



Blood transfusion in Sub-Saharan Africa: Historical perspective, clinical drivers of demand and strategies for increasing availability

La transfusion sanguine en Afrique subsaharienne : perspective historique, motifs cliniques de la demande et stratégies d'augmentation de la disponibilité

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ABSTRACT

Several decades after the World Health Assembly gave a declaration that every nation should adopt the use of voluntary non-remunerated blood donors (VNRD), operate a centralised system of blood collection, screening and transportation, many countries in Africa are still practicing hospital-based blood transfusion services. They also recruit family replacement blood donors and paid donors known to be less safe than the VNRD. Although in the early 2000s, there was noticeable improvement in blood testing and preservation. This positive effect was as a result of foreign aid from World Health Organization (WHO), President's Emergency Plan for AIDS Relief (PEPFAR) and other external funding, but the gains were quickly lost as soon as the funds were withdrawn. In order to achieve a sustainable and safe blood transfusion in Africa, blood transfusion guidelines should be implemented. This review examines the history of transfusion in Africa and the strategies to increase blood availability in Sub-Saharan Africa.

RÉSUMÉ

Plusieurs décennies après que l'Assemblée de l'Organisation Mondiale de la Santé a déclaré que chaque nation devrait adopter le don de sang volontaire non rémunéré (VNRD), utiliser un système centralisé de collecte, de dépistage et de transport du sang, de nombreux pays d'Afrique pratiquent encore la transfusion dans les services hospitaliers. Ils recrutent également des donneurs de sang de remplacement familiaux et des donneurs rémunérés connus moins sûrs que le VNRD. Cependant, au début des années 2000, il y a eu une amélioration notable des dépistages infectieux et de la conservation. Cet effet positif était le résultat de l'aide étrangère de l'Organisation mondiale de la santé (OMS), du President's Emergency Plan for AIDS Relief (PEPFAR) et d'autres financements externes, mais les gains ont été rapidement perdus dès que les fonds ont été retirés. Afin de parvenir à une transfusion sanguine durable et sûre en Afrique, des directives sur la transfusion sanguine doivent être mises en œuvre. Cette revue examine l'histoire de la transfusion en Afrique et les stratégies pour augmenter la disponibilité du sang en Afrique subsaharienne.

INTRODUCTION AND HISTORY OF TRANSFUSION

Blood transfusion is a therapeutic infusion of blood or blood components from one person to another. Clinical transfusion as we know it was rather unsuccessful until the 19th century and previous documented attempts at transfusion had tried to use blood from different animals as a donor source but this was largely not rewarding.¹ Transfusion of blood between humans was first performed by John Blundell in 1818² and repeated attempts were recorded in history. This was obviously because successful blood transfusion required both a good knowledge of the human vascular anatomy and the components of blood, both aspects of which took the scientific world a while to discern.^{2,3} William Harvey, in 1628, described human circulation and thus opened the gates for accurate venous access with regards to venesection and blood transfusion.⁴

The discovery of ABO blood group antigens by Landsteiner in 1901 and the anticoagulant, sodium citrate, by Lewinsohn in 1915 paved the way for the creation of the first blood donor services by Oliver Percy in London in 1921.³ Since then, improvements have been made in all aspects of transfusion with regards to screening of donors, anticoagulants used, compatibility testing as well optimal storage of blood and blood components.⁵ Therapeutic blood transfusion has continued also to be plagued by infections, reactions and lack of a good donor pool in some areas.^{5,6} Compatibility testing and the discovery of other red cell antigens helped to a large extent in explaining and reducing the occurrence of adverse effects of transfusion. The spectrum of infection risk kept changing over time with the emergence of new pathogens and this buttresses the need for

HISTORY OF TRANSFUSION IN AFRICA

Many ancient African and South American tribes venerated blood and had the notion that blood contained the spirit and essence of human life.⁷ Blood sacrifices both from animals and human beings were noted in history of different regions of Africa, this was felt to provide some cleansing or redemptive powers. The first recorded history of blood transfusion is that of Ibn al-Nafis an Arab Muslim physician who practiced Medicine in Egypt, and described the pulmonary circulation following Harvey's publications in 1242.^{1,8} Subsequently, following the end of the First World War transfusions were performed piecemeal in some regions of Africa in the early 1920s as a last resort between individuals with same blood group.^{9,10} Transfusions were later performed in well-resourced hospitals in Kampala, Nairobi and Dakar as documented by Luise White.^{9,11}

Several African countries have over the years evolved different strategies and policies to ensure provision of safe blood though these have mostly fallen short of the mark.¹² The Safe Blood for Africa™

