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Allogeneic Blood Transfusion: The Cost of Blood Transfusion at a Large Urban Hospital in Zimbabwe

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Abstract

Whole blood and its respective blood components are indispensable in today's medical practice and their use is associated with significant costs. Blood utilization and blood transfusion costs are generally perceived to be increasing at a time when healthcare budgets continue being constricted. This may have far reaching consequences, particularly in resource limited settings where healthcare spending is mainly foreign funded. A cost-activity based blood transfusion study was carried out at a large urban hospital in Harare, Zimbabwe on 100 patients prospectively. The inclusion criteria took into consideration only pregnant women between the ages 15 and 50 years receiving blood transfusion. Activity based costing was achieved through prospectively following the activities of blood transfusion from the point of collection, storage, matching, pre-transfusion preparations, transfusion and post-transfusion, as well as hospitalisation services costs. The average cost of blood transfusion was found to be $540.71 from the provider's perspective. This cost was compared with the gross domestic per capita and the poverty datum line of Zimbabwe. A continuous review of transfusion systems to alter the supply chain system into a very economic system was recommended.

Keywords

Allogeneic, Blood, Transfusion, Cost, Haemorrhage

1. Introduction

In the modern day, medical practice, whole blood and the respective blood components have become indispensable products, owing to the various life-saving interventions done in patients [1]. Several predicaments to humanity have landed generations in different conditions requiring medical attention, and one such need has been blood

transfusion. In Zimbabwe, blood has been prescribed for several conditions which include anaemia which has less than 5 g/dl (for which the patients are due for haemodialysis), chronic anaemic conditions (where the patients are symptomatic of cardiac failure), haemorrhagic conditions, prior to and following aggressive cytotoxic programmes and also in different surgical procedures, among many other reasons [2].

Maternal haemorrhage is one major indication for blood transfusion in obstetrics and gynaecology. Obstetrics in particular refers to the branch of medicine that deals with the care of women during pregnancy, childbirth and post-partum period. In pregnancy, anaemia is considered to be a haemoglobin count of less than or equal to 11 g/dl in the first and third trimesters, whilst it is 10.5 g/dl in the second trimester. Obstetric bleeding may be unpredictable and massive. Blood loss during normal vaginal delivery of birth or Caesarean section may necessitate blood transfusion if maternal haemoglobin is below 10.0 - 11.0 g/dl before delivery. The haemoglobin concentration should return to normal by 2 weeks after birth, if not, then transfusion is a necessity. Post-partum haemorrhage is the leading cause of maternal mortality [3].

Since blood is an indispensable fluid which no human can do without, thus the existence of blood transfusion, continued efforts to ascertain its availability at any point that it is needed are very important.

There are generally two major types of blood transfusion, allogeneic blood transfusion and autologous blood transfusion. The most common type in Zimbabwe is the allogeneic blood transfusion. This is a type of blood transfusion in which there is the administration of blood or blood components donated by an individual to a different person who matches their blood type. Allogeneic blood transfusion is mostly dependent on the compatibility of blood types between the donor and the receiver [4] [5]. Autologous, on the other hand, blood transfusion refers to the same-self blood donation by an individual for his or her own later use.

The costs of blood and blood components are not easily identified and quantified hence may be regularly under-estimated. This can be attributed to the complex nature of the processes and activities that exists throughout the entire blood transfusion chain. These complex systems have components that include but not limited to donor education, donor screening, donor selection and deferral procedures; screening for transfusion transmissible infections; blood typing and cross-matching; blood components processing; storage and distribution; hospital costs for storing, handling and transfusing the blood. The continual introduction of advanced technologies for protecting against existing and emerging blood safety risks, together with increased donor recruitment and retention costs, have contributed to the rising costs of managing a safe and adequate blood supply. Other costs involved include the rising costs of labour, stringent regulatory demands, and need for compliance with voluntary industry standards. In Zimbabwe, a unit of blood costs about 135 dollars [6], for which between 400 and 500 dollars is charged in order to transfuse the same unit of blood.

There is limited published data on the costs of blood transfusion in sub-Saharan Africa. However, the costs of blood transfusion have been evaluated in several studies for developed countries. Unfortunately, these costs are not transferable to the sub-Sahara

Africa region for various reasons. Firstly, the application of different models for collecting blood: developed countries exclusively recruit voluntary non-remunerated blood donors whilst most African countries still rely on family or replacement donors. Secondly, sophisticated blood safety measures that exist in developed countries such as nucleic acid testing, pathogen inactivation and leuko-reduction, are not available in most sub-Saharan African countries. Thirdly, the preparation of blood components is common practice in developed countries whereas blood is mostly transfused as whole blood in sub-Saharan Africa. These fundamental differences will likely result in differences in the cost of blood between regions.

