood examination and involved in this research were excluded from the study.

Statistical analysis was perform using SPSS 20. Non-normally distributed data was presented as median and analysed by using Spearman correlation test. The Health Research Ethical Committee of Medical Faculty of Universitas Sumatera Utara approved this research under the number 518/TGL/KEPK FK USU-RSUP HAM/2019.

Results

There were a total of 59 research subjects admitted to the PICU involved in the study, where 20 (33.9%) of them were female and 39 (66.1%) were male. The patients admitted to PICU were treated for the following conditions: respiratory (13.6%), central nervous system (28.8%), cardiovascular (27.1%), nephrology (16.9%), and postoperative (13.6%). The characteristics of the research subjects are presented in Table 1.

PELOD-2 score and RDW were measured within 24 hours of PICU admission. The median value of PELOD-2 score was 8 (ranging from score 2 to 21). The median value of RDW was 14.7% (ranging from 11.4% to 31.2%). Using Spearman correlation test, the correlation between PELOD-2 score and RDW within 24 hours PICU admission in the research subjects was not significant ($r=0.187$, $p=0.156$). Figure 1 shows the correlation assessed by Spearman correlation test.

Table 1 – Characteristic of the research subjects

Variable		N=59
Age (year); median (min–max)		5.75 (0.08–17.00)
Gender; n (%)	Male	39 (66.1)
	Female	20 (33.9)
PELOD-2 score; median (min–max)		8 (2–21)
Underlying disease; n (%)	Respiratory	8 (13.6)
	Central nervous system	17 (28.8)
	Cardiovascular/circulation	16 (27.1)
	Nephrology	10 (16.9)
	Post surgical	8 (13.6)
Outcome; n (%)	Survive	33 (55.9)
	Die	26 (44.1)
Red cell distribution width (%)		14.7 (11.4–31.2)

N – number

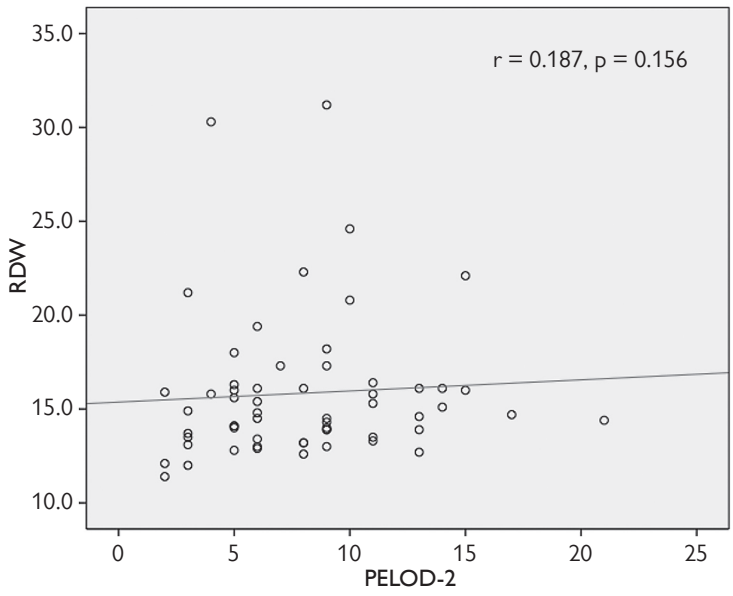

Figure 1 – Correlation between RDW (red distribution width) and PELOD-2 score.

Discussion

The research subjects in this study were admitted to PICU with underlying diseases, such as respiratory, central nervous system, cardiovascular, and nephrology diseases. Some of them were also admitted to the PICU as postoperative measures. The patients in this study showed elevated RDW, with a median of 14.7% and the highest RDW level elevation recorded was up to 31.2%. Although RDW has been

traditionally used for anaemia diagnosis (Weiss and Goodnough, 2005), patients who are critically ill usually have elevated RDW levels as a response to the systemic inflammatory processes (Bazick et al., 2011). Studies have shown that elevated RDW levels may indicated adverse outcomes and mortality among patients with heart failure and coronary heart diseases (Tonelli et al., 2008). Zhang et al. (2020) reported the association between high RDW on admission and increased risk of long-term mortality in patients suffering from respiratory failure. Furthermore, there have been many previous studies that link RDW to other various diseases and their adverse outcomes (Bazick et al., 2011; Said et al., 2017).

