

Original article

Availability and safety of blood for transfusion in three districts in Malawi

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Abstract:

Objective: Since its establishment in 2003, the Malawi Blood Transfusion Service (MBTS) has co-existed with an earlier decentralised hospital-based system for collecting, testing and distributing blood. The aim of this study was to assess the availability of blood for transfusion in Malawi and explore the challenges facing the current dual system of blood supply.

Methods: A survey of all hospitals (8 hospitals) in three districts in Central Malawi.

Results: MBTS provides two-thirds (66.7%) of the blood used by hospitals, and the hospital-based system provides the other one-third. MBTS centrally tests blood for HIV (ELISA), hepatitis B virus (HBsAg), hepatitis C virus (anti-HCV), syphilis and malaria parasite, and uses standard operating procedures (SOPs) to prevent errors. The hospital-based system does not routinely test for hepatitis C virus and malaria but routinely tests for HIV (rapid tests), hepatitis B virus (HBsAg), and syphilis. The major challenges faced by this dual system include poor communication, inadequate knowledge of the availability and clinical use of blood, difficulties recruiting and retaining donors, difficulties distributing blood, high prevalence of HIV and costs of running the two systems.

Conclusions: The nationally coordinated centralised system provides high quality blood which is insufficient to meet demand and the hospital-based system supplements the deficit in blood supply by providing blood which is not routinely screened for all transfusion-transmitted infections. Both the centralised and decentralised systems of blood transfusion will continue to co-exist until the transition period is over. It is important that the hospital-based system be operated according to the same quality standards as the centralised system and that some form of regulatory control be put in place.

Keywords: blood safety; availability of blood; blood transfusion; transfusion-transmitted infections; Malawi

INTRODUCTION

In most developing countries of Africa the blood transfusion system is decentralised in individual hospitals. In these countries blood is obtained from family members and friends of the patients who need transfusion. The potential donors are screened in the local hospital for transfusion-transmitted infections (TTIs). The hospitals usually provide the “basic adequate” transfusion services defined by the World Health Organisation (WHO) as screening of donors for human immunodeficiency virus (HIV), hepatitis B virus and syphilis, and determining the blood groups and cross-match compatibility of donor and recipient samples [1, 2]. This decentralised system has been criticised because the system is not properly organised, it is increasingly difficult to ensure blood safety in an era where HIV epidemic is spreading rapidly, people are reluctant to give blood and

transfusion-transmitted infections are high. This is especially true when one looks at WHO statistics: transfusion or injection of unsafe blood accounts for 8-18 million hepatitis B virus infections, 2.3-4.7 million hepatitis C virus infections and 80 000-160 000 HIV infections each year [3].

In 2000 the WHO launched a blood safety initiative to increase the availability and safety of blood in developing countries. This initiative focuses on the establishment of nationally coordinated transfusion services, collection of blood from low risk non-remunerated donors, screening of donated blood for HIV, hepatitis viruses, syphilis and other infectious agents, and reduction of unnecessary transfusion through appropriate use of blood and blood products [4]. Therefore, one of the major activities of this initiative is to replace the traditional decentralised transfusion systems with centralised systems where transfusion services are nationally coordinated. Malawi is one of the countries that

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have established a national blood transfusion service according to WHO recommendations and guidelines.

The Malawi Blood Transfusion Service (MBTS) was established in 2003 with a head office in Blantyre. The goal of MBTS is to provide a safe and adequate supply of blood and blood products (packed red cells, fresh frozen plasma, platelets and cryoprecipitate) and prevent the spread of HIV and other diseases transmissible by blood transfusion [5]. Two centres are operational, one in Blantyre and another in Lilongwe. It is a centralised system where blood is collected from low risk, non-remunerated volunteers, tested, stored and distributed to health facilities nationwide. MBTS has eight mobile blood donor teams that go out to schools, colleges, places of worship and workplaces on a daily basis to conduct blood collection activities. Blood donor recruitment campaigns and blood collection sessions take place on a daily basis in the southern and central regions of Malawi [5]. MBTS has a cold chain system to ensure proper storage and transportation of blood and blood products to users at various hospitals. There is also a quality management system to ensure quality planning, quality assurance and quality control. Collected blood is tested for HIV using ELISA (p24 antigen and antibodies for HIV 1&2), hepatitis B surface antigen, hepatitis C (anti-HCV antibodies), syphilis (TPHA) and malaria parasite (blood films) [5]. P24 antigen, hepatitis C and malaria were not routinely tested for in donated blood before the establishment of MBTS.

