

Prevalence of anemia in critically ill children needing ventilation and its role in morbidity and mortality

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Abstract

Background: Anemia is not uncommon in children admitted to the Pediatric intensive care unit (PICU). It has major consequences on human health as well as social and economic development. It occurs in all age groups but is more prevalent among children and pregnant women. There is a dearth of published data of anemia in ventilated children admitted to the PICU.

Objectives: To estimate the prevalence of anemia in ventilated children and to analyze anemia as a risk factor contributing to morbidity and mortality in ventilated children.

Methods: This was a prospective observational study conducted in a tertiary care hospital PICU. A 100 children who satisfied the inclusion criteria were enrolled in the study after conducting a pilot study. Morbidity factors including prolonged hospital, PICU stay and others were analyzed during the hospital stay. PRISM III scores were also used to study the correlation of anemia in children needing ventilation as a risk of mortality.

Results: Anemia was observed in 62% of children needing ventilation at admission to the PICU. It was observed that there was no statistically significant correlation between anemia, PRISM III scores at 12 hours and 24 hours and mortality (p values were 0.713 and 0.052 respectively). Children with severe anemia had increased risk of mortality.

Conclusion: Mild and moderate anemia does not seem to be a significant factor that contributes to morbidity or mortality in children needing ventilation. However severe anemia increased the risk for mortality in children requiring ventilation.

Key words: Critically ill, PRISM-III, Ventilation, Anemia

Introduction

Anemia is a major public health issue affecting both developing and developed countries. It has major consequences on human health as well as social and economic development. It occurs in all age groups but is more prevalent among children and pregnant women. Anemia is the second leading nutritional cause of disability^[1,2,3]. Approximately 273 million (43%) children are anemic all over the world in which more than 50% are residing in Africa and South East Asia^[2]. In anemia the red blood cell number is inadequate to meet the body's physiological needs. The definite physiologic requirements may be varying with individual's gender, age group, altitude, various stages of pregnancy and smoking^[4]. Iron deficiency is the most common cause of anemia all over the world. Other causes of anemia includes nutritional

deficiencies, parasitic infections, inflammation, defects of hemoglobin synthesis (both inherited and acquired) as well as red blood cell production or survival^[4]. Anemia is more prevalent in children with critically illness admitted to the Pediatric intensive care unit (PICU). The etiology of anemia in these children includes phlebotomy loss, active bleeding (from gastro-intestinal tract, surgical site and trauma), drug induced, invasive procedures, anemia of critical illness, inflammation, nutritional deficiencies and coagulopathy. The low hemoglobin levels in these children will cause inadequate tissue oxygenation and affects oxygenation of vital organs^[5,6]. Critically ill children may have several anatomic issues related to their breathing apparatus (large tongue, high and floppy epiglottis, low functional residual capacity, higher closing capacity and narrow airways)

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and physiological issues related to high oxygen requirements which makes them more prone to hypoxemia^[7,8,9]. Anemia among these children adds on to these issues and the need of ventilation and their associated morbidities and mortality. Studies done in the past in critically ill children revealed anemia is highly prevalent at discharge and it contributes to several adverse outcomes^[10,11,12]. But there is a dearth of published data of anemia in children needing ventilation and needing admission to the PICU. Hence this study was undertaken to assess the prevalence of anemia in children admitted to the PICU and needing ventilation, and to analyze its contribution to morbidity and mortality.

Methods:

This study was a Prospective, observational study. It was conducted in the Pediatric intensive care Unit of a premier Institute in South India. Children aged 1 month to 18 years were included in the study. Ethical clearance was obtained from the institutional review board. Children admitted to the pediatric intensive care unit and needed ventilation which included both non-invasive and invasive, and had a minimum duration of 24 hours PICU stay, were recruited in the study. Children with cyanotic heart disease, chronic renal failure, active bleeding, pre-existing chronic anemia, patients undergoing myeloablative therapies and children less than 1 year were excluded from the study. Children satisfying the definition of anemia as per the WHO criteria were taken as the cases in the study. Children who required ventilator support and did not have anemia were considered as controls. Anemia was diagnosed and categorized into mild, moderate and severe based on the level of hemoglobin in various age groups as per the WHO classification. Peripheral smear examination findings were also used to classify anemia into macrocytic, normocytic and microcytic. As there were no studies similar to the current one as per our literature search, a pilot study was conducted to assess the sample size. Based on the prevalence rate of anemia (70%) observed from the pilot study report with a 10% allowable error and 95% confidence, the minimum sample size was computed to 81. Thus the sample size was recruited to 100. A short demographic profile was recorded and a detailed clinical examination was done. At admission to the PICU, the blood samples were analyzed. Once anemia was diagnosed, it was sub-classified into mild, moderate and severe anemia as per the WHO cut off values of hemoglobin. Anemia was also sub classified into macrocytic, microcytic & normocytic with the peripheral smear which was done manually. The blood investigations of all the children at the

