A study of placental umbilical cord whole blood transfusion in 72 patients with anemia and emaciation in the background of cancer

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Summary

In the under-resourced world, transfusion to advanced oncological patients involves two major problems, i.e., (a) transfusion transmitted disease, and (b) infrastructural deficiency. Many hospitals cannot cope with the specialized requirements of immunocompromised cancer victims, for instance, leucoreduction, selective apheresis, irradiation of the blood, viral inactivation of the blood by solvent and/or detergent treatment or photochemical inactivation using psoralen or long wavelength ultraviolet light and cytomegalovirus safe blood.

The exorbitant cost of red blood cell (RBC) substitutes like hemoglobin-based oxygen carriers or perflurocarbon emulsions, liposome encapsulated hemoglobin, is simply unacceptable for an average oncological patient in the developing world.

Moreover, it should be underscored that none of the total blood functions are replaced by any available so-called blood substitute, the primary function of which is oxygen delivery and volume expansion only. A more accurate term should be red cell substitute. Cord blood, because of its rich mix of fetal and adult hemoglobin, platelet and white blood cell (WBC) count, and plasma filled with cytokine and growth factors – as well as its hypoantigenic nature and altered metabolic profile – has all the potential of a real and safe alternative to adult blood during emergencies or any etiology of blood loss. In the present series, the collection of cord blood varied from 54 ml-128 ml, mean 82 ml ± 7.6 ml SD; mean packed cell volume 48 ± 4.1% SD; mean percent hemoglobin concentration 16.4 g/dl ± 1.6 g/dl SD.

Not a single case of immunological or non immunological reaction has been encountered so far after transfusion of cord blood to cancer patients with percent of hemoglobin 8 g/dl or less.

It appears that the medical fraternity can safely use this precious gift of nature – which is free from infection, hypoantigenic with altered metabolic profile, filled with growth factors and cytokine-filled plasma, and has the potential of a higher oxygen carrying capacity than adult blood – as an emergency source of blood for the management of advanced cancer cases with anemia.

Key words: Placental cord whole; Safe blood transfusion; Advanced cancer with anemia.

Introduction

Anemia is the commonest hematological abnormality seen in cancer patients. It increases with progression of the disease. The frequency and severity of the disease depend on the stage, grade, and duration of disease, current and previous treatment protocols and outcome of the therapy [1]. Correction of anemia often improves the quality of life of the cancer patients [2]. Treatment options, particularly in the developing world, include administration of different hematopoietic growth factors, red blood cell (RBC) transfusion, different erythropoietin preparations and dietary enrichment and supplementation in patients. In a report published in the United States [3] it was noted that 37% of cancer patients were anemic (percent hemoglobin less than 12 g/dl) prior to chemotherapy and an additional 41% of patients became anemic during and after chemotherapy. Some of these cases may require RBC transfusion or erythropoietin, if the situation so demands on the basis of the criticality of the disease. However, the problems of erythropoietin use include cost, inconvenience of frequent injections, limitation of efficacy, bone marrow refraction, and other indication restriction [4]. Another unresolved issue of erythropoietin use is its potential to trigger thromboembolic manifestations [5]. Certain cancer chemotherapies are notorious for triggering anemia through their bone marrow suppression effect. Radiation and rapid tumor progression can also trigger anemia through bone marrow suppression and/or infiltration or refraction. Under normal circumstances the antitumor effect of radiation is mediated through interaction with oxygen to form labile free radicals. The intratumoral oxygen level also has a direct impact on radiation-induced tumor cell killing potential, apart from the type of the tumor cell and the composition of its constituents. If not corrected before the initiation of radiation, anemia and subsequent tumor cell hypoxia can reduce the tumorocidal effect of radiation in general [6]. This is quite apart from the negative effects of anemia on the quality of life of cancer victims with progressive and worsening fatigue and depression. Patients with malignant diseases often require transfusion for relief of the symptoms of anemia. In most cases, marrow function may be severely depressed by chemotherapy and/or radiotherapy. Infections and thrombocytopenic bleeding may be also present and the recov-

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ery of the marrow is delayed further due to a combination of drugs, malignant infiltration and/or poor nutrition. Physiological adjustment to chronic and acute anemia has a limit and, particulary in elderly patients with myocardial and vascular disease, anemia is poorly tolerated. The physician must decide as to when the patient is approaching this limit [7].