However, the MBTS is not currently able to provide the total amount of blood required by the health facilities. Therefore, in addition to the blood received from MBTS, some hospitals still continue to collect, test, and store blood at the facility level. For a long time, hospitals in Malawi had relied on family replacement blood donors whereby the hospitals asked patients' guardians to look for family members to come to the hospital to donate blood for the sick relative or friend. This system was found to be inadequate because time is wasted in the process of looking for donors, getting them to hospitals, testing for their blood groups, testing for infectious agents, and conducting blood a donation session [6]. The MBTS was born to address these challenges. Since the MBTS is not able to provide adequate supply of safe blood to hospitals, the two systems co-exist side by side.

To the best of our knowledge little is known about this type of dual system of blood supply. It is not known how the two transfusion systems (decentralised hospital-based system and centralised national system) relate to each other. Is there an effective communication linking the two transfusion systems? Is there a need for a dual system at all? There is currently insufficient data about the effectiveness

of this dual system to meet the demand for blood in the hospitals. We assessed the availability and safety of blood in three districts in Malawi and explored the challenges faced by this dual system of blood supply in order to inform policy makers who are unable to make evidence-based decisions on which type of blood transfusion service to establish.

METHODS

Data were obtained from the Malawi Blood Transfusion Service (MBTS) and from all hospitals that provide blood transfusion services in three districts of Malawi (Lilongwe, Kasungu and Salima). The population of the three districts is estimated at 2,812,183 and there are 127,000 deliveries per year of which 40% take place in the health facilities (hospitals and health centres). A third of the blood used in these districts goes to the maternity units.

There are a total of eight hospitals that provide blood transfusion in the three districts and all the eight hospitals were included in this survey. The eight hospitals included one hospital in Salima, one hospital in Kasungu and six hospitals in Lilongwe. The two hospitals in Salima and Kasungu were district hospitals and the six hospitals in Lilongwe included one tertiary referral hospital, one tertiary referral maternity hospital, and one community hospital and three mission hospitals. Lilongwe does not have a district hospital but it has many hospitals because of the dense population in the capital city. Data was collected from the three hospitals about blood requirements, availability of blood bank fridge, availability of back-up electricity supply and pre-transfusion tests carried out for a period of three months (October, November and December 2006).

The laboratories of the eight hospitals were visited and the person in-charge of the blood bank was interviewed about the hospital blood requirements, blood availability, sources of blood used in the hospital, blood testing, availability of a back-up electricity supply, availability of a thermostatically controlled blood bank fridge and the use of standard operating procedures (SOPs). WHO currently recommends that to ensure blood safety each blood bank must have written SOPs for each procedure to prevent errors which may arise from verbal communication only. The SOPs provides a complete set of instructions about how to perform a certain task and contains a written description of the procedure. Direct observation of blood bank registers, equipment and supplies was used to validate information from the person in-charge of the blood bank. This information was entered in an assessment tool developed for the purpose.

The MBTS was visited and secondary data obtained on

the number of units of blood requested per hospital and the number of units of blood supplied by the MBTS from January to December 2006.

A workshop was then organized in Lilongwe (Malawi) and brought together the hospital laboratory and maternity staff, and staff of the MBTS including the Chief Executive Officer (CEO) of MBTS. The aim of the workshop was to enable staff from the hospitals and MBTS to share their experiences, learn from each other and understand the challenges facing the dual system.

Data were entered and analysed using the Excel software. The results are presented in tables as absolute values or percentages.

The study was approved by the Reproductive Health Unit of the Malawi Ministry of Health

RESULTS

Availability of blood

Hospital data

Two hospitals obtain their blood entirely from the MBTS, while two others obtain their blood entirely from donors at the facility level. The rest of the four hospitals,

however, obtain blood from a combination of two sources: MBTS and donors at facility level. Between 15% and 30% of this blood goes to the maternity units, except in Bwaila Hospital which is a tertiary obstetric hospital and where all blood goes to the management of obstetric complications (Table 1).