Foundation was developed with an aim to provide a backbone for collaboration, upscale skills in transfusion medicine and advocacy across several countries in Africa. The World Health Organization (WHO) had earmarked the year 2012 as a possible date for Nigeria (and possibly Sub-Saharan Africa) to meet the demands for safe, available and sustainable transfusion needs using well implemented transfusion policies.^{11,13} In 2013 WHO recorded that 122 (73%) out of 167 countries had national policies on blood transfusion, out of which 41% and 64% of Low- and Middle-income Countries (LMICs), respectively, had a specific legislation in this regard [14]. More recently, studies by Loua et al., as well as other investigators, have shown that some progress has been made and 90.2% of the African countries investigated had a blood policy, while 73.2% had a national guideline on the clinical use of blood in their country.^{15,16}

TRANSFUSION POLICIES ACROSS SUB-SAHARAN AFRICA

The WHO Regional Committee for Africa resolved in 1994 to have member countries adopt policies which will ensure safe and adequate blood supply.¹⁷ These policies concentrated on adopting the use of altruistic VNRD as put forward by WHO, testing every blood unit for transfusion transmissible infections (TTIs), adhering and maintaining quality control and quality assurance in all the phases of blood collection, processing and storage; and adopting good clinical use of blood [18]. Another strategy which was employed in the African sub-region of the WHO is the centralised method of blood transfusion. This centralised system was noted to be financially more demanding and has not been sustained in many countries.^{19,20} Centralised blood system required an organised system of recruitment of VNRDs, collection and screening of donor units at the blood center and transportation of those units to the various nearby hospitals. Several countries lack infrastructure, skilled staff and financial backing to run a centralised system.^{21,22} In Malawi, a specialised system where family replacement blood donors were used was fashioned. This system proved successful because it has cultural acceptance in the region.²³ Another practice introduced in SSA was the establishment of National Blood Transfusion Services (NBTS) in various countries in Africa including Nigeria, Malawi, Mauritius and a host of others. In Nigeria, the NBTS was established to cater for the six geopolitical areas of the country. Recruitment of blood donors and screening for TTIs were done at the designated centers. These blood units are then made available to hospitals that are located within the region. The NBTS in Nigeria failed to live up to expectations due to lack of funding and irregular supply of reagents for screening of blood units.²⁴ In addition, sustenance of a VNRD pool was impractical since there was noted apathy towards voluntary blood donation in this region. Many people preferred donating blood for their family and friends only.^{11,12}

CONCEPT OF SAFE BLOOD: THE AFRICAN SCOPE

During the HIV pandemic in the 1980's, a great number of people contracted HIV following blood transfusion.^{26,27} Africa has the highest maternal mortality in the whole world, under five mortality from malaria burden is also high.²⁸ About 51% of all malarial deaths occurred in African region according to 2019 Report.²⁹ In addition, SSA accounts for majority of the countries with the highest maternal mortality of 200,000 maternal deaths per year. This figure sharply contrasts with mortality of 18 per year in North America and 8 maternal deaths per year in Europe.³⁰ Severe bleeding accounts for 44% of maternal deaths in SSA. Previous studies have revealed that mortality was 52% in children with severe anaemia who were not transfused within 8 hours and that 90% of them died within 2-5 hours of arrival to the hospital.^{31,32} These medical conditions often lead to anaemia with high blood transfusion needs. Outside the infection rate and death due to severe haemorrhage, Africa is fraught with many manmade disasters, unavailability of testing kits, scarcity of blood donors, poor funding by various governments- these factors contributed immensely to unhealthy blood bank practices in this region of the world.^{33,34} For these reasons, it became necessary to establish strategies and make policies on how to improve blood transfusion services in Africa in order to ensure the availability of safe blood in our various hospitals.³⁵

The regional strategy for provision of safe and continuous supply of blood and blood products was established in September, 2001 by the WHO Regional Office for Africa.³⁶ This strategy was established to ensure that member countries implement a quality assurance programme, ensure the proper clinical use of blood, promulgate a national blood transfusion policy that will effectively act to ensure compliance with the laid down rules including mandatory screening all blood units for HIV, Hepatitis B, Hepatitis C and Syphilis.³⁶ Many countries in Africa are at various stages of implementing the 'safe blood' policy.^{37,38} Mauritius is one country that has done remarkably well with implementation of the guidelines. About 86.2% of the blood donors in that country were voluntary non-remunerated donors (VNRDs) as of 2016, this figure increased from 60% in 2002. Mauritius has also embarked on use of nucleic acid testing as opposed to enzyme-linked immunosorbent assay (ELISA) that was previously in use and since 2010 has embarked on apheresis method of blood collection and separation. These developments have made transfusion medicine in Mauritius very safe.¹⁸