In this study, we assess the costs of blood transfusion in obstetrics and gynaecology patients at a large urban hospital in Harare, Zimbabwe.

1.1. Justification

Despite blood being indispensable, it is associated with high costs which are estimated figures. There is therefore a need to perform an activity-based procedure to standardise costing. The information available on the costs of blood transfusion, derived in developed countries is not transferrable to the local setup due to practise differences that exists and assuming that they are the same may result in over or under valuation. With the total consumption poverty datum line for a five household being $500 and the gross domestic product per capita being rated at $750 [7], there is a need for cost analyses of healthcare services such as blood transfusion to assess if they are affordable to the general public.

1.2. Aim

The aim is to estimate the costs of allogeneic blood transfusion at a large urban hospital in Harare, Zimbabwe.

Objectives:

- To determine the cost of blood transfusion from a provider's perspective.
- To calculate the costs incurred from the point of acquisition to post-transfusion reactions management.
- To assess if the cost of blood transfusion is affordable to the general populace of Zimbabwe.
- To identify the prevalent conditions leading to blood transfusion in obstetrics and gynaecology.

2. Methodology

2.1. Study Design

The study was a Single Centre cohort of 100 obstetrics and gynaecology inpatients at a large urban hospital in Harare receiving blood transfusions. The patients were followed prospectively to identify resources used.

2.2. Data Collection

A management accounting approach, based on the Activity Based Costing (ABC)

methodology [8], was used to develop the costing model for administering blood to obstetrics and gynecology patients, from the provider's perspective. The cost analysis adapted the 9-step process flow model (see **Figure 1**) as recommended in the Cost of Blood Consensus Conference. Cost information for the last 4 steps of this process flow model (steps 6 - 9), reflecting the transfusion facility, was collected from the study hospital. The cost elements associated with the blood collection centre were collected from a recent study on the cost of producing blood at National Blood Services Zimbabwe.

2.3. Data and Data Sources

The resources used for processing and administration of blood and blood components in the obstetrics and gynecology wards at the hospital were identified and their quantities estimated. The activities for which resource-use data was gathered include; transfusion facility inventory and storage; pre-transfusion preparation, transfusion administration and follow-up. Cost information on direct labour, equipment and supplies or materials used to ensure transfusion of one unit of blood was gathered using a structured questionnaire specifically designed for this study.