Overall, the eight hospitals consume 595 units of blood per week and 66.7% (397/595) of this comes from the MBTS.

MBTS data

The MBTS supplied 7,007 units of blood and blood products out of 8,076 requested between January and December 2006, thereby providing 86.8% (7,007/8,076) of the demand for blood (Table 2). Only the Kamuzu Central Hospital (a tertiary referral hospital) showed a consistent use of other blood products such as packed red cells, fresh frozen plasma, platelets and cryoprecipitate. Details of blood requested against blood issued by MBTS in 2006 are shown in table 2.

Looking at data from hospitals and MBTS, it was clear that the number of units of blood requested by hospitals from the MBTS was less than the units they require, and

Table 1: Blood availability and safety in eight hospitals in three districts of Malawi (Lilongwe, Kasungu and Salima).

	Hospital 1 ^a	Hospital 2 ^a	Hospital 3 ^b	Hospital 4 ^b	Hospital 5 ^c	Hospital 6 ^c	Hospital 7 ^c	Hospital 8 ^c
Weekly blood transfusion requirement (in units)*	225	70	100	70	40	30	30	30
Proportion of blood obtained from MBTS in three months*	225/225 (100.0%)	70/70 (100.0%)	40/100 (40.0%)	30/70 (42.9%)	17/40 (43.5%)	15/30 (50.0%)	0/30 (0.0%)	0/30 (0.0%)
Proportion of blood used in maternity in three months*	68 (30.2%)	70/70 (100%)	25/100 (25.0%)	18/70 (25.7%)	6/40 (15.0%)	8/30 (26.7%)	8/30 (26.7%)	8/30 (26.7%)
Blood bank fridge is available	Yes	No	Yes	Yes	Yes	Yes	No	Yes
Back-up electricity supply is available	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pre-transfusion tests	HIV (ELISA) HBsAg Anti-HCV Syphilis Malaria (by MBTS)	HIV (ELISA) HBsAg Anti-HCV Syphilis Malaria (by MBTS)	HIV (rapid) HBsAg Syphilis Malaria	HIV (rapid) HBsAg Syphilis Malaria	HIV (rapid) HBsAg Syphilis Malaria	HIV (rapid) HBsAg Syphilis Malaria	HIV (rapid) HBsAg Syphilis	HIV (rapid) HBsAg Syphilis
Catchment population	105,322		92,868	62,500	200,000	150,000	35,000	33,417
Average number of Caesarean sections per year	220	900	484	416	432	368	100	396
Average number of deliveries per year	2,368	14,716	3088	1104	2788	1648	2248	508
Number of laboratory technicians	8		2	2	2	4	1	2
Total number of hospital beds	831	220	179	148	150	200	230	150

* October, November and December 2006

^a Tertiary referral hospital

^b District hospital

^c Christian Hospital Association of Malawi (CHAM) hospital

Table 2: Blood & blood products requested vs supplied to the eight hospitals in three districts of Malawi (Lilongwe, Kasungu and Salima) from January to December 2006 (data from MBTS)

Hospital		WB	PRC	PLAT	FFB	CRYO	Total
Hospital 1 ^a	Requested	4895	603	255	815	137	6705
	Supplied	3429	1203	241	804	137	5870
Hospital 2 ^a	Requested	459	11	0	0	0	470
	Supplied	363	13	0	0	0	376
Hospital 3 ^b	Requested	154	7	0	0	0	161
	Supplied	120	17	0	0	0	137
Hospital 4 ^b	Requested	195	5	0	0	0	200
	Supplied	155	6	0	0	0	167
Hospital 5 ^c	Requested	134	1	0	0	0	135
	Supplied	114	3	0	0	0	117
Hospital 6 ^c	Requested	399	3	0	0	0	402
	Supplied	324	5	0	0	0	337
Hospital 7 ^c	Requested	3	0	0	0	0	3
	Supplied	3	0	0	0	0	3
Hospital 8 ^c	Requested	0	0	0	0	0	0
	Supplied	0	0	0	0	0	0

WB = whole blood; PRC = packed red cells; PLAT = platelets; FFB = fresh frozen plasma; CRYO = cryoprecipitate

^a Tertiary referral hospital

^b District hospital

^c Christian Hospital Association of Malawi (CHAM) hospital

this gave the false impression that the MBTS was providing 86.8% of the hospitals' blood needs. In fact, the MBTS provided 86.8% of blood requested by hospitals, and this request was lower than their needs.