The concept of "safe blood" demands that there must be safety ensured all through the vein-to-vein transfusion process; from the donor to the recipient. This requires incorporation of high-quality donor recruitment and selection, infection screening, serological testing and rational use of blood and blood products. This concept was brought into transfusion practice by the WHO in 2016 and strategies aimed

at achieving this were rolled out by several countries.¹⁴ This was planned to motivate individual countries to set up national blood services to regulate and provide transfusion guidelines against on a background of their peculiar circumstances which can be adopted to suit their demands.^{14,18}

Red cell concentrate and whole blood remain the major blood products issued in SSA. This is unlikely to change in the near future due to lack of funds for obtaining and sustaining blood processing using apheresis or cold centrifuges. Most of the progress that were made in some parts of the region was due to external funding (PEPFAR) and now the funds are being withdrawn, many of the milestones gained have been lost.³⁹

FACTORS DRIVING BLOOD DEMAND

The WHO places blood transfusion in its list of essential medications. This is due to the fact it considers blood transfusion a life-saving therapy. To further buttress this point, the 21st edition of the WHO list of essential medication clearly states that globally, blood transfusions should be in keeping with the World health assembly resolution WHA63.12.⁴⁰ Thus, with respect to the afore mentioned resolution, the WHO expects that unless some adverse special circumstances prevent it, all nations of the world are expected to attain some levels of self-sufficiency with regards to supply of safe and affordable blood and blood components to its citizens using exclusively VNRDs. The urgency of maintaining such steady blood supply should be considered an important national goal.^{13,40}

Unfortunately, this is not the case with many nations in SSA, with their numerous socio-economic, political and leadership issues. The issues result in a chaotic, and a mostly insufficient and inefficient blood transfusion mechanisms that create a huge gap between demand and supply of blood and blood products. All these subsequently lead to poor health indices like high infant mortality and maternal mortality rates prevalent in these areas.^{11,41,42}

It is important that countries estimate the total blood requirements to effectively close the gap between demand and supply. The clinical drivers of blood transfusion and blood demand must be identified and isolated to estimate of the total blood requirements of a country.⁴¹

Factors that drive blood demand are heterogeneous and vary significantly, within and between High-Income and LMICs. They are best illustrated when the pattern of usage of blood and blood products in the two regions are analyzed. Demand for blood may be influenced by geographic, socioeconomic, quality of health care delivery and epidemiological factors. In countries of SSA, the following factors contribute immensely to the blood transfusion requirements; complications of pregnancy and childbirth like antepartum/postpartum

haemorrhage, puerperal sepsis, that results from poor access to quality health care delivery like antenatal care, use of traditional birth attendants, severe childhood anaemia from malaria and sickle cell anaemia which are endemic in SSA [43]. Others includes trauma from road traffic accidents due to poor public infrastructure and transfusions due to chronic anaemia. Micronutrient deficiencies prevalent in these regions is a common cause of chronic anaemia. A cursory glance at these drivers of blood transfusion demand in SSA shows that young children and women of reproductive age form the major segment of their population who use blood and blood products.³⁵ Previous research has shown that in most LMICs, 50% of blood products are usually administered to children below the age of 5 years. Special mention must also be made of increased demand that is occasioned by trauma as a result of conflicts and natural disasters.^{40,44,45}

In high income countries of the world, the vista with regards to blood transfusion demands are significantly different. Here, complex medical and surgical procedures such as cardiovascular surgeries, transplant surgeries, management of haematological malignancies and other forms of cancer care and trauma care form the major drivers of blood demand in these areas.^{41,41,44}

It is important to point out that the abovementioned model for estimation of blood transfusion requirements is not “one size fits all”, as other models exist. Countries should adapt existing models and develop models that suit their particular health care needs and is also aligned with their socio-political and cultural experiences. For example, a particular model used in specific target population may not be sensitive enough to capture the inherent peculiarities related to blood transfusion demands. Secondly, a dearth of data due to poor record keeping and databases might make such models difficult to apply in such regions. Absence of comprehensive databases has been the bane of efficient and effective blood transfusion mechanisms in SSA. Improvements in record keeping and data collection should be part of the strategies to improve blood transfusion in SSA.