In order to include all direct labour costs, standard operating procedures were

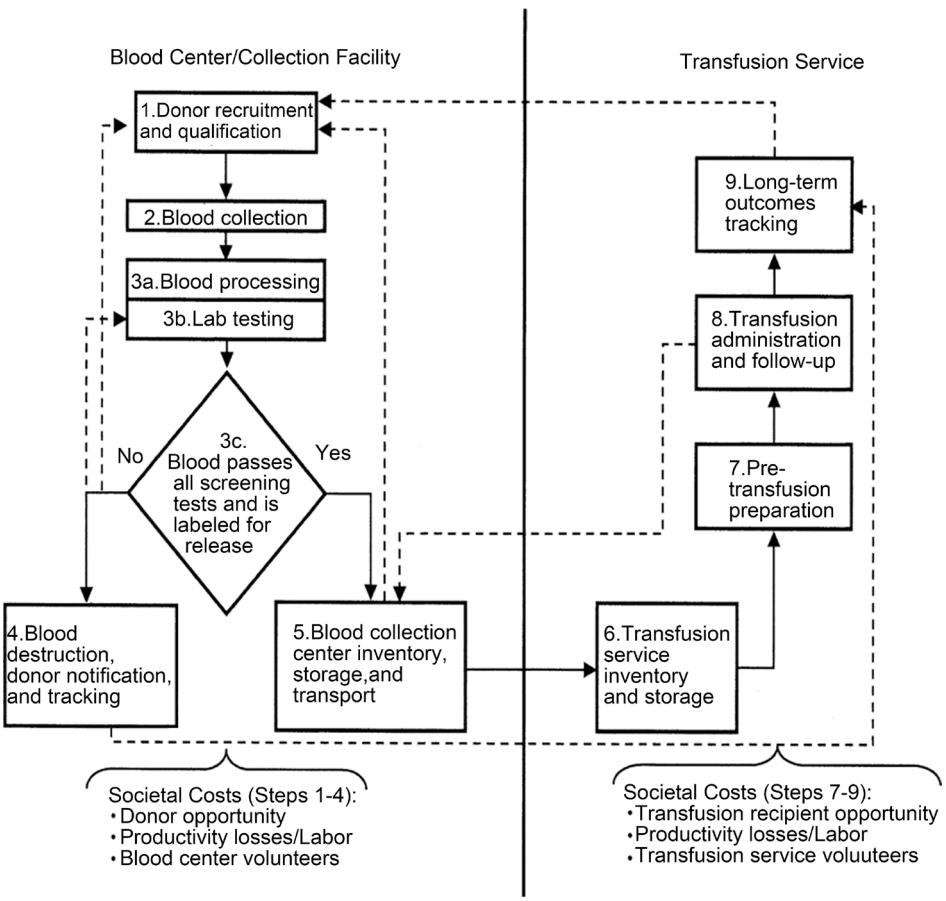

Figure 1. A 9-step process flow model for blood collection and transfusion [8].

reviewed to identify all the personnel involved in all the standard activities directly associated with transfusing a unit of blood. The personnel included orderlies/porters, nurses/midwives, doctors/gynaecologists, laboratory scientists and ward clerks. Interviews with key personnel such as nurses and laboratory scientists were carried out to determine (estimate) the amount of time contributed by each staff member towards the activities leading to, during and after a transfusion. The cost of staff time was estimated based on the mean salaries and benefits for each employee category. Salary and benefit information was obtained from the finance department at the hospital.

The materials required for all the activities leading to, during and after the administration of a blood transfusion were identified from the patient charge sheets and corroborated through interviews with nurses in charge of transfusion. The costs of these supplies were obtained from the procurement and purchasing department in the hospital.

3. Results

The activity based costing process showed that $54071.37 was used in 100 obstetrics and gynaecology women patients who required blood transfusion. As is shown in Table 1, the average cost to transfuse a unit of blood was found to be $540.71. The minimum amount used to transfuse blood was $201.88 with the highest cost being $1373.61.

These results are represented by the box and whisker plot (Figure 2).

Table 2 shows the different causes for the need for blood transfusion and the importance of each, as a percentage, in the study population. Post-partum haemorrhage (36%), anaemia (18%) and ante-partum haemorrhage (14%) were the major causes for the need for blood transfusion in pregnant women.

Figure 3 shows the relationship between the age of pregnant women and the conditions which necessitate blood transfusion. Post-partum and ante-partum haemorrhage were the most contributors to the need for blood transfusion in the 30 - 34 years age group. Post-partum haemorrhage was also the major cause for the need for blood transfusion in the 20 - 24 and 35 - 39 year age groups. Anaemia also contributed significant to the need for blood transfusion as shown in the figure below.

The most prevalent blood group was O+ (38%), followed by A+ (37%) and the least prevalent blood type was O− (1%), as shown in Figure 4.

Table 1. The costs of blood transfusion after activity based costing.

Cost Type	Amount in $
Highest cost	1373.61
Lowest cost	201.88
Median	451.18
Upper quartile	611.75
Lower quartile	380.86
Average	540.71
Total cost	54,071.37

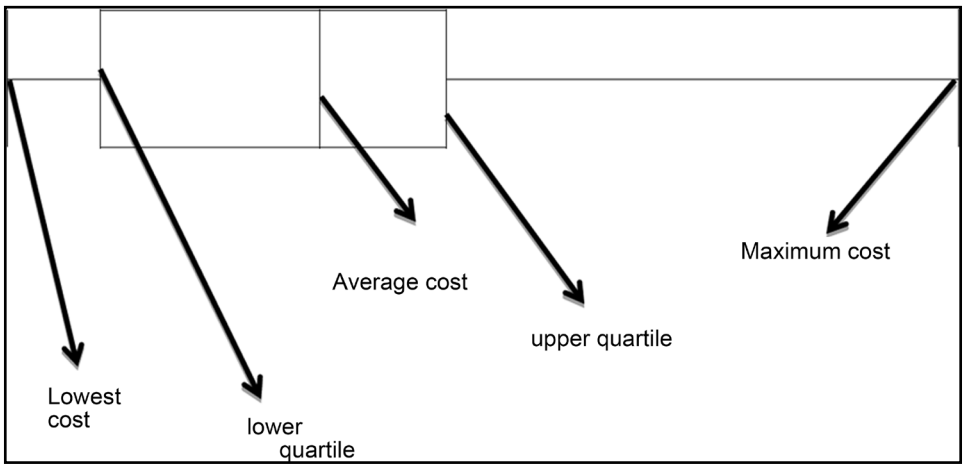

Figure 2. Box and whisker plot for the average costs determined by activity based costing.

