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Original Research Article

Frequency of Anemia in Children at Discharge from a Pediatric Intensive Care Unit

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Conflict of interest: Nil

Abstract:

Objectives: The present study was to evaluate the diagnostic categories and frequency of anemia in children at discharge from a Pediatric Intensive Care Unit.

Methods: Medical records were reviewed of eligible patients (aged 1 month to 14 years). The demographic data (age and gender), admitting diagnostic categories and pertinent study variables (Hb on admission (T1) and Hb on discharge from PICU (T2) were extracted from medical records. Anemia was defined as Hb <10 g/dl, severe anemia as Hb <7 g/dl for study purpose, which is in clinical practice of most of PICUs.

Results: A total of 100 anaemic subjects' data were extracted from medical records of PICU. The median age at admission was 11 (IQR:6.0–24.0) months, and 56% (56) were male and 44% were females. The most common admitting diagnostic categories were respiratory illnesses (53%), followed by severe tropical infections (29%), neurological disorders (14%), cardiovascular conditions (4%). At admission, patients 9(9%) had severe anemia (Hb <7 g/dl). 49(49%) had Hb 7-10 and 42(42%) patients had Hb >10 g/dl. At discharge, patients 2(2%) had severe anemia (Hb <7 g/dl). 58(58%) cases had Hb leve 7-10 and 40(40%) patients had Hb >10 g/dl. Patients who had Hb <7 at the time of admission was significantly improved Hb level at the time of discharge (p=0.03).

Conclusions: Anaemia at PICU discharge is associated with worse outcomes after PICU stay, more than half admitted children have anaemic at discharge form PICU of low-income countries. Therefore, efforts should be made to better understand its causes and consequences as well as to implement optimal care and follow- up strategies.

Keywords: Anaemia, PICU, Diagnostic Categories, Children.

Introduction

Anaemia is defined as a decrease in haemoglobin (HGB), haematocrit levels, and erythrocyte count below two standard deviations according to age and sex [1,2]. Anaemia is a common and serious problem in the Paediatric Intensive Care Unit (PICU) [3]. It is known that one-third of critically ill children hospitalized in the PICU for at least two days are anaemic at admission, and 40% develop anaemia during their stay [4]. In critically ill children, chronic anaemia, acute or chronic blood loss, underlying diseases, bone marrow-suppressing treatments, and insufficient erythropoietin response contribute to anaemia development. In these patients, anaemia reduces the oxygen-carrying capacity of the blood and causes tissue and organ failure. Critically ill children with low baseline HGB levels have been shown to require multiple transfusions, prolonged intensive care stay, and more inotropes, invasive mechanical ventilation and extracorporeal therapy [5,6].

Given the high prevalence and incidence of anaemia at admission and during ICU stay and given that red blood cell (RBC) transfusion guidelines recommend a restrictive strategy for most critically ill patients [7, 8], it makes sense to wonder about anaemia at ICU discharge.

In epidemiological studies, it was found that anaemia is associated with impaired neurocognitive outcomes, including learning difficulties, corrupted memory and processing speed, and emotional instability. Iron, folic acid, and vitamin B12 are essential for brain development and function. In general, a deficiency of these micronutrients results in decreased myelin production by altering gene and protein profiles, which can regulate central nervous system development processes. Impaired synaptogenesis and neural repair may lead to delays in brain development or dysfunction [8,10].

There are very little data available about anaemia in paediatric critical care survivors. Packed red blood cell (PRBC) transfusions in critically ill patients have multiple risks and are associated with worsened clinical outcomes [11]. Recent randomized control trials in children supports the use of restrictive transfusion strategy in critically ill children [12,13]. Studies suggest that children with normal cardiac output can maintain tissue oxygenation despite fall in haemoglobin (Hb) level to 7 gm/dl [14]. Objectives of the present study was to evaluate the factors, diagnostics categories and frequency of anemia in children at discharge from a Pediatric Intensive Care Unit.