Blood safety

The two tertiary hospitals obtain their blood entirely from the MBTS after it has been screened for transfusion-transmitted infections. Two mission hospitals do not get any blood from MBTS and obtain their entire blood requirements by collecting blood from donors at facility level and screening the blood for HIV (rapid tests), hepatitis B virus, and syphilis. These two hospitals do not screen for malaria. Four hospitals obtain the blood from the two systems of blood transfusion service namely, the MBTS and hospital-based collection of blood. None of the six hospitals that collect blood at facility level currently screen for hepatitis C virus. All hospitals have back-up electricity supply. Six of the eight hospitals have thermostatically controlled blood bank fridges to maintain blood within the recommended temperature range (2 °C-6 °C) [4]. None of the hospitals use standard operating procedures (SOPs).

The MBTS screens for hepatitis C virus (Anti-HCV antibodies). The MBTS in addition to the serological tests conducts antigen testing for HIV. The MBTS screens for HIV using the ELISA test (p24 antigen and antibodies for HIV 1&2) to reduce the window period between HIV infec-

tion and sero-conversion. The MBTS has back-up electricity supply and a cold chain system to ensure proper storage and transport of blood to hospitals. The MBTS uses standard operating procedures (SOPs) to prevent errors and ensure that safe blood is provided to hospitals.

Similar diagnostic kits were used in different hospitals. Malaria was screened using microscopy of thick peripheral blood film for malaria parasites. HIV testing was conducted according to the recommended national guidelines using Determine and Unigold antibody-based spot tests [7]. Simple rapid assays were used for HBsAg (Serodia HBsAg Particle Agglutination [PA] method, Tokyo, Japan) and anti-HCV (Serodia HCV PA method, Tokyo Japan) and rapid plasma reagin (RPR) test was used to screen for syphilis.

Challenges to obtaining adequate safe blood

Staff from hospitals and MBTS met at a workshop in Lilongwe (Malawi) to share their experiences, learn from each other and discuss the way forward. Some major challenges to obtaining adequate safe blood were identified during the workshop.

- Most hospitals tend to request less blood from MBTS than they require. This gives the false impression to the MBTS that the need for blood transfusion is met. For example, in Salima District Hospital the blood requirement per week is about 70 units. The hospital requests only 30 units of blood per week from MBTS

and about 15-20 units are supplied by the MBTS following the request. A communication problem was identified between the MBTS and hospitals as the MBTS was not aware that hospitals tend to request less blood than they need and the hospitals were not aware of how much effort the MBTS was making to meet their blood requirements.