Table 2. Causes of the need for blood transfusion (Key: PPH—Post-partum haemorrhage, APH—Ante-partum haemorrhage, PA—Placenta abruption, Misc—Miscarriage, CS—Caesarean section, MP—Molar pregnancy).

Condition	PPH	Anaemia	APH	PA	Misc	Malaria	RE	CS	Eclampsia	MP
%	36	18	14	5	7	2	5	4	3	1

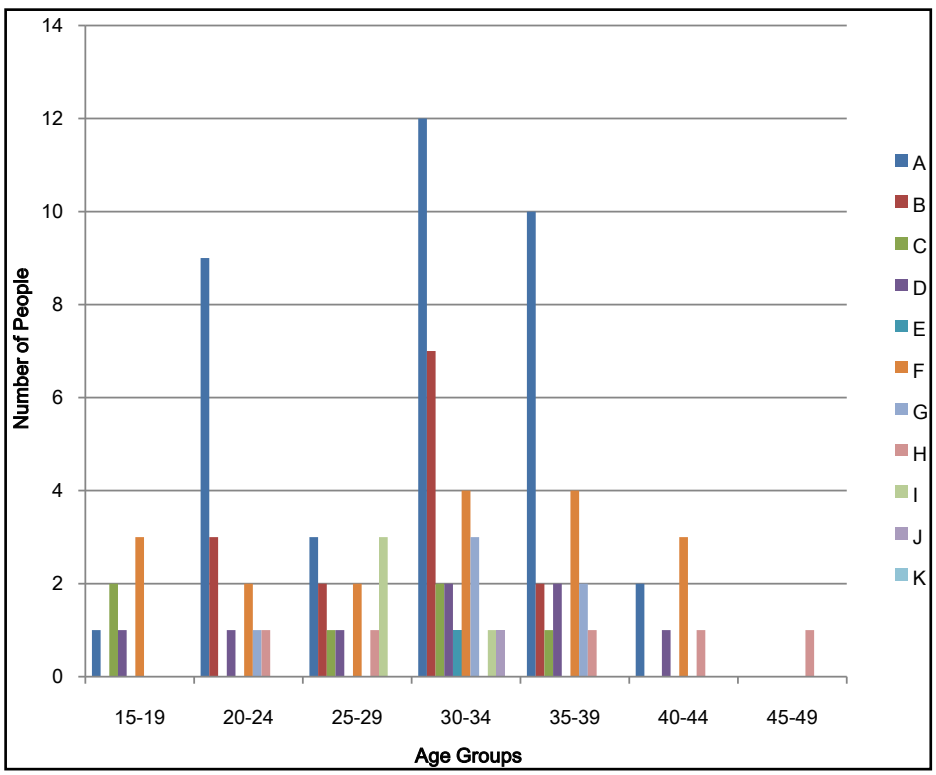

Figure 3. The relationship between age of mother and the major conditions leading to blood transfusion (Key: A—Post partum haemorrhage, B—Antepartum haemorrhage, C—Placenta abruption, D—Miscarriage, E—Malaria, F—Anemia, G—Ruptured ectopic, H—Caesarean section, I—Eclampsia, J—Molar pregnancy).

Most of the participants in the study (36%) were found to originate from the high density suburbs, as shown in Figure 5. A fairly large proportion (22%) was from the rural areas, whereas low density and medium density suburbs contributed 18% and 16% participants respectively. There was one participant from prison and 7% participants from farming areas.

