



Determinants of Blood Discard at the Muhimbili National Hospital Blood Donation Center Dar es Salaam, Tanzania

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Abstract

Background: Blood and blood products are scarce resources worldwide, with Sub-Saharan African countries being the region most affected due to the lack of adequate funding for blood safety programs. In addition to low blood donation rates, blood discard has an essential impact on the blood supply and financial stability of the blood centre due to wastage. This study was conducted to determine factors contributing to blood discarding following donations at the Muhimbili blood donation centre.

Methods: We conducted a cross-sectional study at Muhimbili National Hospital's blood donation centre for three months. During the study period, 1200 donated blood units at the centre were monitored. Data were collected using a checklist, and frequencies were compared using a statistical package for the social sciences (SPSS) version 23.

Results: The overall leading cause of blood discard was Transfusion-Transmissible Infections (TTIs), with Hepatitis B virus infection accounting for 4.8% of total blood discard, followed by cold chain failure, which contributed 2.7% of the total discarded.

Conclusion: Hepatitis B infection was the leading cause of blood discard among TTIs, whereas cold chain failure contributed to blood discard among non-TI reasons.

Keywords: Blood, Blood discard, Transfusion Transmissible Infections

Introduction

Blood and blood products are scarce resources worldwide, with Sub-Saharan African countries being the most affected region due to lack of adequate funding for blood safety programs (Loua *et al.* 2018). To meet blood demands, the World Health Organization (WHO) recommends each member state have a minimum of 10 donations per 1000 individuals per year and the WHO global status report on blood safety and availability 2016 reported 5.6 whole blood donations per 1000 individuals in African regions compared with 26.5 donations per 1000 individuals in Europe (WHO.2016).

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In Tanzania, blood safety is centrally coordinated by the National Blood Transfusion Service (NBTS), a program under the Ministry of Health. The role of the NBTS is to ensure an accessible and adequate supply of safe, high-quality blood and blood products by providing guidelines to safeguard both blood donors and recipients. To meet quality standards, blood should be collected from Voluntary Non-remunerated Regular Blood Donors (VNRBD) per standard operating procedures (SOPs), processed, stored, and transported under optimum temperature (NBTS. 2021, unpubl).

Blood should be collected from a healthy donor, and to maintain vital properties and function, it must be cooled towards +10°C during transportation. Depending on blood components, storage temperature varies, whereby whole blood and packed red blood cells (PRC) are stored at +1°C to +6°C; if this temperature is not maintained, red cells' oxygen-carrying ability is significantly reduced (AfSBT.2017). Platelets should be kept at room temperature between +20°C and +24°C for a maximum of five days, and fresh frozen plasma (FFP) should be kept at -30°C and below (AfSBT.2017). Under standard procedures, about 450ml of blood should be collected in a plastic bag containing 63ml of anticoagulant preservatives to maintain vital blood function (WHO.2013, WHO.1995). The NBTS follows WHO guidelines; in our setting, all donated blood is screened for Human Immunodeficiency Virus (HIV), Syphilis, Hepatitis B (HBV), and Hepatitis C (HCV) as a minimum requirement (NBTS.2021, unpubl).

Multiple factors contribute to blood discard when standard operating procedures are not adhered to. These factors are categorized into Transfusion Transmissible Infection (TTIs) and non-TTIs factors. TTIs are infections that are transmitted via transfusion of infected blood and blood products. The non-TTIs related factors may result from traumatic draws leading to hemolysis, inadequate mixing with anticoagulant leading to blood clotting, delay in centrifugation to separate the blood components and storing blood at an incorrect temperature. Other factors are being overweight, underweight, improper labeling, and expiring blood products before use.

To minimize blood discard risk, pre-donation services include health check procedures where general health is assessed and risk for acquisition of TTIs using blood donor questionnaire is done to all eligible blood donors through pre-donation counseling. Blood donors with higher risk due to behavioral factors, previous risk exposure, or infections are deferred from donating blood. During blood donation some SOPs are used to monitor the blood donation process which includes blood volume monitoring, timing and mixing of blood and cold chain maintenance. Upon arrival to the testing laboratory, blood is screened for TTI's, blood weight measured, temperature monitored and hemolysis measured (NBTS.2021, unpubl, NBTS.2015, unpubl).