- Many hospitals do not request other blood products because of limited knowledge of their existence as well as limited knowledge on the clinical use of these products. The hospital staff observed that they had recorded many cases of maternal deaths from severe anaemia and congestive heart failure following whole blood transfusion when the patients ought to have received packed red cells instead. There are national guidelines on blood transfusion, which however are not widely accessible to the providers in the facilities.
- The MBTS depends on students for blood donation. Continuity of blood supply is not ensured especially during examination periods and during holidays when students return to their homes. During these periods the MBTS frequently runs short of blood. For example, during the period of this survey Kamuzu Central Hospital had been without blood for a week because students were on holidays. Similarly, Likuni Hospital had not received blood from MBTS for two weeks during the time of data collection for this study.
- Despite potential economies of scale, a unit of blood in a centralised transfusion system costs three times as much as one from a decentralised hospital-based system. Therefore a centralised blood transfusion service such as the MBTS is not financially accessible. In Malawi the cost per unit of blood in a decentralised hospital-based system is US \$16.28, compared to US \$56 in a centralised blood transfusion system [2]. The high cost in a centralised system is partly due to donor recruitment and partly due to quality management systems. This cost is hidden in a decentralised system because it is borne by the family.
- The MBTS has difficulties recruiting and maintaining donors, especially as there are only two centres serving the whole country. There are also difficulties in distributing blood throughout the country, especially to the northern region as the two functional centres are located in the southern and central regions.
- The current high prevalence of HIV (estimated at 12% in the general population) limits the number of potential donors (i.e. low risk groups) from which safe blood can be collected [8]. Currently only students and young males have been identified as low risk groups for blood donation [9].
- When blood is collected it has to be stored in a specially designed blood bank fridge with temperature maintained at 2°C-6°C [1]. Two of the eight hospitals do not have these fridges, meaning that they cannot store blood effectively. Blood cannot be safely stored in domestic fridges for more than one week [9].
- The maternity staff declared that traditionally they only request one or two units of blood from the laboratory. The tradition developed when the clinicians realised that the laboratory delivered a maximum of two units of blood for each patient, irrespective of the amount requested. Therefore the actual hospital need of blood is not documented. What is known is the actual demand which is lower than the true need. The junior staff who did not know how this tradition developed were surprised that one could request more than two units of blood. This practice contributed partly to the high maternal mortality from postpartum haemorrhage (PPH). The case fatality rate for PPH (i.e. proportion of women with PPH who die) for the year 2006 was 10.0% in Kasungu District Hospital, while the United Nations currently recommends a case fatality of <1% for all emergency obstetric complications [10].
- One major challenge is the availability of resources. The MBTS was initially funded for 5 years by the European Union (2001-2006). In 2006 a three year extension to provide funding mainly for construction of the Blood Transfusion Centres was made. The funding is now being phased out, and the Malawian Government and other partners will have to increase contribution to the running of the MBTS [6].

The MBTS has not been sleeping in the face of these challenges. It responded to the shortage of donors due to holidays by organising youth blood donor days, national blood donor months, periodic campaigns, district campaigns and Club 25 (where young people 16-25 years pledge to make at least 25 blood donations during their life time) [9]. The MBTS has also responded to the lack of knowledge about blood products by organising workshops to train participants on the clinical use of blood and blood products [5].

DISCUSSION

This paper describes the availability and safety of blood for transfusion in hospitals in Malawi where a centralised blood transfusion system exists alongside a decentralised hospital-based system. The major challenges of this dual system include poor communication between the centralised and decentralised blood transfusion services, inade-

quate knowledge of the availability and clinical use of blood/blood products, few or no alternatives to whole blood, lean periods (such as holidays), difficulties recruiting and retaining donors, difficulties distributing blood from two centres to hospitals throughout the country, high prevalence of HIV, lack of storage facilities, costs of running the two systems, and failure to test hepatitis C virus in blood collected in hospitals.

It is obvious that in terms of quality a centralised blood transfusion system is better than a hospital-based system. The centralised system collects blood from low risk, non-remunerated volunteers and maintains a high quality control system. The use of volunteers rather than family members or friends reduces the risk of transfusion-transmitted HIV infections, especially where the prevalence of HIV is high [11]. Under the centralised system, patients are screened for hepatitis C virus which is generally not screened for in hospital-based systems. The importance of screening for transfusion-transmitted infections should not be underestimated especially as the prevalence of markers of these infections is high in sub-Saharan Africa: 0.5-16% for HIV, 3-22% for hepatitis B virus, 2-7% for hepatitis C virus and 1-21% for syphilis [12-15]

Blood supplies in Africa have never been able to meet the demand, a fact evidenced by the high maternal and child mortality rates [16]. This reflects the failure of the hospital-based systems that are prevalent in Africa and the centralised systems are seen as a way of improving blood supply. Both quality and quantity are crucial when it comes to blood transfusion; we can go neither for more blood of poor quality nor for less blood of high quality. Neither the centralised nor the decentralised hospital-based system has proved satisfactory in terms of quality and quantity in sub-Saharan Africa. The centralised system is capable of providing high quality blood which is often insufficient and the

hospital-based system neither guarantees quantity nor quality of blood supplied.

Studies that evaluated the laboratory costs of a unit of blood in sub-Saharan Africa have concluded that the centralised system costs are higher than costs in decentralised hospital-based systems [2, 17, 18]. The high cost has been attributed to the costs of recruiting and retaining donors and the cost of maintaining a high quality management system. The cost of recruiting donors in a hospital-based system is hidden because it is borne by patients and their families.