4. Discussion

4.1. Estimated Cost of Blood

The estimated average cost of blood transfusion from the provider's point of view in this study was found to be $540.71, inclusive of all costs incurred from the point of acquisition from the Blood Transfusion Services to post blood transfusion management. As represented by the box and whisker plot (Figure 2), acceptable values range would be from $380.86 to $611.75 (as represented by the lower quartile and the

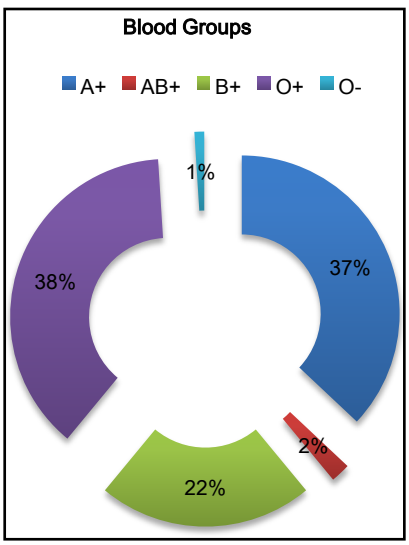

Figure 4. Blood groups for the 100 patients.

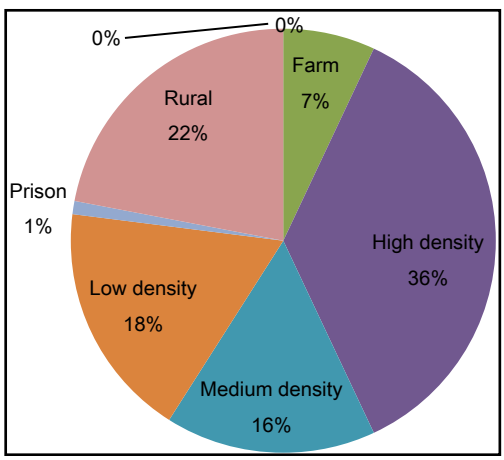

Figure 5. Demographics for the study patients.

upper quartile). However there were outlying values which varied to as low as $201.88 from the acceptable minimum value of $380.86. The biggest variation in the costs were between the upper quartile $611.75 and the largest outlier which was found to be $1373.61. This has shown that even though the average cost is about $540.71, costs can go as high as $1373.61. Variations in individual costs for each patient were mainly determined by the services each patient received from the hospital. The cost of a unit of blood in Canada, 2002 according to a study done was found to be $264.81 [9]. Although this figure was expected to rise in the following years due to expected additional safety measures, it was far less than the one from this study and would have been much more affordable in this setting.

4.1.1. Comparison of the Average Cost against the Gross Domestic per Capita (GDP) of Zimbabwe and the Poverty Datum Line

A comparison of the average blood transfusion cost $540.71 and the gross domestic per capita which was rated at $750.00 per year [7] reveals that almost three quarters of the expected cost of living in a year is spent on blood transfusion for a single patient who requires blood transfusion. Only a quarter is left for consumption, of which this is inadequate. Further comparison with the poverty datum line of Zimbabwe, which is $510.00 per month for a five family household [7], shows that there is not enough funding for the blood transfusion services. If at least one individual in the family requires blood transfusion, then a family does not have enough funding for the transfusion services as well as money for the normal survival of the family.

4.1.2. Costs Determinants

One major determinant of costs variations was the number of units that each patient required and received. Patients received between 1 and 8 blood units. Those who received 7 - 8 units mostly received platelet concentrates or fresh frozen plasma. 58% of the patients in the study received 2 units of blood, with 7% receiving only one unit, 11% receiving 3 units, 15% receiving 4 units, 5% receiving 5 units, 1% receiving 7% and 2% receiving 8 units of blood, thus the average units administered were 2.6 units. The cost of sundries used varied and increased directly proportional to the number of units of blood administered to each patient, and to a lesser extent was determined by the professionalism conductance by each midwife or the physician or gynaecologist.

Some patients required more professional attention than others, thus their resultant cost of blood transfusion was higher in comparison with others. Services rendered depended mostly on the condition of the patient that is the unstable patients required constant monitoring as compared to the stable patients. During the blood transfusion process every patient required continuous monitoring and this was mostly done by the student midwives on rotations. However the unstable patients would require constant checking by the midwife hourly, for standard care. The physician or gynaecologist would be needed every two hours for these unstable patients. The stable patients only required continuous monitoring by the student midwife during the process to check out for any anaphylactic reaction. However the midwife would be needed 2 - 4 hourly for the stable patients and their resultant costs were lower. Partum stages also influ-

enced expertise required and the frequency of patient monitoring. Antepartum stages of pregnancy necessitated monitoring of the foetus as the transfusion was being administered.