It has been shown that the common causes for blood discard include the presence of positive TTI's markers (HIV, Hepatitis B, Hepatitis C, syphilis). Other factors include clots in a blood unit, insufficient quantity collected, hemolysis, expiration, leakage of the blood bags, improper storage and transportation of blood outside optimal temperature (Mathias.2021, Josephine. 2019, Morish.2012). The NBTS 2019/2020 annual report (unpublished) showed that approximately 15.4% of collected blood units were discarded due to several similar factors (NBTS.2020, unpubl). The discard of donated blood has essential impact on blood supply and financial stability of the blood center due to wastage not only of blood units but also of the used blood bags. Findings from this study will enable the MNH administration to address the causes of blood discard and improve safety of both blood donors and blood recipients. Understanding the causes of blood discarding at the center will inform on the areas that need to be addressed to reduce blood wastage. The primary purpose of this study was to determine factors contributing to blood discard at the Muhimbili National Hospital (MNH) donation center.

Methodology

Study design and setting

This was a cross-sectional study that was done for a period of three months, from May to July 2022, at the MNH blood collection center. The Muhimbili blood collection center is a satellite center under the Eastern Zone Blood Center located in Dar es Salaam. It performs blood safety activities, from donor recruitment to blood collection, screening, processing, storage, and distribution. The blood center performs both mobile blood collection and fixed-site donation and receives both voluntary blood donors and family replacement blood donors. In this study, we only included units donated at fixed site.

Inclusion and exclusion criteria

All blood units that were collected at the center were included in the study. We excluded blood units, which were collected from the mobile collection, and units that were transferred from other regions.

Sample size and sampling

We used a convenient sampling method where all blood units that were donated at the center were included in the study. During the study period, a total of 1350 blood units were received at the blood transfusion laboratory; of these, 150 units were excluded because 96 units were brought from Dodoma region; all were safe units and 54 were collected from the mobile collection. Therefore, 1200 units were analysed in this study.

Assessment of blood discard due to non TTIs causes: All blood units were assessed for compliance with quality requirements, including cold chain maintenance, lipemia, blood volume, clotting, hemolysis, leakage and expiry.

Hemolysis: Donated blood units were checked for the presence of hemolysis the units that were macroscopically suspected to have hemolysis were further assessed by diluting two drops of blood cells with normal saline and centrifuge for 3500rpm for 5mins.

Clotting: The blood units were examined for clots macroscopically.

Expiration: Expired blood units were noted by checking the expiration date which was usually written on top of blood bags.

Laboratory testing for TTIs

Donated blood units were screened for TTIs including syphilis, hepatitis B virus, hepatitis C virus, and HIV. The ONE STEP Syphilis Anti-TP TEST kits were used in detecting Treponema specific antigens in the donors' blood by the antibody-conjugated colorimetric (dyed) detector nanoparticles that travel to the capture zones where they were detected as syphilis positive when a test-band appears. HIV, HBV and HCV antibodies were screened by a chemiluminescent microparticle immunoassay (CMIA) principle of immunoassays in the Abbott Architect® analyzer. The serum of donor(s) was loaded into special tubes and given identity numbers. Then, it was processed by the architect analyzer for about 1 hour in a fully automated manner.

Data collection

Blood donors' demographic profiles were extracted from donor's questionnaire, the information of discarded unsuitable blood units after TTI's screening was documented and recorded in the structured study questionnaire.

Data analysis

Analysis was done using Statistical Package for Social Sciences (SPSS) version 23. We mainly used frequencies to describe demographic profile, causes of blood discard both TTIs and non-TTIs. Results were summarized in tables.

Ethical Consideration

We obtained ethical approval from the MUHAS Senate Research and Publications Committee Ref.No.DA.25/111/01/C/176. Permission to conduct the study was obtained from MNH and Centralized Pathology Laboratory administration. In Tanzania blood donors consent for their data and blood samples to be used for further research during donation; therefore, there was no additional consent from blood donors.

