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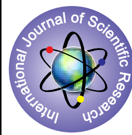
Peri- Operative Blood Transfusion in Infants: A Review of Recent Trends and Guidelines



Medical Science

KEYWORDS :

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ABSTRACT

Blood transfusion therapy for infants can be confusing due to numerous opinions,performas and clinical applications which can result in a picture that is not practical and is often misleading.
Perioperative blood components are required to meet the on-going losses and maintaining cardiovascular stability to sustain adequate tissue perfusion.
Infants have different physiological needs than adults and they are more prone to immune reactions from whole blood therapy therefore component therapy has over taken practise of whole blood therapy.
There are specific guidelines for all the components regarding the initiation and the end point of the transfusion which are there to guide us.
The anaesthesiologist must estimate how much blood to be allowed to be lost before the initiation of blood transfusion .This is estimated with respect to patient's blood volume which is a function of age.
There are certain high risk groups like congenital heart disease and disease affecting respiratory system in which target Hemoglobin or hematocrit values are different.

ARTICLE

Blood transfusion is used in a variety of medical conditions to replace lost components of the blood. Component therapy whereby components of the blood such as red cell concentrate, fresh frozen plasma, cryoprecipitate, and platelet concentrate are infused as indicated, has overtaken the old practice of whole blood infusion.In paediatric transfusion medicine a firm concenses is lacking regarding appropriate haemoglobin(Hb) concentrations at which to transfuse red blood cells(RBCs) to any given patient sub-group(18).

The situation becomes more complicated in perioperative period when sudden and severe hemodynamic changes can occur(19). Paediatric intraoperative transfusion therapy, particularly the approach to massive blood transfusion (blood loss ≥ one blood volume) can be quite complex because of the unique relationship between the patient's blood volume and the volume of the individual blood product transfused. A meticulous blood transfusion management is required in paediatric patients because of an extremely limited margin for error. Hence high level care is required on the part of both paediatrician and anaesthetist for the optimal preoperative preparation of the patient and adequate intraoperative replacement of blood loss. Increasingly complicated surgeries are being performed on neonatal and paediatric patients. Provision of a safe and adequate blood supply is essential for the success of many of these surgeries

WHY SPECIAL CONSIDERATION FOR THIS GROUP?

Infants don't tolerate fluid overload or decreased oxygen carrying capacity as adults because of the numerous physiological differances(1,2,3) -

- Decreased cardiac reserve –
- Less number of beta receptors
- High resting levels of catecholamines
- Decreased ventricular compliance (limited size of myocardium)
- Immature ca2+ transport system so myocardium is dependent on extracellular ca2+
- Stroke volume depends more on heart rate
- Limited oxygen carrying capacity –
- Due to high percentage of Hbf in circulation . Hbf has a high affinity for oxygen which decreases oxygen delivery to tissues.
- Limited or delayed response to various heamatological-stress on infant bone marrow.

NORMAL VALUES (4)–

Hemoglobin –

AGE	HB
Birth	17 (hematocrit -53)
1 week	18.8
4 weeks	14
6 months	12
6 months to 1yr	11(hct 32)

FOR PRETERM

At birth	13 –18.5(hct 49)
At 1 week	14.8(hct 45)

ESTIMATED BLOOD VOLUME

Severity of blood loss is defined in terms of percentage of total blood volume in the body. Massive blood transfusion is defined as equivalent to or more than one blood volume of the patient, such a large transfusion could lead to coagulation errors, fluid overload, hemoconcentration and hyperviscosity syndromes, hypocalcemia, hyperkalaemia and even disseminated intravascular coagulation (DIC)

Preterm	100-120ml / kg
Full term	90 ml/kg
3-12 months	80ml/kg

SIGNS OF ANAEMIA IN CHILD-

- Pallor , tachycardia
- TIREDNESS , LASSITUDE AND GENERALIZED DECREASED ACTIVITY AS COMPARED TO SIBLINGS OR OTHER CHILDREN OF SAME AGE
- Shortness of breath
- Anorexia
- Irritable and crying
- Decreased feeding
- Pica-geophagia(soil), amylophagia (washing powder) pagophagia (ice)