Despite several reports on the link between RDW and various clinical conditions, as well as mortality, the exact pathophysiologic mechanisms have not been clearly established (Weiss and Goodnough, 2005). RDW is known to be elevated in situations of inefficient red cell synthesis and excessive red cell death, which are typical in a number of viral and inflammatory diseases (Qurtom et al., 1998; Scharte and Fink, 2003; Sipahi et al., 2004). Another theory is that RDW is a surrogate for inflammation, which has been proven to promote RDW due to the reduced production of red blood cells. RDW could reflect inflammation, oxidative stress, anaemia, changes in life-span or deformability of the red blood cells, in which they are the risk factors for mortality (Weiss and Goodnough, 2005). Moreover, RDW has been linked to inflammatory indicators in blood, such as interleukin-6 and C-reactive protein (Perlstein et al., 2009). Inflammatory cytokines are known to disrupt red blood cells maturation in the bone marrow through a variety of mechanisms, including suppression of erythropoietin synthesis or responses – resulting in impaired iron metabolism and shorten red cells survival, hence increasing RDW (Fujita et al., 2013).

Ramby et al. (2015) reported the link between RDW measured within 24 hours and the length of intensive care unit stay above 48 hours in patients without sepsis, while link to mortality in all patients. This means that RDW at the time of PICU admission may provide the physicians to group the patients – whether they are the critically-ill-paediatric population with a high risk for adverse outcomes. Early identification of these group of patients allow intervention to improve outcomes and maximize the use and allocations of resources (Ramby et al., 2015). Our data showed no correlation between RDW within 24 hours PICU admission and PELOD-2 score. However, RDW recorded was elevated and PELOD-2 score was high at the median value of 8. The data set allowed us to categorise the critically-ill populations to enable immediate management to improve outcome. The markers of inflammation, however, were not examined in this research. Fernandez et al. (2018) in their study reported that high RDW level classified patients with higher mortality risk, allowing RDW to become the marker for severity of diseases and mortality. RDW that is routinely assessed during complete blood cell counts may be served as an alternative indicator to predict disease prognosis and progression (Zhang et al., 2020).

Nonetheless, the prognostic potential of RDW has obtained a special relevance because RDW is regularly included in a complete blood count analyses in hospitalized patients. Hence, it is available at no additional cost to doctors as prognostic markers and may be a predictive sign for both short-term and long-term mortality in critically-ill patients (Wang et al., 2010; Bazick et al., 2011; Braun et al., 2011). RDW can be associated with mortality and death from various critical conditions, such as cancer, cardiovascular, respiratory, and other diseases. However, it is necessary to note that RDW serves as a significant, but non-specific marker (Pan et al., 2019). The mechanism of low-grade inflammation, which is common in healthy individuals and many diseases, can even increase RDW (Cohen et al., 2008). In the conditions with stress and poor health can lead to delayed red blood cell circulation in the blood stream and elevate RDW. Therefore, RDW level elevation besides serving as prognosis marker in critically ill patients, it can also be served as a prognosis marker of physiological stress and poor health condition in general (Pan et al., 2019).

In conclusion, this study confirmed that RDW was elevated in paediatric patients admitted to PICU Haji Adam Malik Hospital. There was no significant correlation between RDW level and PELOD-2 score on the first day of PICU admission.

Conclusion

The RDW level of paediatric patients in the PICU on the first 24 hours was elevated (median 14.7%, range 11.4–31.2%). The median of PELOD-2 score assessment was 8 (range 2–21). There was no significant correlation between RDW and PELOD-2 in this research (r=0.187, p=0.156).

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