Results

A total of 1350 units of blood were obtained at MNH blood transfusion testing laboratory from May 2022 to July 2022. A total of 1200 units were included in the final analysis, and 150 blood units were excluded because they were collected out of the study site (96 were from Dodoma and 54 units from outreach collection in Dar es Salaam) (Figure 1).

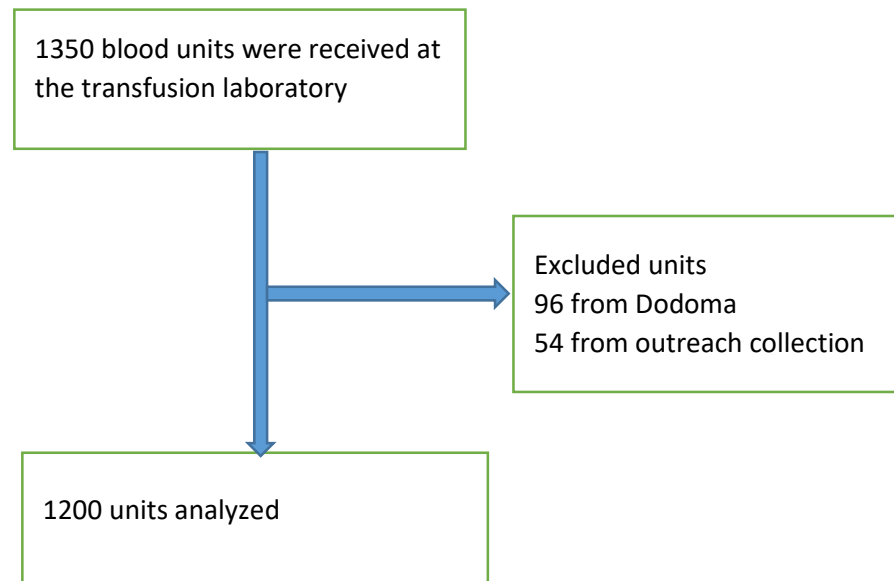


Figure 1: Flow chart of donor units' recruitment

Demographic profile of blood donors who donated blood at Muhimbili Blood Donation Center May to July 2022

Among the 1200 donated units, 1108 (92.3%) units were from male donors with a male to female ratio of 12:1. The 18-30 years age group comprised the most blood donors, 529 (44.1%) with the least donors being those of 57-65 years old, 21(1.8%). The majority of the donated units (1021, 85.1%) were from Family Replacement Blood Donors (FRBDs) (Table 1).

Table 1: Demographic profile of blood donors who donated blood at the Muhimbili Blood Donation Center from May to July 2022

Variable	Number (%)
Gender	
Male	1108 (92.3)
Female	92 (7.7)
Age distribution	
18-30	529 (44.1)
31-43	472 (39.3)
44-56	178 (14.8)
57-65	21 (1.8)
Type of Blood Donor	
Family replacement donors	1020 (85)
Voluntary blood donors	180 (15)

Overall blood discard due to TTI's and non-TTI's

Out of 1200 units a total of 149 (12.4%) units were discarded due to both TTI and non-TTI causes during study period and their records were documented in the "Blood Discard File". The discarded units were broadly categorized into TTI's screening criteria and non-TTI's screening criteria, where 106 (71.1%) were due to TTI's equal to 8.8% of all units included in this study and 43 (28.9%) out of 149 discarded units were due to non-TTI's equal to 3.6% of all units studied. The overall leading cause of blood discard was TTIs with HBV accounting for 57 (4.8%) of the total blood discarded followed by cold chain failure, which accounted for 32 (2.7%) of the total discarded blood (table 2).

Table 2: Overall blood discard due to TTI's and Non -TTIs causes from May - July 2022

Reasons for blood discard	Number (%)
TTIs Causes	
HIV+	21 (1.8)
HBV+	57 (4.8)
HCV+	5 (0.4)
Syphilis	23 (1.9)
Non -TTIs causes	
Cold chain failure	32 (2.7)
Expired	3 (0.3)
Hemolysis	0 (0)
Clotted	0 (0)
Lipemic	5 (0.4)
Bag blockage	3 (0.3)

Individual contribution of blood discard due to TTI's and non-TTI's

TTIs were the leading cause of blood discard, with HBV accounting for 53.8% of the total blood discarded due to TTIs. The least frequent cause of blood discard due to TTIs was HCV.