DONOR AVAILABILITY: THE BANE OF AFRICAN TRANSFUSION PRACTICE

Blood donation in Africa remains at a low rate of 5 per 1000 population compared to 47 per 1000 in the United States.⁴⁵ WHO data collected from 40 out of the 48 countries in SSA showed that majority of the countries – 87.5% (35 countries) collected less than half of the blood needed to meet their transfusion demand. The median annual blood donation per center has been noted to vary from 1 300 in Low-Income countries to 4 100 in LMICs, 8 500 in Upper-Middle Income and 23 000 in High Income Countries.⁴⁵ This trend is most likely the effect of economic prowess or a general reflection of the organisational structure and governance in these countries or both. The WHO Global Status Report in 2016 reported that the

African sub-region contributed only 4% of the global supply. Within the years 2014 to 2016, Nigeria, Lesotho, Gambia and Ghana had a decline in blood supply while Ethiopia had a 40% increase in the number of VNRD.⁴⁶ The blood donation rate according to countries classification is as shown in **figure 1**.

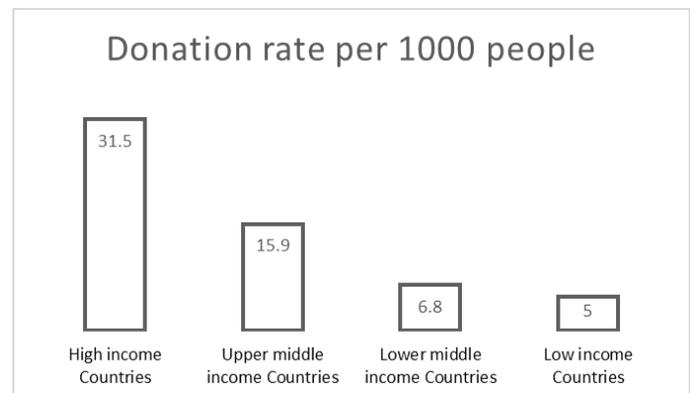


Figure 1: Blood donation rate per 100 people globally⁴⁵

The WHO has recognised three types of blood donors viz: voluntary non-remunerated donors (VNRD), family replacement donors and paid donors.¹⁴ According to WHO, the VNRD are the safest because they are altruistic and have the highest tendency to self-deferral when they are exposed to a risk of contracting transmissible infections. In SSA, majority of blood donors are family replacement donors.²⁵ These donors are also only willing to donate for family members or for their friends. Recent studies have found out that a greater percentage of these replacement donors are repeat donors who are also safe and thus should be allowed to be a source of blood donors in African sub-region.^{21,47} It is pertinent to note that enforcing the transfusion guideline should take cognizance of the culture and financial might of both the developing and developed worlds. Every country should be at liberty to develop a legal blood safety strategy that suits it culturally, economically and politically.⁴⁸ The distribution of VNRD in some countries in Africa is shown in **figure 2**.⁴⁹



Figure 2: The average proportion of voluntary non-remunerated blood donations in 46 countries of the WHO Afro Region in 2013.⁴⁹

CHALLENGES IN PROVISION OF ADEQUATE SAFE BLOOD IN SSA

The challenge of providing adequate safe blood to meet demands in SSA is multi-faceted and include; lack of transfusion policies in several countries, donor profile, poor health systems, lack of funding for implementation of programmes, insufficient skilled manpower lack of government commitment in some countries. The use of reliable, efficient and affordable screening methods for TTIs still remains a challenge in SSA.

The World Health Assembly in its resolution WHA.63.12 requested that all countries begin to use only VNRDs.⁴⁰ Another challenge in meeting the transfusion demands in SSA has been the prevalence of family replacement and paid blood donation. This has improved over the years though recent WHO reports shows that in 58 countries 50 of whom are from LMICs, more than 50% of blood donors are still not voluntary.¹⁴ There is need to aim to convert family replacement donors to VNRDs. In SSA sub-optimal provision of donor blood to meet transfusion demands is due to several challenges in the various steps from lack of advocacy and political will to misconceptions and false cultural beliefs as regards blood.¹⁶

Another aspect is unavailability of screening tests and adequate storage facilities as blood storage requires constant power supply which may not be constant in some regions or rural locations.

Limiting wastage by production of blood components and use of blood components for transfusion instead of whole blood would serve to maximise the available blood units collected. Only 58% of blood collected in low-income countries was processed to blood components, 66% in LMICs, 97% in high-middle income countries and 91% in high income countries. With regards to plasma-derived medicinal products (PDMP), of the 173 countries 83 countries imported all their PDMPs while in 24 countries these PDMPs were not used.^{41,50} All these can be overcome with little difficulty once a national blood policy has been put in place with a firm political will to support provision of safe blood. Hitches in implementation may be encountered due to paucity of funding, lack of manpower and presence of traditional misconceptions surrounding blood and transfusion.