INDICATIONS OF BLOOD TRANSFUSION(12,13)-

- Acute blood loss (15-20%)
- Hb less than 8%
- Symptomatic perioperative anaemia
- Chronic congenital /acquired transfusion dependent state
- Emergency surgery with anticipated blood loss
- Severe infection
- Severe pulmonary disease

- Chronic transfusion dependent states
- Thalassemia
- Bone marrow failure (aplastic anaemia)
- Congenital dyserythropoietic anaemia
- Sideroblastic anaemia
- Paediatric oncology
- <8% with chemo/ radiation
- < 10% with intensive chemotherapy, febrile neutropenia, severe LRTI, thrombocytopenia bleeding
- Hyperleucocytosis

5. Transfusion protocol for preterm

Hb 8 to 11 15 ml/kg PCV over 2-4hrs
Hb 5 to 8 20 ml/kg PCV over 2-4 hrs

FORMULAE FOR PER-OP –
MAXIMUM ALLOWABLE BLOOD LOSS (MABL)(5):

MABL= estimated blood volume x (starting hct–target hct) starting hct (targetperiophct =20-25%)

VOLUME OF PRC TO BE INFUSED =

(desiredhct –present hct)x ebvhct of pcv
idealHct of PCV is 70%(55-75%)

Blood loss during surgery less than the calculated MABL should be repiased by 3ml/ml of RL, or with 5% albumin or hydroxyl ethyl starch in 1:1, no transfusion is required . As replacement some studies have recommended replacing 0.5 ml of PRC per ml of blood loss exceeding MABL. With 70% haematocrit of PRC the replacement may not be accurate but it is well tolerated(6,12).

TARGETS –

- In routine surgery perioperative Hct =20-25%
- Neonates with severe respiratory distress
  Hct>40%
  Hb>13
- Neonates with moderate respiratory distress
  Hct>30%
  Hb>10
- Congenital heart disease –
  Hct> 45%
  Cyanotic –hb>12
  Acyanotic – hb>11
- Major surgery
  Hb>10
  Hct>30

WHOLE BLOOD VS PACKED RED CELLS(PRC)-
INDICATIONS FOR WHOLE BLOOD(7) –

1. Massive blood loss without at least 1 volume of blood transfused
2. Exchange transfusions in neonates
3. During ECMO
4. Hyperleucocytosis (wbc>100x10^9/ l in acute leukemia)

ADVANTAGES OF PRC OVER WHOLE BLOOD

It is more economical to use PRC. PRC has less volume and so no additional circulatory load is imposed on the patient. It contains very less plasma which require lesser anticoagulant to preserve it thereby reducing chances of citrate related toxicity (hypocalcemia,acidosis). Furthermore, removal of plasma with electrolytes and ammonia decreases risk and extra load over kidney. Chances of allergic /anaphylactic reactions minimized by using leucocyte poor rbc(8,9)

ESTIMATED RESULTS OF TRANSFUSION –

- 3ML/KG PRC INCREASES HB BY 1 AND HCT BY 3%
- 10ML /KG PRC INCREASES HCT BY 10% AND HB BY 3-4 G%
- 10ML/KG OF WHOLE BLOOD INCREASES HCT BY 5% AND HB BY 1-1.5%

INDICATIONS FOR PLATELET TRANSFUSION(10)-

a. platelet count <20-30,000/μL in infants with failure of production;
b. platelet count <50,000/μL with bleeding, or prior to non-neurologicinvasive procedures or minor surgery like lumber puncture etc;
c. platelet count <100,000/μL prior to neurological invasive procedures, cardiovascular or neurologic surgery, or other major surgery;
d. platelet count <100,000/μL with a recent (within one to two
weeks) intracranial hemorrhage;
e. qualitative platelet defect with bleeding, prior to invasive procedures or surgery, or with unexplained excessive bleeding during cardiopulmonary bypass; and
f. platelet count <80-100,000/μL prior to and during ECMO therapy, or with unexplained excessive bleeding during the procedure.