Blood discarded due to a break in cold chain contributed 74.4% of the total non-TTIs units discarded, followed by lipemia 11.6%. Other factors, such as hemolysis and clotting, were also analysed and the results showed no contribution to the discard of blood during the study period (Table 3).

Table 3: Individual contributions of blood discard due to TTI's and non-TTI from May - July 2022

Factor	Number (%)
TTIs Causes (n=106)	
HIV+	21 (19.8)
HBV+	57 (53.8)
HCV+	5 (4.7)
Syphilis	23 (21.7)
Non -TTIs Causes (n=43)	
Cold chain failure	32 (74.4)
Expired	3 (7.0)
Hemolysis	0 (0)
Clotting	0 (0)
Lipemic	5 (11.6)
Bag blockage	3 (7.0)

Discussion

The MNH blood donation center is as an autonomous donation center under the coordination of the NBTS eastern zone. Our findings revealed that the majority of blood donors were males comprising 92% of blood donors. Mathias *et al* and Josephine *et al*. reported similar findings where male donors comprised 81% and 98% of donations respectively (Mathias *et al*.2021, Josephine *et al*. 2019). Multiple factors could contribute to the observed difference in gender.

In Tanzania, the frequency of blood donation in a calendar year differs between women and men. While women are allowed to donate blood after every four months, males are allowed to donate blood after every three months. Due to biological reasons such as inherent low haemoglobin, women are more likely to be differed from donation than their male counterparts. Women also have more deferral criteria compared to male donors such as being in menses, being pregnant and breastfeeding (NBTS.2015, unpul). However, studies from Ethiopia and Brazil reported slightly higher frequencies in female donors, with 30.5% and 32.7% respectively of all donors (Aliyo *et al*.2022, Pessoni *et al*.2019).

The observed difference could be due to slight differences in donation eligibility among women in Tanzania and these two countries. Firstly, in Tanzania acceptable body weight is from 50kg while in Ethiopia body weight eligibility is from 45kg. This imply that the donors with body weight of 45 - 49kg would be differed from donating blood until they reach 50kgs. Secondly, blood donation interval among females in Tanzania is four months while in Ethiopia is three months. The interval difference means female in Ethiopia have opportunity to donate four times a years as opposed to three times a year among Tanzanian female counterpart (Nureye & Tekalign, 2019). In Brazil, the age eligibility criteria is wider 18-68 years and volunteers blood donors aged 16 & 17 years may donate

upon consent by a responsible adult (Wambier *et al.*2012) where as in Tanzania acceptable age limit is 18-65 years.

Most blood units (85.1%) were from FRBDs; this could be attributed to study site being a fixed site that is in a hospital setting. This aligns with the NBTS 2018/2019 annual report (NBTS.2020, unpubl) which showed a decrease in the proportion of blood collected from VNRBD from 63% to 58% in 2017/2018 (NBTS. 2020, unpubl). The subsequent years report also showed similar trend where blood collected from council and referral hospitals blood collection centers that are in hospital setting were from FRBDs 45.5% and 69.9% respectively (NBTS. 2021, unpubl). A study on the prevalence and associated factors for TTIs in Kenya that had two study sites showed that all blood donors from the hospital setting were FRBDs whereas all from the regional blood center were voluntary blood donors. The hospital setting Tenwek Mission Hospital comprised 17% of the study population while those from the regional blood center Nakuru comprised 83% (Bartonjo *et al.*2019). Higher proportion of voluntary donations than what we found in this study have been reported from Brazil and India 79.37% and 74.17% respectively (Pessoni *et al.*2019, Rawat *et al.*2017). Therefore, these observed differences could be due to differences in study settings highlighting the need to invest on mobile blood donation and walk in center in areas other than hospital setting.