In our search for a solution to the problem of anemia in patients with advanced cancer, our team has examined viable alternatives. We have noted that in the animal kingdom, swallowing the afterbirth by the mother is a general norm. Nature appears to have provided this precious wisdom to some of its creatures. Even herbivorous animals swallow the placenta after the birth of their babies (e.g., the cow). However humans do not seem to know about the many properties of this precious afterbirth, which has protected and nurtured the baby for so long in the womb. This placental barrier is formidable. Even in cases of HIV infection, there are reports which indicate that the trophoblastic placental barrier remains uninfected in full-term placentae of HIV-seropositive mothers undergoing antiretroviral therapy [8]. The authors suggested that in utero, HIV transmission occurs, if at all, at the end of gestation through alternative routes, such as chorioamnionitis with leakage of the virus into the amniotic cavity or trophoblast damage.

Of late, however [9, 10], global consciousness regarding the use of umbilical cord blood stem cells as an easily available source of hematopoietic stem cells for bone marrow transplantation, is increasing. Scientists seeking a suitable substitute for human blood have attempted several things. Hemoglobin has been extracted from bovine RBC, or its chemically or genetically modified form [11]. Sea creatures (Arenicola Merina), i.e., sea worms [12] have also been examined for potential human use. The problem with animal hemoglobin, however, is that it can trigger allergic reactions and even damage the kidneys.

This work is based on the premise that placental umbilical cord blood could serve as a replacement of adult blood in cancer patients with anemia, and may have other multifaceted advantages. Fetal hemoglobin rich placental umbilical cord whole blood was collected aseptically from the discarded placenta after the birth of a healthy baby through lower uterine cesarean section. Permission was taken from both the donor of the blood and the recipient and each case was assessed by the Institutional Ethical Committee.

Material and Methods

Human placental umbilical cord blood was collected from consenting mothers aseptically after lower uterine cesarean section under general or regional anesthesia. If there was gross prematurity or dysmaturity or the projected weight of the fetus was less than 2 kg, or there was any specific disease of the mother like hepatitis, HIV, etc., the cord blood collection was abandoned. Cord blood was collected from only informed, healthy mothers with their consent after the birth of their healthy babies. The collection process started only after the baby was safely removed from the operation field and the anesthetist verified the stable physical condition of the mother. The cord was disinfected by spirit/Betadine solution at the site of the proposed puncture of the umbilical vein and a 16 g needle was attached to a standard pediatric collection bag (containing 14 ml anticoagulant citrate phosphate dextrose adenine solution), which was used for the purpose of collection. A second bag was used if the collection exceeded or neared 100 ml and a second prick was made at a proximal region after using a clamp at the first site of the prick. Blood flows by gravity and generally within a minute, a major percentage of the collection was over, and within a very short time, in most cases, the blood flow ceased completely due to clot formation. In case of any confusion about the condition of the baby, a decision was immediately taken to preserve the blood in consultation with the pediatrician for future use by the baby, or stamped "unsafe for transfusion", and no risk or chance whatsoever was ever taken for the eventual recipient of the blood. The methodological details of the cord blood transfusion protocol has been reported earlier [13, 14].

When the collection was complete, the blood bag tubing was closed, sealed, and stored at 1-4°C, after putting necessary identification markings. Another sample of the cord blood collected from the placenta was immediately tested for blood group (Rh and ABO), HIV (1 and 2), hepatitis B and C, VDRL, malarial parasite, hemoglobin, total count, differential count, erythrocyte sedimentation rate, and complement reactive protein (CRP).

In case of any real or suspected contamination, blood culture was arranged for identification of the offending organism. This was in addition of the random culture done routinely (every 5th sample) for identification of the pathogen, if any, through appropriate protocol, and if there was isolation of any offending organism, the sample was stamped unfit for transfusion.

An osmotic fragility study (Table 1) in our laboratory, with 45% NaCl (n = 40) at 4°C, 35° and 40° with a time gap of 24 hours, 48 hours, seven days and 14 days along with oxyhemoglobin (mmol/ml) (Table 2) and plasma hemoglobin (mg/ml) (Table 3) assessment in an identical schedule, showed that the cord blood was reasonably stable at room temperature.