time of admission to the PICU was carried out as per the diagnosis and severity of the critical illness. The children were followed up during the hospital stay and the outcome was recorded. Morbidities like prolonged hospital stay, prolonged PICU stay, prolonged mechanical ventilation, failed extubation, difficult weaning, need for tracheostomy, discharge to home on oxygen support/home ventilation were studied. Prolonged hospital stay was considered when there was a stay more than or equal to 10 days, Prolonged ICU stay was considered when there was a stay more than or equal to 14 days, mechanical ventilation was considered as prolonged when there was a need for mechanical ventilation for 21 consecutive days for more than 6 hours in a day^[13,14,15]. Failed extubation was defined as reintubation within 24 hours of extubation and failure to tolerate spontaneous breathing trial was considered as difficult weaning from ventilator support^[16,17]. PRISM III scoring was done at 12 and 24 hours to assess the correlation of anemia to the risk of mortality^[18].

Statistics

The statistical analysis was conducted using the SPSS. Pearson Chi-Square test or Fisher's exact test was used to compare the categorical variables among children with anaemia and those without anemia and the subgroups. The Mann Whitney test was used to compare hospital stay, PICU stay and duration of ventilation with the anaemic and non anaemic groups. A p value less than 0.05 was considered as statistically significant.

Results

A hundred (n=100) children who satisfied the inclusion criteria were recruited in this study. The Mean age of the study group was 70 (± 62 S.D.) months. Among the children included in the study, 55 (55%) were males and 45 (45%) were females. The male to female ratio was 1.2:1. It was observed that the children who satisfied the inclusion criteria predominantly either had a Respiratory system involvement (33%), or a Central nervous system involvement (31%).

Anemia in children who were ventilated (n=100)

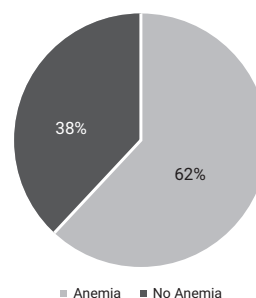


Figure 1: Prevalence of anemia in children who were ventilated

In the present study, 62 (62%) of the children who needed ventilation were observed to have anemia at the time of admission to the PICU (figure 1).

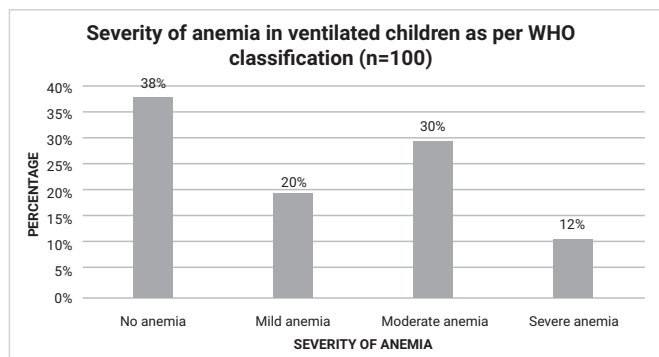


Figure 2: Severity of anemia in children who were ventilated

It was observed that 20% had mild anemia, 30% had moderate anemia, and 12% had severe anemia as per the WHO classification (figure 2).

Among the 62 children who were ventilated and diagnosed to have anemia, 1.6% had normocytic normochromic anemia, 37.1% had normocytic normochromic anemia and 61.3% had microcytic hypochromic anemia. Microcytic hypochromic anemia was found to have a statistically significant correlation among those with and without anemia (p value:<0.001). Among the children who needed ventilation and were diagnosed to have anemia, 30.6% needed non-invasive ventilation and 69.4% needed invasive ventilation. Patients were followed up during the entire period of the hospital stay and morbidity factors such as prolonged hospital and PICU stay, prolonged need of ventilation, failed extubation, difficult weaning, need of tracheostomy and need of discharge to home on oxygen/ ventilator support were analyzed, but none of these morbidity factors were found to have a statistically significant correlation among the children with anemia (table 1).