The relative number of days spent by each patient in the hospital was largely influenced by the availability of the patient's blood group at the blood bank and the Blood Transfusion Services. The time taken to make the decision and patient consent signing on blood transfusion also contributed to the average time taken in the hospital. The time taken by the patient to recover to a stable condition also had an effect on the overall hospitalisation period. Average number of nights spent in the hospital for the 100 patients was six nights.

Most patients took between 4 - 72 hours being transfused, depending on the availability of their blood type. Because blood was required in several other departments, priority was given according to condition. Even though maternal haemorrhage is treated as emergency, sometimes the patients would not receive all the requested blood units when there was scarcity. For this rationale, the patients would receive some units, and later receive the rest until they were better controlled. This therefore prolonged the hospitalisation period for the patients, and inevitably the costs.

4.2. Leading Causes of the Need for Blood Transfusion

The most prevalent cause of blood transfusion observed in this study was post-partum haemorrhage which was 37%. Most patients bled and lost several blood units during and after parturition. The second most prevalent cause was anaemia during pregnancy (18%), followed by antepartum haemorrhage which claimed 14%. Anaemia due to miscarriages had 4%, placenta abruption (6%), raptured ectopic (6%), caesarean section occupied 5% and molar pregnancy. 24 of the 37 cases of post-partum haemorrhage were patients above the age of 30, with the rest, 13, well distributed amongst the 15-29 age group. This shows that above the age of 30 the risks of parturition haemorrhaging are higher than the ages below. Also 11 of the 18 cases of anaemia in pregnancy were found to be above the age of 30 years. 9 of the 14 antepartum haemorrhage cases prevailed above the age of 30. This indicated that above 50% of the maternal cases of blood transfusion were patients above the age of 30. The safest period for conceiving becomes below 30 and above 15 since literature defines juvenile conception to be more risky and being a cause for maternal haemorrhaging and mortality.

4.3. Blood Groups

Blood groups most existent in obstetrics and gynaecology patients according to this study was O+ which was found to be 38%, followed by A+ with 37% of the study population. Blood group B+ had 22% of the study population, AB+ blood type was only found in 2% of the study population and O− blood type was only found in one patient. These findings are consistent with the general blood type distribution worldwide.

4.4. Demographics

The payment mode for 94 of the 100 patients was cash, making only 6% of the total

study population to be paying by medical aid. Income estimation for the study population was made by direct observation on the place of residence for each patient who was being attended. In relation with the residential areas, most patients came from the high density suburbs (36%) and 22% was referred from rural areas where they resided. Only 18% came from the low density and 16 % from the medium density, these being the groups estimated to be of a higher income. This was evidently revealed by the reference points of where the patients had originally registered during pregnancy, with some not registered to any.

2% of the total study population suffered anaphylactic reactions with one delayed and the other acute. This mounted the costs of blood transfusion as the transfusion reactions necessitated management by the hospital.

5. Conclusion

The average cost of blood transfusion in Zimbabwe was estimated to be $540.71, calculated from the point of acquisition from the National blood services Zimbabwe to the post transfusion management of blood transfusion, which is almost 75% of the gross domestic per capita ($750.00) and more than the poverty datum line ($510.00) of Zimbabwe. Thus, accessibility to blood transfusion by the public is compromised by the high cost as the majority cannot afford it. The top conditions in Obstetrics and Gynaecology that necessitated blood transfusion were post-partum haemorrhage (36%), anaemia (18%) and ante-partum haemorrhage (14%). Blood type O+ was the most prevalent blood group among the study participants (38%) followed by blood group A (37%), B (22%), AB (2%) and O− (1%) respectively.

6. Recommendations

The supply chain management system of blood requires a very close follow-up and proper management in order to control the costs involved. There is need therefore to trace the cost from the acquisition point up to the point of patient service in order to quantify and document the logistics management information system and to relate the entire supply chain system to the environment and policies governing the health care system of the country.

It is also of importance to implement the activity based costing on the laboratory related processes to see the actual cost of blood tests since all the costs for tests were reimbursement costs which require repositioning.

This study was only done in maternal patients; therefore, for standardisation of costs, there is a need to carry out the study in other conditions requiring blood transfusion in the country.

A model for Zimbabwe, comprising cell salvage autologous blood transfusion, dietary intervention through fortification of indigenous cereal foods (such as millet, sorghum) and the transfusion services integration have to be considered.

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