Table 1. — *Results on the stability of cord blood with temperature and time variation. Mean fragility (% hemolysis in 0.45% NaCl) with standard deviation (n = 40).*

Temperature	Time			
	24 hr	48 hr	7 days	14 days
4°C	12.6 ± 3.4	32.9 ± 4.3	45.6 ± 2.8	82.5 ± 4.6
35°C	16.6 ± 2.7	20.4 ± 4.3	53.5 ± 3.9	100
40°C	45.0 ± 6.4	77.5 ± 3.8	92.6 ± 4.8	100

Table 2. — *Effect of time and temperature on mean oxyhemoglobin (mmol/ml) with standard deviation (n = 34).*

Temperature	Time			
	24 hr	48 hr	7 days	14 days
4°C	0.32 ± .12	0.31 ± .14	0.27 ± .05	0.26 ± .12
35°C	0.31 ± .06	0.29 ± .03	0.24 ± .06	–
40°C	0.16 ± .01	0.09 ± .01	–	–

Table 3. — *Effect of time and temperature on mean plasma (mg/ml) with standard deviation (n = 36).*

Temperature	Time			
	24 hr	48 hr	7 days	14 days
4°C	6.08 ± .87	6.35 ± .78	7.04 ± .89	14 days
35°C	4.49 ± .54	7.65 ± .86	10.0 ± 2.3	9.69 ± 1.7
40°C	10.3 ± 1.6	13.3 ± 2.4	–	–

In the present series, the collection of the blood varied from 54 ml - 128 ml (Figure 1) mean 82 ± 7.6 ml SD; mean packed

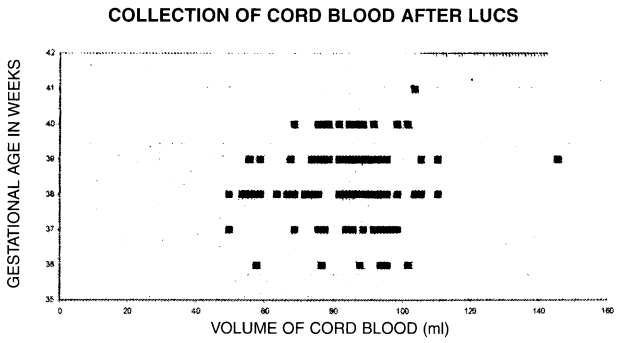

Figure 1. — Collection of placental umbilical cord blood after lower uterine cesarean section (LUCS)

cell volume 48 ± 4.1 SD; mean percent hemoglobin concentration 16.4 g/dl ± 1.6 g/dl SD. After collection, the blood was immediately preserved in the refrigerator and transfused within 14 days of collection. Donation of the cord blood to the recipient followed the strict guidelines of the Human Ethical Committee of the hospital followed by grouping and cross-matching, apart from strictly following World Health Organization (WHO) guidelines for safe transfusion. As a rule, cancer patient volunteers who wish to enroll for the cord blood transfusion program, must have a percent hemoglobin count below 8 g/dl. Before the umbilical cord blood transfusion, a thorough clinical examination of the recipient was done, including proper monitoring of the BP/pulse/respiration and other cardinal and presenting features. Cord blood transfusion was done slowly as per standard blood transfusion protocol.

Results and Analysis

In the present series we are presenting the data of 213 units of aseptically collected cord blood from consenting mothers undergoing lower uterine cesarean section (LUCS) (from 1st April 1999). Transfusion services and effective follow-up have been continued in the outpatient department to date. The blood was transfused to 72 informed consenting cancer patient volunteers with severe anemia, after the cases were passed through the institution-based ethical committee.

Of the 72 volunteers who opted for cord blood transfusion, 30 patients were male and 42 were female (Figure 2). The age of the patients varied from 14 to 86 years. In the

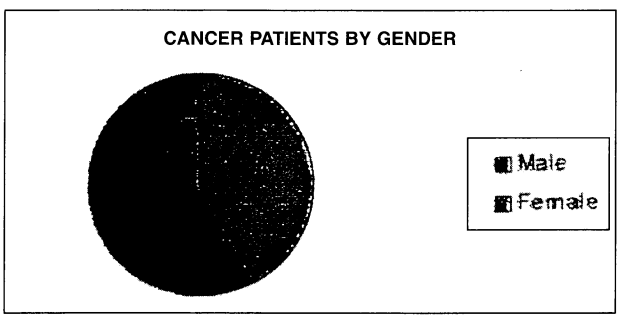

Figure 2. — Distribution of cancer cases on the basis of gender.