Material & Methods

The present study was conducted in the Department of Paediatrics, Jan Nayak Karpoori Thakur Medical College, Madhhepura, Bihar, India during a period from January 2024 t0 May 2024. A total of 100 anaemic subjects' data were obtained from the medical records of PICU.

Inclusion Criteria: Patients were eligible only if they had at least two documented hemoglobin (Hb) values, and the final one recorded within 24 hours of discharge.

Exclusion Criteria: All children who expired in PICU, stayed less than 48 hours, had only one Hb and last Hb was measured before 24 hours of discharge from PICU.

Operational Definition: Anemia was defined as Hb <10 g/dl, severe anemia as Hb <7 g/dl for study purpose, which is in clinical practice of most of PICUs.

Data collections and statistical analysis: Medical records were reviewed of eligible patients (aged 1 month to 15 years). The demographic data (age and gender), admitting diagnostic categories and pertinent study variables (Hb on admission (T1) and Hb on discharge from PICU (T2) were extracted from medical records.

Statistical Analysis: Data was analyzed with the help of latest version of SPSS software. Chi Square test was applied. P-value was taken is than or equal to 0.05 ($p \leq 0.05$) for significant differences.

Observations: A total of 100 anaemic subjects' data were extracted from medical records of PICU. The median age at admission was 11 (IQR:6.0–24.0) months, and 56% (56) were male and 44% were females.

Table 1: Gender wise distribution of study participants

Gender	Frequency	Percentage
Male	56	56%
Female	44	44%
Total	100	100%

The most common admitting diagnostic categories were respiratory illnesses (53%), followed by severe tropical infections (29%), neurological disorders (14%), cardiovascular conditions (4%).

Tabe 2: Distribution of diagnostic categories

Diagnostic categories	Frequency	Percentage
Respiratory illness	53	53%
Cardiac	4	4%
Neurological	14	14%
Other	29	29%
Total	100	100%

At admission, patients 9(9%) had severe anaemia (Hb <7 g/dl). 49(49%) had Hb 7-10 and 42(42%) patients had Hb >10 g/dl.

At discharge, patients 2(2%) had severe anaemia (Hb <7 g/dl). 58(58%) cases had Hb leve 7-10 and 40(40%) patients had Hb >10 g/dl. Patients who had Hb <7 at the time of admission was significantly improved Hb level at the time of discharge (p=0.03).

The patients who with Hb >10 g/dl at admission, 2% cases developed anemia by discharge, whereas 40% maintained normal hemoglobin levels during the PICU stay.

Table 3: Hb level at admission and discharge

Hb level	At admission	At discharge	P-value
< 7	9(9%)	2(2%)	0.03
7-10	49(49%	58(58%)	0.203
>10	42(42%)	40(40%)	0.774

Discussions

Anaemia often occurs in critically ill children. According to Rawal et al. (2016), anaemia is almost unavoidable in critically ill patients in the Intensive

Care Unit or ICU [15]. Anaemia is also associated with increased morbidity and mortality in women and children, poor birth outcomes, decreased productivity in adults and impaired cognitive and behavioural development in children [2]. Anaemia 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 [11].

Concerning the distribution of oxygen in the body, patients with very low haemoglobin (Hb) levels may experience hypoxemia, so the distributed oxygen cannot meet the body's metabolic needs [16]. If the condition worsens, severe anaemia occurs which can be a direct cause of mortality [17]. The erythropoietic response to anaemia is inhibited by decreased erythropoietin production and spinal cord suppression by various inflammatory cytokines [18].

In the present study, we were extracted data of anaemic children's aged >1 month to 14 years from medical records of Paediatric Intensive Care Unit (PICU) of the department of Paediatrics, Jan Nayak Karpoori Thakur Medical College & Hospital. A total of 100 anaemic children's data were collected.

