Original Research Article

ANEMIA PROFILE IN PEDIATRIC PATIENTS AT THE PEDIATRIC INTENSIVE CARE UNIT (PICU) OF DR. SOETOMO GENERAL ACADEMIC HOSPITAL

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ABSTRACT

Introduction: Anemia often occurs in critically ill children and is associated with increased morbidity and mortality in women and children and impaired cognitive and behavioral development in children. **Objective:** This study aims to understand the profile and characteristics of anemia patients in the critical care population. **Methods:** This is a retrospective, descriptive study of the patient's medical records. Data were collected by the total sampling technique. **Results:** Among 203 patients, 52% were anemic at admission to the Pediatric Intensive Care Unit (PICU), while 45% were anemic at discharge. Anemia tends to be more common in older age and male individuals with their chief complaints being respiratory symptoms, higher mean Red Cell Distribution Width (RDW) levels, and poorer nutritional status. There were 84 patients (41%) who received Packed Red-Cells (PRC) transfusions, among them there were 54 patients (51%) who were anemic at PICU admission. Of the 84 patients who received PRC transfusions during their PICU stay and 43 patients (47%) were anemic on PICU discharge. **Conclusion:** Anemia is quite common in critically ill children and is dominated by male patients aged under 5 years. Anemia also mostly happens in patients with higher organ dysfunction scores and poorer nutritional status than nonanemic patients. Half of the patients with anemia at the PICU also received PRC blood transfusion.

Keywords: Anemia; Children; Good Health; PICU; Transfusion

ABSTRAK

Pendahuluan: Anemia sering terjadi pada pasien anak sakit kritis dan berhubungan denan peningkatan morbiditas dan mortalitas pada wanita dan anak kecil juga gangguan perkembangan kognitif dan perilaku pada anak. **Tujuan:** Penelitian ini bertujuan untuk mengetahui profil dan karakteristik pada pasien dengan anemia di populasi sakit kritis. **Metode:** Penelitian ini merupakan penelitian deskriptif dengan desain retrospektif pada rekam medis pasien. Data diambil menggunakan tehnik *total sampling*. **Hasil:** Dari 203 pasien, terdapat 52% pasien dengan anemia saat masuk *Pediatric Intensive Care Unit* (PICU) dan 45% pasien dengan anemia saat keluar dari PICU. Anemia lebih banyak terjadi pada pasien dengan usia lebih tua, berjeniskelamin laki-laki, memiliki keluhan utama pada pernapasan, dan memiliki level *Red Cell Distribution Width* (RDW) lebih tinggi serta status nutrisi yang lebih rendah. Terdapat 84 pasien (41%) yang mendapatkan transfusi *Packed Red-Cell*s (PRC), diantaranya terdapat 54 pasien (51%) yang mengalami anemia saat masuk PICU dan 43 pasien (47%) menjadi anemia saat keluar dari PICU. **Kesimpulan:** Anemia cukup umum terjadi pada populasi anak sakit kritis, didominasi anak laki-laki dan usia di bawah 5 tahun. Anemia juga terjadi pada pasien dengan skor disfungsi organ lebih tinggi dan status nutrisi lebih buruk. Sebagian dari pasien anemia di PICU mendapatkan transfusi PRC.

Kata kunci: Anemia; Anak; Kesehatan; PICU; Transfusi

INTRODUCTION

Anemia often occurs in critically ill children. According to Rawal et al. (2016), anemia is almost unavoidable in critically ill patients in the Intensive Care Unit or ICU (1). Anemia is also associated with increased morbidity and mortality in women and children, poor birth outcomes, decreased productivity in adults and impaired cognitive and behavioral development in children (2). Anemia in critically ill children is a condition that requires attention because it could contribute to poor outcomes and is associated with negative neurological outcomes such as inhibiting the children's mental development (3).

Concerning the distribution of oxygen in the body, patients with very low hemoglobin (Hb) levels may experience hypoxemia, so the distributed oxygen cannot meet the body's metabolic needs (4). If the condition worsens, severe anemia will occur which can be a direct cause of mortality (5). The erythropoietic response to anemia is inhibited by decreased erythropoietin production and spinal cord suppression by various inflammatory cytokines (6). To this day, there is a limited number of studies about the profile and characteristics of anemia in critically ill children. This study aims to investigate the demographic characteristics, clinical characteristics, blood test results, and nutritional status of pediatric patients admitted to the Pediatric Intensive Care Unit of Dr. Soetomo General Academic Hospital Surabaya. The data obtained from this study can serve as a reference for the incidence of anemia in critically ill pediatric patients.