present series 9.72% of patients had Stage I and 19.44% of patients had Stage 2 cancer. The rest, i.e., 70.84% of the patients, had an advanced stage of disease (Figure 3). In the present study, 1.38% of patients belonged to the age group of 21-30 years and another 1.38% of patients belonged to the age group of above 80 years. However, the vast majority of the patients belonged to the age group of 41-50 years, i.e., 41.66%, followed by 25% belonging to the age group of 51-60 years (Figure 4). In this study, 69 patients were suffering from carcinoma and three patients were suffering from sarcoma. Among the cancer victims, breast cancer was the highest (28 cases) followed by head and neck (11 cases), then closely followed by gastrointestinal cancer (10 cases), gynecological cancer (8 cases) lung cancer (5 cases), urological cancer (4 cases) and blood cancer (3 cases) (Figure 5).

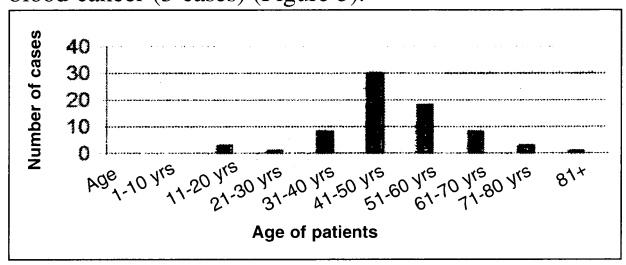

Figure 3. — Distribution of cases showing correlation between age and number

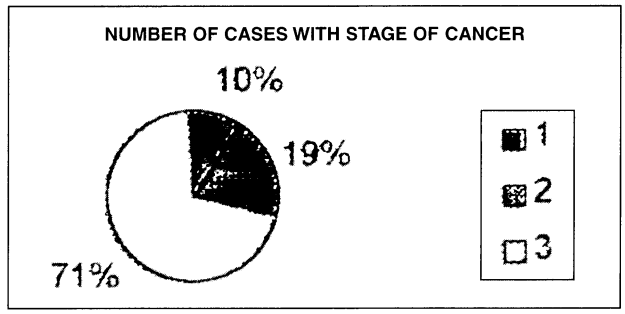

Figure 4. — Correlation of cancer cases on the basis of stage of disease.

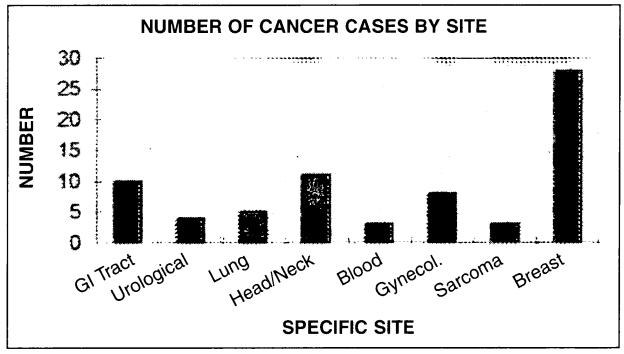

Figure 5. — Number of cancer victims on the basis of site.

The blood volume of a term fetus is approximately 80-85 ml/kg [15]. The placental vessel at term contains approximately 150 ml of blood [16]. The cord blood contains three types of hemoglobin [17]. Hba accounts for 15-

40% of hemoglobin and HbA2 is present only in trace amounts at birth [18]. HbF has a greater oxygen affinity than HbA [19]. The oxygen tension at which the hemoglobin of the cord blood is 50% saturated is 19-20 mm of Hg, 6-8 mm Hg lower than that of normal adult blood. This shift to the left of the hemoglobin oxygen dissolution curve results from poor binding of the 2-3 diphosphoglycerate by HbF [20, 21].

Antigen expression of adult RBCs differs from that of the newborn's RBCs. Decreased branching and increased stimulation of glycoproteins on neonatal red cells may be at least partially responsible for a reduced expression of blood group antigen A and B [22]. Apart from A, B, S and Lutheran antigens are expressed in lesser levels in the RBCs of the newborn. The Lewis antigens are absent in newborn RBCs [23, 24].

