

## Cord Blood Transfusion: an Alternative to Adult Blood Transfusion

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**Abstract:** Adult blood for transfusion has become more increasing a scarce product. WHO estimate that 14 million units of blood are needed per annum in the subsahara Africa but only 3.6million, representing 25.7% of WHO estimate were collected in 2004. The prescription of blood by some physicians on the basis of Haemoglobin (Hb) of  $\leq 10\text{g/dl}$  and the non availability of cell separators have made the scarce available adult blood to be wasted. Placenta cord blood has been found to be rich in adult and fetal haemoglobin stem cells, cytokines, platelets and has minimal immunological reaction. It has been demonstrated by several authors that cord blood is a very good alternative to adult blood especially in anaemia accompanying disease like Tuberculosis, Leprosy, HIV, Diabetes mellitus with Microalbuminaemia, advanced rheumatoid arthritis and malaria. The limitation of placenta cord blood transfusion is the short storage duration (72hrs), superstitious beliefs by pregnant women and small volume that can be collected per unit (mean volume of 150mls compared to 450mls from adult donors). However these limitations could be overcome by haemovigilance, constant interaction with labour ward staffs and counseling of pregnant women who will be donors of cord blood. We recommend that in developing countries where placenta cord blood is readily available, cord blood could be an effective alternative to adult blood.

**Key words:** Placenta cord blood • Blood transfusion • Anaemia

### INTRODUCTION

Blood transfusion is the process of transfusing blood or blood products from one person into the circulatory system of another. The first documented transfusion was by Dr. J. Denis in 1667 who gave a small amount of calf blood to a patient that initially recovered but died later. This was followed by several controversies that in 1670 the procedure was banned. In 1818 Dr. James Blundel performed the first successful blood transfusion using human blood (patient's husband) without anticoagulation. The first blood transfusion from a stored blood was in 1916 establishing the first blood bank system world wide.

Blood transfusion or transfusion medicine has continued to grow to reflect the pace of technological advancements. Unfortunately blood or its components are increasingly scarce despite so much effort aimed at their procurement. This is worsened by HIV pandemic and superstitious beliefs [1]. Though WHO estimated that 14 million units of blood per annum are needed in sub-Saharan Africa of which only 3.6 million units (25.71%) was donated in 2004 with a deficit of 10.4million (75.29%).

In most developing countries, the donated blood is further wasted by some physicians who still prescribe blood on the basis of haemoglobin (Hb) of  $10\text{g/dl}$  rather than using the clinical state of patients. Also clinical evidence has shown that in the absence of anaemic heart failure,  $\text{O}_2$  delivery to tissue is still adequate at haemoglobin concentration of  $6 - 7\text{g/dl}$  [2]. In an attempt to make blood available in developing countries like Nigeria, blood banks have resulted to the use of commercial donors [3] despite several legislation against such practices [5]. The above commercial donor drive has also made donated blood to have increase chances of having infections like HIV, hepatitis etc [6].

Another challenge in the developing countries with blood transfusion is that despite the huge units of blood collected e.g. in UBTH Nigeria a total of 160, 431 units of blood were collected between 1986 to 2006 [7] due to no facilities for cell separation blood is therefore transfused as partially packed red cell or as whole blood. This practice has been outdated and whole blood is only recommended in rare cases of blood loss e.g. trauma [8].

Difficulties in recruiting voluntary donors have made several authors to consider alternatives to blood

transfusion in order to correct Hb deficit (anaemia). Several alternatives including erythropoietin injection, dietary supplements micronutrients such as folic acid and iron and blood substitutes e.g. perfluorocarbon compounds, apotinin. However the term blood substitute is in real sense a misnomer as only a part of the total function of blood (mainly Oxygen delivery and blood volume expansion) is modified by the so called substitute. Cord blood now recognized as a very important source of red cells that is readily available from cord blood of women during delivery has all the functions of adult blood and an ideal substitute for blood transfusion.

**Comparing Cord Blood Versus Adult Blood:** The essence of blood transfusion is to improve the ability of the red cells to deliver oxygen to the cells in critically ill patients [9]. The cord blood and adult blood red cells have haemoglobin and the ability to deliver oxygen to cells of tissue. However Haemoglobin F which is found more in cord blood (50 - 80%) [10] has a greater affinity for oxygen ( $O_2$ ) than Hb A found in adult blood [11]. The cord blood has about 0. 1% nucleated cells (mainly stem cells), high in platelet, white blood cells, haemoglobin (mean 16. 6+/- 1.5g/dl) [12] more than adult blood with Hb of 15.1+/- 1.7g/dl [13]. It is also immunologically safer than adult blood for transfusion.