METHODS

This is a descriptive, retrospective study of the medical records of critically ill patients with anemia at the PICU of Dr. Soetomo General Academic Hospital between January and December 2019. The variables in this study were demographic data (age and gender), chief complaints, organ dysfunction, Mean Corpuscular Volume (MCV), Red Cell Distribution Width (RDW) values, Pediatric Logistic Organ Dysfunction-2 (PELOD-2) score, nutritional status, and Packed Red Cells (PRC) transfusion. MCV is a value that indicates the size and average volume of red blood cells while RDW is a sum of variations in the size of red blood cells. MCV and RDW values can indicate the morphological category and the etiology of anemia. The PELOD-2 is a score to assess organ dysfunction in critically ill pediatric patients. Whereas PRC transfusions are when red blood cells are administered to patients with certain conditions.

The population in this study included all patients with anemia upon admission and/or discharge at the PICU of Dr. Soetomo General Academic Hospital between January and December 2019. The sample is members of the population that met the inclusion and exclusion criteria. The inclusion criteria are patients with anemia at admission and/or discharge from the PICU. Patients with incomplete medical records were excluded. The total sampling technique was used. Next, the data obtained were processed by editing, coding, entry, and cleaning. The instrument used in this study was the medical records of patients with anemia at the PICU Dr. Soetomo General Academic Hospital between January and December 2019. The data were analyzed descriptively by using SPSS. The data were then grouped based on research variables and presented in a frequency distribution table. This study was approved by the Dr. Soetomo General Academic Hospital Health Research Ethics Committee (0220/LOE/301.4.2/XI/2020).

RESULTS AND DISCUSSION

The total population of pediatric patients at PICU in 2019 was 318 patients, among them only 203 were eligible for further analysis in this study. Anemic patients were determined according to the criteria set by the WHO based on age and gender. Data on hemoglobin levels were taken when the patient was admitted and discharged from the PICU. A total of 106 patients (52%) had anemia at admission to the PICU and 91 (45%) patients had anemia at discharge from the PICU. The distribution of anemic patients' demographic characteristics at PICU admission and discharge was dominated by the age group 6-59 months and male patients. The demographic characteristics data are presented in Table 1.

Table 1. Demographic Characteristics of Anemic Patients

Characteristics	Anemic at PICU Admission N (%)	Anemic at PICU Discharge N (%)
Age (months)		
1-5	15 (14)	11 (12)
6-59	45 (42)	34 (37)
60-143	24 (23)	21 (23)
144-179	12 (11)	14 (15)
≥180	10 (9)	11 (12)
Gender		
Male	65 (61)	49 (54)
Female	41 (39)	42 (46)

In critical patients, the diagnosis is not confined to only one organ system. Critically ill pediatric patients generally have more than 1 organ system dysfunction. In this study, most of the patients with anemia both at admission and discharge from the PICU had dysfunctions in two organ systems. The most frequent chief complaints were respiratory complaints. The clinical characteristics data are presented in Table 2.

Table 2. Clinical Characteristics of Anemic Patients

Characteristics	Anemic at PICU Admission N (%)	Anemic at PICU Discharge N (%)
Organ/Multiorgan Disfunction		
1 organ	30 (28)	23 (25)
2 organs	48 (45)	42 (46)
3 organs	24 (23)	19 (21)
4 organs	3 (3)	6 (7)
5 organs	1 (1)	1 (1)
Chief Complaint at Admission		
1. Respiratory Symptoms	27 (25)	25 (27)
2. Decreased of Consciousness	10 (9)	6 (7)
3. Seizure	19 (18)	6 (7)
4. Anemia Symptoms	18 (17)	18 (20)
5. Digestive Symptoms	20 (19)	18 (20)
6. Fever	6 (6)	13 (14)
7. Others	6 (6)	5 (5)

In patients with anemia at the PICU, the distribution of MCV values in anemic patients showed that most were within normal limits (62.3%). Conversely, most of the patients with anemia had an increased RDW value. An increased RDW value indicates heterogeneity of erythrocytes. The erythrocytes index data are presented in Table 3.