The potential complications of adult blood transfusion therapy can be grossly divided under two headings, (a) immunological and (b) non-immunological reactions [25]. Immunological reactions are related to the stimulation of antibody production by foreign alloantigens *via* the different components of transfusion, e.g., RBC, leucocytes, platelets and plasma proteins. Alloimmunizations may lead to immunological reactions in case of future stimulation by a similar antigen. The commonly encountered immunological reactions are hemolytic reactions due to red cell incompatibility. Febrile or pulmonary reactions are related to leucocyte and platelet antigens. Allergic and anaphylactic reactions are related to antibodies and only very rarely can we see graft *vs* host reactions due to engraftment of the transfused lymphocytes in case of immunosuppression. The commonly encountered non-immunological reactions are because of the physical or chemical properties of the transfused blood/blood products due to bacterial or viral contamination or the circulatory load.

The transfusion of 213 units of cord blood to cancer patients over the past five years has not revealed a single episode of immunological or non-immunological reaction so far. On the other hand, there is the potential advantage of the fetal hemoglobin (Bohr's effect) of the cord blood, by which it can carry more oxygen at low PCO_2 than at high PCO_2. Another potent advantage of cord blood transfusion is the rich cytokine and growth factor filled plasma in the cord blood, which eventually has had a positive effect on the distressed and emaciated patients in the clinical group in the present study. This may have specific therapeutic implications. On the basis of clinical experience, it can be said that cord blood transfusion is safe and can be used in oncological patients at the time of need, as an alternative to adult whole blood transfusion, not as an inferior method of transfusion but as an effective supplementation of blood, which has had no transfusion related hazards detected so far.

Discussion

If the theoretical potentialities of the oxygen carrying of blood are calculated, we find that human adult hemoglobin consists of 2 alpha and 2 beta polypeptide chains, each bound to a heme group, capable of binding with one molecule of O_2 (1 g hemoglobin binds with 1.39 ml of oxygen). Therefore, 14 g/dl percent of adult hemoglobin can carry, on an average, 19.46 ml of oxygen. Cord blood at term carries, on an average, 16.8 g/dl percent hemoglobin, of which 20% belongs to the adult hemoglobin type (3.36 gms) and 80% belongs to the fetal hemoglobin type (13.44 g). The concentration of the fetal hemoglobin may increase further depending on fetal stress, maturity and several other fetomaternal factors. Fetal hemoglobin has the potential to carry up to 50% more oxygen than adult hemoglobin, i.e., 1 g of fetal hemoglobin may carry up to 2.08 ml of oxygen. If we calculate theoretically, the oxygen carrying potential of 100 ml of cord blood, after taking into account its 80% fetal hemoglobin component (2.08 ml O_2 carrying capacity per gram of fetal hemoglobin) and 20% adult hemoglobin component (1.39 ml O_2 carrying capacity per gram of adult hemoglobin), would be around 32.62 ml of O_2, which is a 67.62% additional oxygen carrying capacity as compared to adult blood (19.46 ml oxygen/100 ml). There are, however, several factors which can modify the O_2 binding affinity, i.e., (a) concentration of hydrogen ions, (b) carbondioxide concentration in the blood, (c) body temperature, and (d) 2-3 diphosphoglycerate concentration only, to name a few. Apart from the (potential) increased oxygen carrying capacity of cord blood, i.e., the fetal/neonatal blood, it also enjoys certain biological privileges which comes with the placenta being nature's finest biological sieve.

The human fetomaternal barrier has two anatomically distinct components: the chorioallantoic placenta and the chorioamnion. This barrier is formed at the placental level by the villous syncytiotrophoblast. This specialized epithelial lineage is in direct contact with maternal blood circulating through the intervillous space. In a subadjacent layer, mononuclear cytotrophoblasts divide, differentiate, and fuse to renew overlying multinucleated syncytiotrophoblasts. A basement membrane separates these trophoblastic cells from a connective tissue core that contains fetal capillaries. The amniotic epithelium forms the fetomaternal interface in the chorioamnion. The apical surface of this epithelium is exposed to amniotic fluid, whereas its basal surface sits on a basement membrane that overlies the amniotic mesoderm. This barrier is formidable and provides protection to the growing fetus. In spite of having so many natural privileges, the scientific world has never utilized this precious neonatal blood. On the other hand, transfusion specialists and scientists have concentrated their efforts more on the use of hematopoietic growth factors and the search for costly alternatives or blood substitutes.