STRATEGIES FOR INCREASING AVAILABILITY

Over time some countries have made a remarkable improvement in increasing their donor pool and availability of safe blood. Lessons can therefore be learnt from the successes in these climes. In 2005 the WHO World health assembly WHA 58.13 encouraged all countries to establish or strengthen recruitment and expansion of a VNRD database to ensure safe and adequate blood supply to meet transfusion

demands.⁵⁰ To achieve this, important strategies that have been outlined by WHO learning from countries with 100% VNRDs who were able to meet up with transfusion demands. Mauritius had increased their donor supply from 26.3 to 34.2 per 1000 and their percentage collections from VNRDs from 60% to 82.5%, between 2004 and 2016 by adopting and implementing these WHO directives.¹⁸

The role of advocacy is vital in the success of any transfusion policy. This must involve advocacy with partner, government, media, agencies and groups involved in all aspects of healthcare. This has to be continued and sustained at all levels of healthcare and government structure.^{42,51,52} Advocacy will only yield fruits if the community and government are convinced the mutual benefits of the success of this programme bearing in mind that transfusion practice needs the community and vice versa.^{20,51} Prominent people in the community and celebrities can be coopted to champion this in order to make for better public appeal and acceptance. This will help to also dispel myths and misconceptions and encourage many volunteers who have been known to donate blood for altruistic reasons.

Establishment and strengthening of national blood transfusion programme is necessary for central coordination and database capture of all recruited VNRDs. This will ensure retention, efficiency and cost-effectiveness in managing donations.⁵¹ Organisations like the National Red Cross or Crescent Society have some formal responsibility in helping with donor recruitment in several countries where they function and should be collaborated with.^{50,53} The integrity and competence of the national transfusion programme in each country is important as public profile and image of the programme will to a large extent determine its success.⁵⁴ The organisational structure of the transfusion programme may be broken down into different levels especially in countries with a large population and geographical land mass. This will require efficient coordination between sites as well as with the central programme coordinating unit. There will also be need to strategise to handle upcoming infection risks as well as update practice in order to keep up public acceptance and deliver quality and safe blood where and when needed.⁵⁵ Realistic goals and methods of monitoring progress in the various aspects of the programme should be established. These must all be enshrined in the constitutional and ethical framework of health service of each country. This will serve to ensure continuation and protect the national transfusion policy from political 'turbulence' and wavering government will or support.

THE FUTURE OF BLOOD TRANSFUSION PRACTICE IN AFRICA

The current state of affairs with regards transfusion policies and practices amongst some African countries needs to be improved. Targeted strategies and plans will include setting up national

transfusion policies which will guide transfusion practice, patient blood management programmes, as well as provide a framework for future improvement. SSA will also benefit from the use of institution-based transfusion committees which will set guidelines to guide and monitor transfusion practice within closed communities as well as document adverse transfusion reactions. There is a need for development of hospital linkage system where tertiary hospitals with better equipped transfusion services recruit blood donors, screen the blood units and transport same to smaller and less equipped nearby hospitals. The hospital linkage system ensures availability of blood units, mandatory screening for TTIs and maintenance of quality assurance.

Haemovigilance practice was observed to be lacking in previous studies on transfusion practice in Africa.^{56,57} This will involve training of health workers on best practices in various aspects of transfusion medicine; blood donation, screening transportation, storage and transfusion as well as monitoring and documenting adverse reactions.^{56,58}

Advocacy will require special attention at various levels of governance in order to achieve and sustain desired goals.

Africa should target achieving 100% of safe blood available at all locations by the year 2030. This is an achievable goal once commitment, partnership and the political will is obtained.

Future areas of transfusion research will involve investigating modalities of transportation and storage of blood and blood components in rural communities where power supply may be difficult as well as areas which are far to reach. Current transfusion practice generally requires the presence of trained medical personnel, effort should be made to train community health workers on how to detect severe anaemia and different alternatives that can be utilised while awaiting blood. This is necessary to bridge the observed time gap from presentation to transfusion as this would ultimately reduce mortality.

CONCLUSION

Transfusion practice has evolved remarkably throughout the centuries. Adequacy in terms of blood safety and availability has been achieved in most high- and medium-income countries. A huge gap exists between demand and supply of blood and blood products in SSA. Strategies to bridge this gap has been proffered by WHO and has been adopted for use in most African countries. Implementation of these strategies still remains a challenge and demands advocacy, institutionalizing of transfusion policies and massive awareness campaigns. Strategies to achieve safety will involves optimizing haemovigilance processes as well as infection screening. These measures will ensure that maternal and infant health as well as overall wellbeing is maximised.

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