Table 3. Erythrocytes index of Anemic Patients

Value	Anemic at PICU Admission N (%)	Anemic at PICU Discharge N (%)
MCV		
Normal	66 (62)	60 (66)
Increased	25 (24)	19 (21)
Decreased	15 (14)	12 (13)
RDW		
Normal	28 (26)	33 (36)
Increased	78 (74)	58 (64)

In this study, it was found that most patients with anemia had PELOD-2 scores between 1-10. Patients with anemia at the PICU had a higher mean PELOD-2 score than nonanemic patients. The PELOD-2 score data are presented in Table 4.

Table 4. PELOD-2 Scores of Anemic Patients

Characteristics	Anemic at PICU Admission N (%)	Anemic at PICU Discharge N (%)
At Admission		
0	16 (15)	17 (19)
0-11	89 (84)	73 (80)
≥11	1 (1)	1 (1)
At Discharge		
0	27 (25)	25 (27)
0-11	77 (73)	65 (71)
≥11	2 (2)	1 (1)

Anthropometric data were also taken when the patients were admitted to the PICU. The anthropometric data were then calculated to obtain the Z-Score value and used to categorize the patients based on nutritional status. This study used body mass index for age Z-Score (BMIz). It was also found that patients with anemia at admission to the PICU had poorer nutritional status than nonanemic patients. The nutritional status data are presented in Table 5.

Table 5. Nutritional Status of Anemic Patients

Nutritional Status	Anemic at PICU Admission N (%)	Anemic at PICU Discharge N (%)
Normal	45 (42)	42 (46)
Obese	5 (5)	3 (3)
Overweight	4 (4)	2 (2)
Risk of Overweight	11 (10)	10 (11)
Wasted	16 (15)	17 (19)
Severely Wasted	25 (24)	17 (19)

Among 106 patients with anemia at PICU admission, 54 patients (51%) received PRC transfusions during their stay in the PICU. Of all PICU patients, 84 patients received blood transfusions during their PICU stay and as many as 43 of them (47%) became anemic at PICU discharge. The PRC transfusion data are presented in Table 6.

Anemia is determined by the levels of hemoglobin and hematocrit in the blood, which are obtained from the results of a complete blood count. The complete blood count technique used in this study is an automated hematology analyzer and has been proven to provide accurate and reliable results (7). This study found that half of the PICU population had anemia at PICU admission and discharge. However, a previous study by Ngo et al (2013) found a low prevalence of anemia at PICU, which are contrary to our results (6). Nevertheless, some studies had similar results to our findings. Maji et al. (2021) found that 64.8% of patients had anemia on discharge from the PICU while Demaret et al. (2017) found that 57.4% of their patients were anemic on discharge from the PICU (3,8). Overall, existing research has indicated the high incidence of anemia in the critically ill pediatric patient population.

Table 6. PRC Transfusion of Anemic Patients

PRC Transfusion	Anemic at PICU Admission N (%)	Anemic at PICU Discharge N (%)
Receiving	54 (51)	43 (47)
Not Receiving	52 (49)	48 (53)

Anemia that occurs in the critically ill pediatric population is complex and multifactorial (9). In critically ill patients, procedures that allow the occurrence of anemia are performed, such as phlebotomy for laboratory examination. Critically ill patients could also have falling hemoglobin levels, such as decreased erythrocyte production caused by EPO deficiency due to the body's inflammatory response. Inflammation inhibits the release of proinflammatory cytokines such as TNF- and interleukins that cause the EPO response (10). In this study, the hemoglobin levels of the sampled patients improved during their stay at the PICU. Therefore, the possibility of disrupted EPO response was minor. Several other mechanisms can also cause anemia in critically ill patients, such as increased erythrocyte destruction, bleeding, hemodilution, and nutritional deficiency.

Demographic data showed that most patients with anemia in the PICU were in the 6-59 months age group. Similar results were also found in the studies conducted by Demaret et al. (2017) and Maji et al. (2021) (3,8). Anemia is common in under-five patients possibly due to maternal care regarding breastfeeding and the lack of provision of complementary foods, but this was not investigated further in this study. Children under the age of 2 years also experience a phase of rapid growth. To assist this growth phase, higher reserves of iron, folic acid, and vitamin B12 are needed (11). In children under the age of 1 month, decreased hemoglobin level is the result of the replacement of erythrocytes produced before birth (12). These reasons may cause the prevalence of anemia in the age group under 5 years.