The majority of blood donors (44.2%) were in the age range between 18-30 years. This is slightly similar to what was reported by Aliyo *et al.*, Mathias *et al.* and Josephine *et al.* where donors in the age range between 20 and 29 years comprised 55.7%, 21-30 years comprised 55.37% and 18-35 years comprised 49% of the donors respectively (Aliyo *et al.*2022, Mathias *et al.*2021, Josephine *et al.* 2019). This implies that investing in youth-targeted awareness campaigns may help yield more repeat blood donors hence voluntary donors further evidenced by initiative on pledge 25 club in Zimbabwe which showed higher donation rates among youth who were tracked and encouraged to donate blood post school (Mchokwani. 2018).

The overall blood discard for both TTIs and non-TTIs was 12.4%. The leading cause was TTIs that contributed 71.1% of all blood discard which is similar to findings from a study conducted in Northern Tanzania that reported an overall blood discard due to TTIs of 71.4% (Mathias *et al.*2021). The blood discard frequencies in the two studies conducted in Tanzania are higher than findings from a study conducted in Kuala Lumpur that showed only 2.3% of blood discard (Morish *et al.*2012). The difference could be due to study settings whereby data from our study were all collected in the hospital setting blood center which family replacements donors are likely to donate blood because they are under pressure of having sick relative hence high TTIs rates.

The leading cause of TTIs in the blood analyzed in this study was HBV which contributed 38% of all blood discard. HBV remains the major cause of blood wastage globally (Aliyo *et al.*2022, Borelli *et al.*2013). However, results from a study conducted in India for over three years reported a decline in HBV infection (Kulkarni *et al.*2022). The findings reported here raise a need for strengthening HBV control to combat transmission among adult populations who did not benefit from HBV childhood vaccination in Tanzania that started in 2002 (Metodi *et al.*2010). The ministry of health Tanzania efforts to combat HBV infection are also in line with our findings and recommendation as we have witnessed the revolution of National AIDS Control Program (NACP) to the National AIDS, Sexually Transmitted Infections (STIs) and Hepatitis Control Programme (NASHCoP) (MoH.2023).

Cold chain failure contributed 21% of total non-TTIs blood discard in this study followed by lipemia (3%). Other studies have shown expiration of 24 hours FFP as the leading non-TTIs cause followed by underweight (17.4% and 9.5%, respectively) (Mathias *et al.*2021). Other reported non-TTIs causes of blood wastage were failure in storage quality control, expiration of blood components, platelet and plasma components contamination by red blood cells and blood bags leakage (Kulkarni

*et al.*2022, Morish *et al.*2012). Cold chain maintenance is essential for maintaining blood's vital properties necessary to achieve intended treatment outcome and prevention of adverse transfusion reactions such as hyperkalaemia resulted from hemolysis of RBCs that may occur in both extremes of temperature. To prevent cold chain failure, the use of temperature monitors like alarm systems and log tags is recommended

Conclusion

Majority of blood donors recruited in our study were family replacement donors. Hepatitis B infection was the leading cause of blood discard among TTIs causes, whereas cold chain failure was a leading non-TTI cause.

Study limitation

Our study was conducted at the Muhimbili blood donation center and we excluded blood units that were not collected at the center with the purpose of monitoring blood units from collection to transfusion. This could affect information on other causes of blood discard, including breaks in the cold chain during blood transportation from collection sites. We were not able to obtain information on blood volume of collected units hence we could not analyse blood volume status. The study duration was also short, which resulted in the inclusion of fewer studied blood units.

Recommendations

To improve transfusion safety and reduce blood wastage due to non TTI causes, modern equipment such as a blood mixer, which automatically controls blood volume, timing and mixing of blood during donation is recommended. The use of temperature log tags for continuous cold chain monitoring is also recommended. Most donors were family replacement donors, the conversion of FRBDs via donor education and donor recall is recommended to improve the pool of voluntary blood donors.

Conflict of interest disclosures

The authors declare that they have no conflicts of interest.

Author contributions

All the authors contributed to the writing of the final manuscript and approved the submission of the final version.

Data sharing statement

We will provide primary data access to the Tanzania Journal of Health Research when requested during the review process and/or for editorial decisions.

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