Random donor platelet(RDP) contains 5-6x 1010 platelets in 50-60 ml of plasma per unit. 1 UNIT / 10kg body weight will raise the platelet count by 20—30000/ μl.

Single donor platelet contains 2-3 x1011 platelets into 250-300 ml of plasma thus it has 6-7 times more platelets than RDP.

Use OF SDP restricts one to limited donors as same donor can be reused after 2-3 weeks in chronic patients(11).

INDICATIONS FOR FRESH FROZEN PLASMA (FFP) TRANSFUSIONS(10) -

1. Reconstitution of red blood cells for exchange transfusion or other massive transfusion;
2. Coagulation factor deficiency, with bleeding, or prior to invasive procedures or surgery, if specific factor replacement is not possible;
3. Vitamin K deficiency resulting in a coagulopathy, with bleeding, or prior to invasive procedures or surgery;
4. Thrombotic thrombocytopenic purpura (TTP), congenital or acquired;
5. Replacement therapy in congenital antithrombin III deficiency, protein C deficiency or protein S deficiency, when specific factor replacement is not available; and
6. Clinical evidence of coagulopathy whenever laboratory results are pending.

Prophylactic treatment with FFP transfusion is not appropriate, except prior to invasive procedures or surgery, in the presence of significant congenital or acquired factor deficiency(ies).

Maximum tolerated FFP dose is 10-15 ml /kg /hr. 1 UNIT of FFP has 200-250 ml of plasma and 1 ml of plasma contains approximately 1 UNIT of each clotting factor so one cannot achieve very high plasma level of missing clotting factors without volume overloading the patient.so its better to use crypoprecipitate for replacing the desired clotting factors.

INDICATIONS FOR CRYOPRECIPITATE TRANSFUSIONS(10)-

1. von Willebrand disease, with bleeding, prior to invasive procedures; or preoperatively whenever desmopressin acetate (DDAVP) is contraindicated, unavailable or does not elicit the desired response; and whenever viral-inactivated factorconcentrate containing von Willebrand factor is not available;
2. hypofibrinogenemia or dysfibrinogenemia, with bleeding or preoperatively; and
3. replacement therapy in factor XIII deficiency.

The rate of transfusion depends upon the component, the total volume to be infused, venous access characteristics and the infant's intravascular fluid tolerance. As a general rule, small transfusions under 20 mL do not require a pump and may be pushed in via a syringe by intermittent small bolus, taking into considerationthe volume-tolerance of the infant.

Larger-volume transfusions should be administered by an infusion device, within two to four hours. If the transfusion interval is to exceed four hours, the blood component should be subdivided, and its second portion stored in the blood bank until needed.

The following infusion flow rates are commonly used:
RBC: 3-5 mL/kg/hour;

FFP: within 30 minutes, provided the volume does not exceed 5-10 mL/kg;

Platelets: within 30 minutes. It is seldom necessary to reduce the volume of the platelet concentrate if the dose does not exceed 5-10 mL/kg; forvolumes greater than 10 mL/kg, centrifuge to remove all but 10-15mL of the plasma from a unit of whole blood-derived platelets, and/orproportionately somewhat more from a pool or apheresis unit(16,17)

CONCLUSION-
A trend appears to be developing towards allowing lower Hb concentrations in stable asymptomatic infants. But before undergoing any major surgery, any deficits in the child's blood profile should be corrected so as to optimize the cardiovascular functioning and oxygen delivery. This minimizes the surgical stress, improves prognosis by improving healing and immune status and also reduces the postoperative load on the hematopoietic system.

As such infant transfusion therapy must be individualised.

Component therapy is always the first choice and whole blood should only be used in the special conditions mentioned earlier, to prevent the side effects of overloading and immune mediated reactions. Several studies have indicated that paediatric patients especially those below 4 months of age are more susceptible to these side effects because of an immature immune system.

Most importantly numerical guidelines should not be followed to the exclusion of clinical judgement, depending upon the time interval required to perform analysis and to receive the reports there can be significant exacerbations emphasising the role of clinical judgement.

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