The condition is terrible in the case of cancer victims because transfusion therapy continues to play an important role in the care of advanced cancer patients. As a result of improved therapeutic regimens for the prolongation of the life of cancer victims, more and more patients develop anemia, hemorrhage, thrombocytopenia, leucopenia, and coagulation disorders due to the disease, treatment or both. The decision to transfuse blood is no

longer based solely on the patient's hematocrit value only. Other collaborating clinical factors include excessive fatigue, malaise, tachycardia, headache, nausea and other additional factors depending on the organ specificity and stage and grade of malignancy. Younger patients tolerate anemia better than older patients who may have a coronary, myocardial or even a pulmonary or renal impairment. Hence, transfusion of red cells should be based on clinical criteria rather than broadly applied threshold hemoglobin values.

The cancer patient also faces the problem of susceptibility to various infections. The overall risk of transfusion-transmitted viral diseases has substantially improved within the last 25 years as a result of proper screening by PCR technology with the exception of the newer identified viruses like the typical or atypical form of the Creutzfeldt-Jakob, etc. The real problem in oncological patients, however, is bacterial and occasionally, fungal transmission. In resource restricted countries, transfusion-associated hepatitis and HIV are also a persistent problem. In a major part of the world, there is a non-availability of routine screening tests done by modern PCR technology for the detection of any viral load at the nano level. Instead, a majority of the world's population depends on the Elisa test for routine screening of the blood for hepatits B and C and HIV 1&2. This is not totally risk free because the antigen load of the HIV or hepatitis virus can go undetected in the grey zone (in between micro to nano level viral antigen load) of the window period of the disease. Due to the immunocompromised state of cancer patients, they belong to a specialized group with increased susceptibility and vulnerability to infection. Many laboratories, in the developing world in particular, cater blood or blood products for oncological patients, without specialized treatment of it for the inactivation of viruses by the solvent or detergent method, or do phytochemical inactivation through the use of psoralens or long wavelength A light [26]. Apart from hepatitis B, C, G and cytomegalovirus, a number of other infectious diseases are known to take advantage of the immunocompromised state of cancer patients, i.e., malaria, Chagas' disease, leishmaniasis, toxoplasmosis, parovirus B19 and Babesiosis, etc. [27]. Though continuous supply of donated blood is vital for the practice of modern medicine, in case of cancer patients, due to ever increasing worry over blood-borne disease transmission, the search for an alternative source for blood transfusion to combat emergencies is gaining momentum, *viz.*, the hemoglobin based oxygen carriers which have an intrinsic advantage of universal compatibility and storability at room temperature [28]. However, the high cost of such alternatives makes them prohibitive, especially in the developing world. Moreover, there are also specific problems of hypertensive impact, gastric irritability and unexplained deaths as reported in a trauma trial on the treatment of severe hemorrhagic shock [29]. Other hemoglobin substitutes with lesser importance include perflurocarbons, i.e., fluorine substituted with linear or cyclic carbon atoms with high oxygen carrying capacity, and liposome encapsulated hemoglon [30]. These have not yet passed through FDA screening.

The scientific literature, in any case, suggests that the transfusion of adult blood is never a zero risk event anywhere in the world. Risks increase in case of pregnancy, hemolytic anemia and an immunocompromised background. Lastly, there may also be problems due to immunomodulation [31]. Newly identified, though well known, potential risk factors include the possibility of the transmission of Creutzfeldt-Jakob disease in its classical or variant form, even after leucodepletion (lymphocytes are a possible source of transmission of infection) as reported in an editorial article [32].

As mentioned earlier, due to disease load or treatment, cancer patients are often immunocompromised and thus become predisposed to a wide variety of bacterial, viral and fungal infections and allied cellular mediated immune responses [33]. Advanced cancer patients, by virtue of their frequent exposure to transfusion, develop HLA alloantibodies, which can adversely affect the therapy, for example, refractoriness of platelet functions. Thus, cancer patients should ideally receive specially processed blood products, for example, leucoreduced, irradiated, cytomegalovirus seronegative blood products. Leucoreduction can prevent febrile non-hematological reactions including HLA alloimmunization. Blood components are irradiated to prevent the potentially lethal transfusion induced graft *vs* host disease. Irradiation interferes with the ability of the lymphocytes to proliferate.

A minimum dosage of 2500 cGi radiation is recommended for blood products before transfusion to a cancer patient [34].