Recruiting donor for cord blood only involves consent from the pregnant woman whose placenta will invariably be discarded anyway through a non - invasive venesection of the placenta cord vessels. It does seem that the doctors might pose greater obstacle than the mother (parents) consent to donate cord blood. This obviously necessitates adequate education of the pregnant woman stressing that there is no danger to the baby whatsoever. The major constraints with cord blood are identified in the following section.

**Limitations:** A major limitation of Cord blood is small volume of an average of 150mls [14] that can be collected from one placenta. This when compared to an average of 450mls of adult blood implies that using cord blood for adults will require more units of cord blood to correct red cell deficits. Also the small volume of cord blood will necessitate the use of special smaller bags to avoid excess anticoagulants if adult blood bags are used. The process of collecting cord blood could be very unhygienic especially through per vagina delivery and occasionally only small volume (150 mls) will be collected. Cord blood could only be stored for 72hrs at 1-4°C. In an African society like Nigeria superstitious belief could be a strong limitation to consent by pregnant women who may insist on burying their placenta intact.

**Preparing Cord Blood for Transfusion:** Usually consent is obtained from a pregnant woman who must be negative for HIV, Hepatitis B and C antigen. The ABO Rhesus blood group and Hb genotype should also be typed. Pregnant women for elective caesarian section are better donors because it is more hygienic and much easier to collect but vagina delivery can also be a source. Once the cord of the placenta to the baby is separated, the cord to the placenta is immediately cannulated using a pediatric blood bag or a cord blood bag.

The advantage of the cord blood bag is that it has a separate pouch for blood specimen collection for further investigation especially if it is to be used for cord blood transplant. The cord blood is mixed with the anticoagulant in the bag intermittently until the blood stops running. The cord blood is immediately preserved in a refrigerator and should be transfused within 72hrs of collection to the recipient [15]. The usual serological test for adult blood before transfusion and the usual cross matching with the recipient blood is routinely done before the cord blood is transfused to the recipient.

Table 1: Comparison between cord blood and adult blood

SN	Characteristics	Adult blood	Cord blood
1	Source	Adult peripheral blood	Placenta cord blood
2	Volume	450mls/unit	150mls/unit
3	Hb g/dl	15.1+/-1.7g/dl (male)	16.6+1.5g/dl
4	Platelets	240,000 +/- 76/ul	Higher
5	White blood cells	7,300 +/- 1.7/ul	Higher
6	Nucleated cells (mainly stem cell)	Less	0. 1%
7	Hb F	1 - 2%	50 - 80%
8	Storage temperature	4°C - 8°C	1° - 4°C
9	Duration of storage	28 days	72hrs
10	Post transfusion increase in Hb	1.5g/dl to 1. 8g/dl	0. 6g/dl to 1. 5g/dl
11	Units transfused at same time	1	2
12	Need for serology test	Extremely necessary	Minimal
13	Immunoglobulin, cytokines & growth factor	Minimal	Numerous
14	Adverse effects	Common	Uncommon
15	Collection process	Invasive	Non - invasive

Two units of cord blood can be simultaneously transfused which is an average of 150mls each (total 300mls) similar to one unit of packed cell of adult blood.

**Cord Blood as an Alternative to Adult Blood Transfusion:**

Cord blood has been shown to be a good source of stem cell in stem cells transplantation especially for sickle cell and thalassaemia patients [16]. However because of its rich content of red cells with high haemoglobin, its rich source of platelets, cytokine and growth factors some centres have successfully used it as an alternative to adult blood for transfusion as enumerated below.

**HIV Patients with Anaemia and Emaciation:**

A preliminary report of 123 units of placenta umbilical cord blood transfusion in HIV patients with anaemia and emaciation was shown to be beneficial to these patients. It was shown that in these patients apart from the correction of anaemia there was also some definite improvement in their clinical parameters such as improvement in the energy level and relief of fatigue, physical functioning, a sense of wellbeing and weight gain from two to five pounds within ten months of commencing cord blood transfusion. In addition there was a rise in peripheral CD34 levels without any clinical graft versus host reaction [15].

**Anaemia in Patients with Tuberculosis and Emaciation:**

Cord whole blood transfusion has been used also to treat anaemia in patients with tuberculosis who were emaciated because of its role as an immuno - adjuvant therapy. Apart from correcting anaemia in these group of patients, their CD34 rose from the pre -transfused base level of 0.09% (varying from 2.99% to 33%) and returned to base level in 66.66% of the patients in the three months CD34 re-estimations without triggering any clinical graft versus host reaction in the patients at 3 months post transfusion [17].