Table1: Correlation of Anemia in children needing ventilation

Sl. No	Morbidity factors	p value
1	Prolonged hospital stay	0.127
2	Prolonged PICU stay	0.537
3	Prolonged mechanical ventilation	0.727
4	Failed extubation	1.000
5	Difficult weaning	0.664
6	Need of tracheostomy	0.762
7	Discharge on oxygen support	0.757
8	Discharge on home ventilation	0.863

Table 1 shows the various morbidity factors that were analyzed in this study.

Table 2: Classification of the cases as per the WHO criteria for Anemia

Severity of anemia as per WHO classification	Mortality n=100(%)		P value
	Yes	No	
No anemia	7 (18.4)	31(81.6)	0.142
Mild anemia	1 (5)	19(95)	
Moderate anemia	3 (10)	27(90)	
Severe anemia	4(33.3)	8 (66.7)	

Children with anemia needing ventilation was classified as per the WHO classification. On analysis, it was found that anemia was not a statistically significant factor that contributed to mortality (p value 0.142)(Table 2).

The PRISM III (Pediatric risk of mortality score III) scores at 12 hours and 24 hours were calculated to analyze the correlation of anemia in children needing ventilation as a risk factor for mortality. It was observed that there was no statistically significant correlation between mild and moderate anemia groups, the PRISM III scores at 12 hours and 24 hours and mortality(p values were 0.713 and 0.052 respectively). However it was observed that there was an increased risk for mortality in children within the severe anemia group.

Discussion

Anemia is not uncommon in critically ill children admitted to the Pediatric intensive care units (PICU). It is also a known fact that it is multifactorial in origin. Anemia in critically ill children can lead to inadequate oxygenation of tissues thus impairing the body's ability for oxygenation of vital organs and hence a high index of suspicion, timely recognition and optimal treatment of the same is of prime importance. Among the various factors that are addressed in critically ill children admitted to the PICU, correction of anemia is usually considered as a key treatment strategy in most protocols. In our study it was observed that the prevalence of anemia was 62% among children who required ventilation and admitted to the PICU. There were no similar studies found as per our literature review on anemia in critically ill children needing ventilation. From our study it was observed that none of the morbidity factors assessed had a statistically significant correlation with anemia. Mortality too was found to have no statistically significant correlation with anemia. It was however observed that there was an increased risk for mortality in children with severe anemia. In this study, 33% of the children who belonged to the severe anemia group succumbed to death as compared to 5% and 10% in the mild and moderate anemia categories respectively. PRISM

III scores were calculated and correlated with the severity of anemia and mortality. It was observed that there is an increased risk of mortality in children with higher PRISM III scores in those having severe anemia. However the statistical correlation and p value could not be assessed as the sample size of the sub group was inadequate. A detailed literature review was done by us to probe any studies, wherein anemia in critically ill children needing ventilation and its role in morbidity and mortality were published in various search engines, but in vain. A prospective observational study done by A.V. Lalitha et al studied the effect of anemia in children with septic shock exclusively. However this study did not analyse children who needed ventilation exclusively as compared to ours^[19]. The prevalence of anemia was almost similar in that study too. It was also observed that in both the studies, there was an increased risk of mortality as the severity of anemia increased.

There were limitations to our study. We evaluated only a solitary hemoglobin value at the time of admission to the PICU. Factors that could affect the hemoglobin values such as hemoconcentration or hemodilution based on the clinical conditions of the patient were not analyzed. Serial hemoglobin values during the hospital stay or at the time of discharge from the hospital were not studied as it was not in the purview of our study. Our hospital being a tertiary level referral centre caters to patients referred after primary treatment given from the referring hospitals which also included blood transfusions. This factor was not taken into account. Our study was a single centre data with small sample size and hence the results cannot be generalized. This study would continue to stress the timely recognition of anemia at the time of admission to the PICU irrespective of the primary illness. Judicious correction by blood transfusion must be done in critically ill children needing ventilation to improve their outcome. Aiming to aggressively correct anemia to improve outcome in children who are ventilated for different etiologies should be thwarted. Large multicentre prospective studies need to be conducted in order to investigate and analyze the risk factors of anemia in ventilated children that could potentially affect the outcomes of critically ill children.

Conclusion

Anemia is a common problem encountered among children who are admitted to the PICU. Anemia in children needing ventilation does not seem to be a significant factor that affects the morbidity or mortality as per our study. There was an increased risk for mortality in children in the severe anemia

category, yet needs extensive studies to prove it beyond doubt.

Recommendations: Larger multicentre prospective studies would help to investigate and analyze the risk factors of anemia in ventilated children that could potentially affect the outcomes of critically ill children. Though anemia in children needing ventilation does not seem to be a significant factor that affects the morbidity or mortality as per our study, it needs to be addressed based on the requirements of each case.

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