The two blood transfusion systems – hospital-based and centralised systems – are in reality two ends of a spectrum of transfusion models. The characteristics of these two systems are presented in table 3. None of these models is optimal for Malawi and poor countries with similar socio-economic profiles [2]. Malawi has joined other countries such as Kenya and Cote D'Ivoire operating a hybrid model which combines a hospital-based decentralised donor system and a centralised nationally coordinated system [15, 19]. African countries are under increasing pressure from international organisations to adapt this centralised model although there is currently no evidence that the model is suitable for poor countries.

Despite the difficulty of establishing a centralised blood transfusion system in Malawi and other sub-Saharan African countries, some countries such as Zimbabwe have been successful. The Zimbabwe model has been used by proponents of the centralised model of blood transfusion system to demonstrate how the model can work in African countries. However, it is worth noting that the model worked in Zimbabwe because of a good network of roads and telephones as well as vehicles and fuel to distribute blood collected centrally to the hospitals [1]. In some countries in sub-Saharan Africa, rural hospitals may be cut off from the capital city for several weeks during heavy rains

Table 3: Comparison of the centralized and decentralized blood transfusion systems in Malawi

	Decentralised system	Centralised system
<i>Coordination</i>	Hospital level	National/regional level
<i>Donors</i>	Family members/friends	Non-remunerated volunteers
<i>Cost</i>	\$16.28	\$56.00
<i>HIV test</i>	Rapid test	ELISA
<i>Hepatitis B test</i>	HBsAg	HBsAg
<i>Hepatitis C test</i>	Not done	Anti-HCV
<i>Syphilis test</i>	Routine	Routine
<i>Malaria test</i>	Not routine	Routine
<i>SOPs</i>	None	Use SOPs to prevent errors
<i>Optimal for Malawi</i>	No	No
<i>Supported by WHO</i>	No	Yes

SOPs = standard operating procedures

that cause muddy and poor road conditions aggravated my poor states of vehicles. In most of these countries electricity supply is unreliable and the rural hospitals generally do not have a back-up generator. In these countries a central blood bank model is not optimal, and this explains the spontaneous development of hybrid models whenever a centralised system is introduced.

The World Health Organisation estimates that 5-10% of HIV infections in developing countries are due to blood transfusion [20]. One study reported that in the Democratic Republic of the Congo, an estimated 25% of paediatric HIV infections, and 40% of infections among children over one year of age, were due to blood transfusion [21]. Moore and colleagues reported HIV prevalence among blood donors of 6.4% in Kenya and found that 26 HIV positive donations (out of a total of 1290 donations) were given to HIV negative patients [22]. They then estimated that 2.0% of blood transfusion led to HIV transmission in Kenya.

One limitation of this study is that hospitals surveyed were all from the Central Region of Malawi and this might not properly reflect the situation in the rest of the country. This is particularly true for the Northern Region which depends on the MBTS centres located in the Central and Southern Regions for their blood supply.

The long-term goal of Malawi Government is to completely replace the existing decentralised hospital-based services with the centralised blood transfusion services. This period during which both services exist is considered a transition period. Until the transition period is over and the MBTS is capable of providing the blood requirements for the entire country, the hospitals will continue to collect blood from donors to supplement the blood received from the MBTS. It is important that each hospital identify its needs for blood as accurately as possible and request exactly what it needs from the MBTS. It is also vital that during this transition period the hospital-based blood banks operate to the same quality standards as the centralised blood service and that there is some form of regulatory control put in place. In addition, it is essential that all blood donors are truly volunteers and non-remunerated. There is also a need to raise awareness on the different blood products available in the MBTS. Training on the use of blood and blood products is essential to make full use of the services provided by the MBTS. Alternative ways of recruiting and retaining donors with MBTS should be sought. Equitable distribution of blood and blood products from the MBTS needs to be complemented by a clear distribution system and policy.

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COMPETING INTERESTS

None declared

AUTHORSHIP STATEMENT

EJK conceived the topic, designed the study, wrote the protocol, collected and analysed the data, and wrote all versions of the manuscript. NVDB reviewed the final manuscript for important intellectual content. Both authors read and approved the final copy. EJK is the guarantor.

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