**Anaemia in Patients with Leprosy:** Also cord blood has been shown to be effective in treating leprosy patients with anaemia. Report of treatment of 16 leprosy patients [5 with pauci Billiary type (PB) and 11 with multibilliary type (MB)] Hb of  $\leq 8\text{gdl}$  were transfused with cord blood in place of adult whole blood shows that apart from correcting anaemia there was no clinical immunological reaction. The CD34 after seven days of transfusion revealed a rise from the pre- transfusion base level (0.09%) varying from 3.6% to 16.2% in 75% of cases [18].

**Anaemia in Patients with Diabetes Mellitus and Microalbuminaemia:**

Patients with diabetes mellitus and microalbuminaemia with a background of anaemia has also been shown to benefit from placenta cord blood transfusion. A study of 39 patients with diabetes mellitus (type 2 fasting sugar 200mg or more) and a microalbuminaemia (Albumin excretion 30 - 299mg/g of creatinine) 78 units of placenta cord blood was collected (56ml - 138ml mean 82ml  $\pm$  5.6ml SD, median 84ml, packed cell volume 49.7 $\pm$  4.2SD) was transfused to the diabetes patients. These patients were randomized into 2 groups with group A as control cases that was transfused with adult blood while group B was transfused with placenta cord blood. In group A the rise of haemoglobin after two units of adult blood transfusion was 1.5 to 1.8gdl as usually seen after 72hrs post transfusion assessment.

The rise of Hb after 72hrs of cord blood transfusion was 0.6gdl to 1.5gdl ((each patient received two to four units but two units at a time) microalbuminuria was assessed in both groups after one month of treatment and result showed that in group A, it was 152 $\pm$  18mgSD of albumin per gram of creatinine excreted through 24 hours urine (pre- transfusion mean excretion was 189 $\pm$  16mg) while in group B, it was 103 $\pm$  16mg SD of albumin excretion per gram of creatinine in 24hrs urine (pre - transfusion mean excretion was 193 $\pm$  21mg). The difference between group A and B values and its comparism with pre transfusion microalbuminuria was statistically significant ( $P < 0.003$ ) [19].

**Anaemia in Patients with a Background of Advanced Rheumatoid Arthritis:**

Placenta umbilical cord whole blood transfusion has been used to treat anaemia in patients with a background advanced rheumatoid arthritis with emaciation and its potential role as immunoadjuvant therapy has been advocated.

Anaemia has been found to be a common co morbidity of rheumatoid arthritis and it is as a result of several factors like cytokine impact of the advanced arthritis process on the host, coexisting steroid induced gastritis with reduced absorption of iron etc. Cord blood because of the rich mix of high platelets, fetal and adult Hb, white blood cells (WBC), plasma that is filled with cytokine, growth factors, hypo antigenicity and altered metabolic profit, is being advocated as a safe alternative to adult blood transfusion. Report shows that 28units of placenta cord blood was transfused to 28 patients with advanced rheumatoid arthritis and Hb  $\leq 8\text{gdl}$ . At 72hrs

post transfusion, there was no clinical graft versus host reaction, anaemia was corrected and the CD34 estimation revealed a rise from the pre transfusion base level (0.09%) varying from 2.03 to 23% which returned to baseline after three months [20].

**Anaemia in Patients with Malaria:** Malaria caused by infection with plasmodium falciparum kills over 1million people each year [21]. Anaemia from malaria is a major health problem in endemic areas especially in young children and pregnant women. Cord blood transfusion has been shown to be effective in under resourced patients with malaria in the background of anaemia [22]. In a study of 39 patients, age 8 to 72years with a Hb of 5.4g/dl to 7.9g/dl were transfused with a total of 94 units of placenta cord blood.

A rise of haemoglobin was observed within 72hours post transfusion of two units of cord blood as 0.5g/dl to 1.6g/dl and no clinical immunological or non - immunological reactions was noticed.

## CONCLUSIONS

Available literature has shown that cord blood because of its rich mixture of fetal and adult Hb, other cellular components of blood, growth factors cytokines and less antigenic properties, is a good alternative to adult blood transfusion. A number of reasons including poor social economic status, infections and illiteracy have contributed to the dwindling blood supply in the blood banks of many developing countries. We suggest that the placenta cord blood a "biological waste" will be a rich alternative to adult blood transfusion and is readily available in our institutions. A major limitation of PCB is the short duration of banking, traditional beliefs and small volume (average 150mls) per donor. However we believe that these limitations would be overcome by haemovigilance and constant interaction between the labour ward, blood bank and the clinical wards. We believe that traditional and superstitious beliefs with fear by prospective donors will need to be allayed through counseling, information and education of the general public in our local environment.

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