In 2017 Demaret et al observed 57% of the prevalence of post-PICU anaemia in their cohort of critically-ill children over one-year period and significant association was noted with anaemia at admission and in adolescent age category [11]. Two large sample size (over 3000 participants in each report) studies from PICU over five-year periods demonstrated more than half of survivors have post-PICU anaemia (50.9% and 58.9%) from Canada and France [19,20]. Meji et al found the frequency of post-PICU anaemia 64.8% in 54 critically-ill children over 3-month period from a PICU of India in retrospective cohort [21]. Walsh et al has reported the overall prevalence rate of anaemia at discharge from adult ICU was 74.4-87% in two cohort of survivors [22,23]. The awareness of post-PICU anaemia is rising in clinical practice during the last decade.

In the present study, the median age at admission was 11 (IQR:6.0–24.0) months. Most of the cases 56% (56) were male and 44% were females. The most common admitting diagnostic categories were respiratory illnesses (53%), followed by severe tropical infections (29%), neurological disorders (14%), cardiovascular conditions (4%).

Most of the epidemiological studies on anaemia at discharge from adult and paediatric ICUs had found presence of anaemia at ICU admission was the strongest risk factor associated with post-PICU anaemia on the multivariate logistic regression model [11,22]. Jutras et al reported post-PICU anaemia occurred in 81.6% and 24.7% of patients who had anaemia and who had no anaemia at PICU admission respectively [20].

In the present study, 60% cases were anaemic at the time of discharge. Among 100 cases. 2% cases had severe anaemia. While, 58% cases had mild to moderate anaemia. At the time of admission, 9% cases had severe anaemia. And 49% cases had mild to moderate anaemia.

Few studies reported 27%-41% prevalence of anaemia during PICU stay in their cohort [4, 19, 11]. There is no universal definition of anaemia or standard cut-off of Hb value for critically-ill children [21]. The age-stratified value of Hb for anaemia does not exist in the clinical practice of PICUs. There are many other questions to be answered in the evaluation and management of post-PICU anaemia. Anaemia persisting at discharge should never be trivialized. The adverse effects of Iron Deficiency anaemia were described extensively in paediatric literature. Many studies have reported that Iron-deficiency anaemia in infant and children is associated with impaired growth and development, decrease motor activity, social inattention and cognitive delay [24]. Jutras et al reported the severe anaemia at discharge 3.6% in their cohort of post-PICU anaemia [20].

We found that anaemia at PICU admission was the stronger predictor of anaemia at PICU discharge. We also found that the strength of this association varied according to age. Several hypotheses may be raised to explain such an interaction: Causes of anaemia may differ from one age category to another; the erythropoietic response may vary depending on age; nutritional and/or therapeutic supports may change from the neonatal period to adolescence and may be associated with a different course of anaemia according to age [11].

Limitations in the present study are several. Most important, single center, retrospective and small sample size which limits external validity. The trends of Hb values during the PICU stay, the record of blood transfusion was not reported. Similarly, the illness-severity score like PRISM-III or organ dysfunction score like p-SOFA or PELOAD-2 were not recorded that might predict a higher chance of post-PICU anaemia which was described in adult and pediatric studies. Anemia at admission in PICU, presence of multiorgan dysfunction and prolong stay in PICU are few risk factors have been identified in published studies [19,11,20].

Another limitation was also not described the type of anemia based on morphology from peripheral smear. Walsh et al described the normocytic-normochromic indices similar to the anemia of chronic disease in most of patients (88%) with anemia at discharge from ICU in their cohort. There is high probability of nutritional anemia in these

children until prove otherwise. This study is also lacking follow-up study in post-PICU anemia. However, few clinical reports have also done 6-month follow-up on these children with mixed results about recovery from anemia.

Conclusions

The present study concluded that the anemia at PICU discharge is associated with worse outcomes after PICU stay, more than half admitted children have anaemic at discharge form PICU of low-income countries. Therefore, efforts should be made to better understand its causes and consequences as well as to implement optimal care and follow- up strategies.

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