Anemia is commonly found in male patients. Based on previous studies, male infants have more infections than female infants, which causes male infants to have a higher risk for iron deficiency and lead to anemia (12). Other studies also found that anemic PICU patients were dominated by male patients (3,8). We found that most patients with anemia have two organ systems dysfunctions. The chief complaint experienced by most patients with anemia is respiratory symptoms. These symptoms include shortness of breath, cough, and airway obstruction. Joo et al. (2016) found similar results where patients aged 6-23 months had iron deficiency anemia in their pediatric department (13). Anemic patients can experience respiratory problems because hemoglobin plays a role in distributing oxygen. Therefore, anemic patients with low hemoglobin will experience hypoxemia and shortness of breath (4). Symptoms of anemia such as pallor of the skin, conjunctiva, and weakness are present in the majority of patients with anemia although they are not the chief complaints.

Complete blood count (CBC) tests are needed in patients with anemia. Other than determining the hemoglobin level, which is a marker of anemia, other indicator values can be used to classify anemia, such as MCV and RDW values. MCV levels can be used to classify anemia into normocytic, microcytic, and macrocytic anemia. Most of the anemic patients in this study had normal MCV values. RDW or Red-Cell Distribution Width are levels that can be used to assess the homogeneity of erythrocyte form. An elevated RDW (more than 20%) also indicates iron deficiency (14). For anemic patients in the PICU, most of the RDW values increased (73.6%). This indicates the possibility that the anemia experienced by most PICU patients was caused by iron deficiency.

This study also found that anemic patients had a higher PELOD-2 score than patients without anemia, although the difference was only slight. Research by Demaret et al. (2017) and Ngo et al. (2013) also found similar results (3,6). The PELOD-2 scores taken at the PICU admission of anemic patients were higher than the scores taken at the PICU discharge. This indicates an improvement in the organ dysfunction experienced by patients with anemia. Nutritional status is also closely related to critically ill pediatric patients and anemia. In this study, wasted and severely wasted patients based on BMIz were more prevalent in patients with anemia than in patients without anemia. This is similar to the studies conducted by Yang et al. (2012) and Ruhman et al. (2020) (15,16). Nutritional deficiency is one of the etiologies of anemia in critical populations. Therefore, greater attention should be paid to critically ill pediatric patients with anemia and poor nutritional status.

Erythrocyte transfusion is one of the treatments for anemic patients in the critically ill population. Theoretically, the purpose of erythrocyte transfusion is to restore the body's oxygen-carrying capacity to provide an adequate response to the body's physiological needs (10). Based on the WHO and IDAI, anemic patients with very low hemoglobin levels or severe anemia (hemoglobin < 5 g/dL) need to receive blood transfusions in the form of packed red cells or frozen red blood cells/erythrocytes (17). PRC transfusions are administered in an emergency and are used to increase the patient's hemoglobin levels. The provision of PRC transfusions can have different hemoglobin threshold values depending on the other pathologies suffered by the patient (18). However, in this study, no further investigation was done.

Next, in this study, 84 patients (41%) of PICU patients received PRC transfusions. Of the 84 patients, 54 patients (51%) were anemic when they entered the PICU and 43 of them experienced anemia when they left the PICU with a percentage of 47%. Ngo et al. (2013) in their study showed a lower percentage of 18.8% while Demaret et al. found that 25.1% of their patients who were anemic on discharge from the PICU received PRC transfusions during their stay in the PICU (3,6).

CONCLUSION

The prevalence of anemia is quite frequent in PICU patients at Dr. Soetomo General Academic Hospital in 2019. Anemia mostly occurs in patients of the male sex, under 5 years of age, and have respiratory systems as their chief complaints. Patients with anemia also had higher organ dysfunction scores and poorer nutritional status than patients without anemia. Half of the patients with anemia in the PICU of Dr. Soetomo Academic General Hospital in 2019 received a PRC blood transfusion.

Further prospective studies about the profile and characteristics of patients with anemia in the PICU are warranted to obtain more accurate data.

Conflict of Interest
The authors declared there is no conflict of interest in this study.

Authors' Contributors
All authors have contributed to all process in this research.

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