After our experience with 213 units of cord blood transfusion in cancer victims, we can affirm that this transfusion protocol is safe. Not a single episode of nausea or vomiting or any other specific gastrointestinal problem or hypertensive response during transfusion of umbilical cord whole blood was encountered. Such side-effects are common in case of transfusion of certain hemoglobin-based oxygen carriers. Taking all essential precautions in the common background of anemia with malignant background disease, 1 unit to 33 units (2706 ml on the basis of mean volume calculation of 82 ml per unit) of cord blood, were transfused very slowly, to the same patient, with ten units (mean 82 x 10 = 820 ml) of cord blood transfusion at a time in a row. Our team's experience to date, suggests that this placental cord blood transfusion could be a safe, unique untapped source of fresh, infection free whole blood (if collected aseptically after the birth of healthy newborns) to cancer patients with anemia and emaciation.

In this connection it is worth mentioning another recent collaborative work of the University of Liverpool, U.K., and Komfo Anokye Teaching Hospital at Kumashi, Ghana, on the use of placental umbilical cord blood. They reported a substantial decrease in the mortality of children in sub-Saharan Africa suffering from severe anemia after falciparum infection, with the use of cord blood [35, 36].

Conclusion

In a report of the WHO, it was revealed that there are about 500,000 pregnancy-related deaths globally, of which at least 25% maternal deaths are due to the loss of blood [37].

An estimated 13 million units of blood worldwide are not tested against human immunodeficiency viruses or hepatitis viruses. In some developing countries, 80% of the blood supply comes from paid donors or replacement donors (family friends or acquaintances), even when the incidence of infection (HIV, etc.) in the given population is high [38].

For the last 70 years since the publication of a report by Amberson *et al.* [39], there have been global attempts to find a genuine blood substitute. Cord blood fulfills all the criteria of an ideal blood substitute though it contains a very high amount of fetal hemoglobin component. Fetal hemoglobin is a natural stress response to hemoglobin synthesis which should be preserved and augmented in case of thalassemia by providing hydoxyurea or other similar drug support. Other conditions like pregnancy, diabetes, thyroid disease, or anti-epileptic drug therapy can also increase the fetal hemoglobin concentration. This fetal hemoglobin, with its abundant source, i.e., the placenta, is actually a cause of environmental pollution in many parts of the developing world because it attracts natural scavengers and spreads infection, unless aseptically treated or incinerated. This hitherto 'environmental waste' has the potential to help patients in the advanced stages of various types of malignancy.

Modern research in medical science has concentrated on the use of a tiny microscopical fraction of cord blood, i.e., CD 34 stem cells only (.01% of the nucleated cells of placental blood). My team of doctors has been successfully tranfusing this blood since 1999, as an alternative emergency source of blood transfusion in the background of anemia and emaciation of any etiology, i.e., from surgery to medicine, from HIV to thalassemia, from leprosy or advanced cancer to patients with crippling polyarthritis, etc. [40-52]. We have applied for a global patent on the use of cord blood in these areas. If we look to nature, all these helpless patients can be provided with safe, hypoantigenic, whole blood with a much higher hemoglobin content and growth factors through the use of human placental umbilical cord blood. Hemoglobin increases with advancing gestational age. At term the cord blood hemoglobin is 16.8 g/dl (14-20 g/dl). In India alone, 20 million placentas are produced each year only to be discarded to the dustbin. Each placenta contains 150 ml of blood of which 80-100 ml can easily be retrieveable by a simple venepuncture through the umbilical vein after the birth of a healthy baby.

Our experience with umbilical cord blood transfusion in 72 patients with severe anemia and emaciation has proven to be extremely effective without encountering a single transfusion-related hazard. In the under-resourced world, blood transfusion to an advanced oncological patients has many problems. On the one hand, there is the problem of transfusion-transmitted disease (prevalent screening by Elisa not by PCR), and on the other hand, infrastructural deficiency cannot cope with the specialized demands of immunocompromised cancer victims. Finally, to combat the emergency requirement of blood for cancer patients, these precious hypoimmune fetal cells which constitute the cord blood, with high fetal hemoglobin, are a true gift of mother nature, entrapped inside the placenta, which could be a readily available source of blood supply not only in the under-resourced countries of the world but in case of the genuine need for a blood substitute for cancer victims anywhere in the world at crisis.

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