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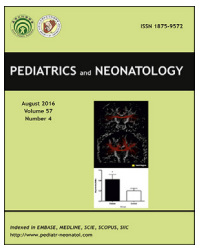

Review Article

# Red blood cell transfusion in infants and children – Current perspectives

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Children routinely receive packed red blood transfusion when they are admitted in the intensive care unit or undergoing cardiac surgeries. These guidelines aim to summarize literature and provide transfusion triggers exclusively in infants and children.


## 1. Introduction

In older children and adults, transfusion is not performed very often. The most commonly transfused groups are children in pediatric intensive care units or those undergoing cardiac surgery. Many caregivers have postulated about the life-saving properties of RBC transfusion in a defined patient population. However, recent studies have demonstrated potential deleterious effects of liberal use of blood in critically ill adults and children.[1]

## 2. Literature search

An electronic search of MEDLINE was performed. The search terms used included "red blood cells" and "transfusion" in combination with "transfusion trigger", "critical illness" "sepsis" and "children".

## 3. Physiologic response to anemia

The primary objective of RBC transfusion is to increase oxygen delivery to tissues to preserve organ function in compromised situations. Oxygen delivery is dependent mainly on 1) haemoglobin, 2) cardiac output and 3) percent saturation ($SaO_2$). When fully saturated each gram of haemoglobin (Hb) can carry 1.34 ml of oxygen at normal body temperature. The data suggest that simply increasing the oxygen delivery by RBC transfusion does not lead to increased oxygen utilization. The mechanisms implicated include changes in 2, 3 diphosphoglycerate, adenosine triphosphate and quantity of free haemoglobin. These factors contribute to the reduction of local oxygen delivery after transfusion and may be responsible for negative outcomes of RBC transfusion in critically ill patients despite an increase in global haemoglobin concentration and theoretical increase in oxygen delivery.[2–4]

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## 4. Anemia and RBC transfusion in intensive care units

Severe sepsis and septic shock are major healthcare problems in adults and children.[5] The pathophysiology of sepsis is such that it involves decreased oxygen delivery and myocardial dysfunction. The physician's goal for these patients is to ensure adequate oxygen delivery by augmenting their cardiac output and hemoglobin level.[6] Two surveys addressed the issue of pediatric intensivists preferring to maintain a high hemoglobin level in children with sepsis.[7,8] Rivers et al.[6] reported an improved outcome in adults with severe sepsis when the central venous oxygen saturation was maintained at >70% in the first 6 h after presentation; the proposed treatment strategy for this was RBC transfusion to reach a central venous oxygen saturation of 70% or more.

2008 guidelines of the survival sepsis campaign recommended that adults admitted with sepsis should undergo transfusion in the first 6 h to maintain a target hematocrit of >30%. Once the hypoperfusion of tissues is resolved, the hemoglobin can be maintained between 7.0 gm/dl and 9.0 gm/dl. The cutoff for RBC transfusion is recommended at a level below 7.0 gm/dl.[9] Lacroix et al.[10] reported their randomized control trial in which a transfusion trigger of 7.0 gm/dl was compared with 9.5 gm/dl in stabilized critically ill children. It was seen that a lower threshold of 7.0 gm/dl was safe in this patient population.

With improvements in the practice of medicine, in order to provide continuous quality of care repeated phlebotomy is performed due to perpetual demand of laboratory investigations. This results in iatrogenic anemia. In the neonatal ICU setting, this problem has been extensively studied. Special protocols can be introduced to reduce blood sampling in the ICU.[11] Point of care testing (POCT) is one methodology that has helped in this setting. In comparison to traditional phlebotomy, POCT requires a small volume of blood resulting in decreased blood loss subsequently leading to fewer transfusions.[12]

## 5. Haemoglobin level trigger for transfusion

Weiskopf et al.[13] studied healthy volunteers undergoing isovolemic hemodilution and found no evidence of impaired tissue oxygenation until the haemoglobin concentration decreased to 4 5 gm/dl. These findings have not been extensively validated and are dependent on the underlying clinical condition. However, children seem at least as capable as adults in their ability to compensate for lower Hb concentration with increased oxygen extraction and cardiac output.[14]

Lackritz et al.[15] retrospectively analyzed over 2400 pediatric admissions in a Kenyan hospital that showed 29% of all children admitted had a Hb of <5 gm/dl. Majority of these patients had malaria. In all these cases, severe anemia was associated with a significantly increased mortality. Another prospective study was conducted in 287 children, also with malaria. These children were randomized to either blood transfusion or iron replacement for 28 days (total 114 children). In 173 children, respiratory distress or a hematocrit of <12% was present. Therefore they were transfused at presentation. Twenty-four deaths were reported in the study. Twenty-three of those children had an admission hematocrit of <12%. Of the children randomized to receive iron therapy, one child died and ten subsequently required RBC transfusion.[16] These children may represent pediatric patients in developing countries and accentuate the imminent risk of low Hb level and the physiologic mechanisms to maintain delivery of oxygen in the setting of severe anemia.

## 6. Transfusion in neonates

In 15%–50% of critically ill pediatric patients admitted in the ICU, RBC transfusion is carried out at some point during their stay.[17] More frequently, packed red blood cell transfusion is a common practice in preterm infants admitted to neonatal intensive care units. Neonates weighing less than 1500 g are the ones with increased transfusion needs. About 40% of neonates weighing 1000–1500 g at birth and 90% of those weighing <1000 g may receive a mean of five RBC transfusions during their hospital stay.[18] A recent international survey of transfusion practices for extremely premature infants showed that the degree of oxygen requirement (44.7% of respondents) and need for respiratory support (44.1% of respondents) were considered the most important triggers for transfusion.[19] Kasat et al.[20] recently observed that tachycardia was the most sensitive predictor of improvement resulting from RBC transfusion. This study also observed no significant changes after transfusion in critically ill, ventilator-dependent neonates, probably due to the complex physiology of neonatal respiratory system. In contrast, the results of this study showed an increased oxygen requirement after transfusion in a cohort of critically ill premature neonates in the first week of life which was likely caused by volume overload. For these reasons, the conclusion of the study was judicious RBC transfusion for critically ill neonates.

Bateman and colleagues[21] published the results of a multicenter, prospective, observational study that explored the frequency of anemia, phlebotomy and RBC transfusions in critically ill children admitted in PICUs. Anemia was present in nearly three - fourths of these children. Almost half of these children received at least one RBC transfusion during their stay. Only 4% of children received transfusion after one week of hospitalization. Blood loss from frequent phlebotomy was a significant and independent risk factor for RBC transfusion (Key recommendations are summarized in Table 1).

## 7. Conclusion

The College of American Pathologists suggests considering the patient's clinical status and the amount of blood loss when making the decision to transfuse.[22] The lowest recommended threshold is a level of haemoglobin less than 6 gm/dl. These recommendations emphasize the importance of considering tissue oxygenation by monitoring the heart rate, arterial blood pressure, lactate levels and mixed venous oxygenation rather than using any one single Hb value in clinical decision - making. The American Society of Anesthesiologists and the Canadian blood transfusion

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