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The Blood Transfusion Outcomes and Analysis of Factors Associated with Blood Transfusion Reactions in Orthopaedic Trauma Patients Managed at Moi Teaching and Referral Hospital, Eldoret, Kenya

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Abstract: Background: Blood transfusion is required in the management of life threatening orthopaedic trauma hemorrhage. However, it is necessary to categorize the patients on the need for blood transfusion as well as adhering to the blood transfusion guidelines in order to avoid risks and hence ameliorate challenges and have good outcomes. Objective: To establish the blood transfusion outcomes and analyze the factors associated with blood transfusion reactions in the orthopaedic trauma patients managed at Moi Teaching and Referral Hospital (MTRH), Eldoret, Kenya. Methods: A hospital based descriptive cross-sectional study of 132 transfused orthopedic trauma patients was carried out between March, 2019 and January, 2020 at MTRH, after approval by relevant authorities. The patients were recruited by consecutive sampling method. Data on blood transfusion outcomes, as well as on factors associated with blood transfusion reactions (Sociodemographic, trauma and laboratory characteristics) was collected using interviewer administered structured questionnaire. Analysis of the aforementioned factors using the Fisher's Exact Test was done and p value < 0.05 was considered statistically significant. Results: A total of 15 out of 132 patients (11.4%) had minor blood transfusion reactions. No mortality was recorded. Majority (6) were young (age group 21-30 years old), followed by age group 41- 50 years old (5). Male (10) dominated over female (ratio- 2:1). Majority (13) were victims of RTA, 8 had long bones fractures, and debridement done in 8 patients. Majority (12) had Haemoglobin level of 7.1- 10.0 g%, and blood groups A^+ and O^+ (5 each). The findings on analysis of association of blood transfusion reactions and the stated factors were all not statistically significant (p>0.05). Conclusion: The incidence of blood transfusion reactions was low (11.4%). Majority of patients were young with male dominance. Majority of patients were victims of RTA, with long bones fractures who were done debridement. Most were of moderate low haemoglobin level and of blood groups A and O positive. Recommendations: High index of suspicion is necessary for diagnosis of blood transfusion reactions and cautions to eradicate these reactions be put in place. Further study on healthcare providers' knowledge on blood transfusion, and the pattern of reactions noted in this study need be encouraged.

Keywords: Blood group, Blood transfusion, Manage, Orthopaedic trauma, Outcomes, Reaction.

INTRODUCTION

The complications of interest associated with blood transfusion are usually categorized as acute blood transfusion reactions which usually occur during, or within, 24 hours of cessation of transfusion (Murphy, Roberts & Yazer, 2017), or delayed. World Health Organization (WHO) strongly advocates for safe and effective blood since needless transfusions, precarious transfusion practices expose patients to the risk of serious adverse transfusion reactions and transfusion-transmissible infections (WHO, 2002). These incidents can have dangerous effects on patients and therefore evidence based transfusion is strongly advocated (Brunskill et al., 2015). Debate exists over the relation of blood transfusion with complications (Dolenc et al., 2016). A study done in Indianapolis, United States of America found that there is significant risk of postoperative complications such as ischemic events, infections and immunity alterations among transfused orthopaedic surgery cases (Mullis et al., 2015). Issues such as immune reactions and infections are considerably worrisome (Sambandam et al., 2013). Most blood transfusion reactions are mild involving urticaria and moderate pyrexia. Acute, severe reactions may occur in 1-2% of transfused patients (Cherian, 2002). Immunologic complications include acute and chronic haemolysis, febrile and allergic reactions, transfusion associated graft-versus-host disease and transfusion related acute lung injury (Hoffman et al., 2018). Non-immunologic complications comprise hypothermia, physical or chemical haemolysis, citrate toxicity, transfusion associated circulatory overload, transfusion induced haemosiderosis (Friedman et al., 2017) and infections. Transfusion of blood and blood components has been documented to be linked to thromboembolism and infections (Ristagno et al., 2018). In Nigeria, it was noted that complications and risks of blood transfusion notwithstanding, there are orthopaedic trauma patients who require blood and blood products (Agaja, 2009). When blood and blood components are given without appropriate indication, the patient seldom benefits and is subjected to iatrogenic risks (Muriithi, 2013). Transfusion-related adverse events are rather common and transfusion may affect infection risk by altering immune function; therefore decreasing blood transfusion may be beneficial for patients in some cases (Teng et al., 2015). Greg McLatchie and colleagues, (2007) have documented transfusion reactions which can be either immediate or delayed. These generally occur as result of clerical, bedside, sampling or laboratory error. In some antibody- mediated reaction cases, patient's antibody (rhesus E, Kell, Duffy and Kidd) present in levels too low to be detected clinically until produced in larger amounts on exposure to circulating antigen may be responsible. The blood transfusion reactions include: acute haemolytic reaction, anaphylactic and allergic reactions, non- haemolytic febrile reaction, delayed extravascular reaction, transfusion- related lung injury, infections (bacterial and non-bacterial), fluid overload and even massive transfusion associated problems. Of these reactions, delayed extravascular heamolytic, and non- bacterial infection reactions are usually not acute. The team of authors has suggested immediate action to be taken in such reactions. They have also expressed the need to adhere to guidelines in order to avoid such reactions in the patients.

Regarding the outcomes of blood transfusion, it should be stressed that blood transfusion is a compelling independent predictor of mortality in trauma (Malone et al., 2003). However, in the United Kingdom, a study among operated hip fracture patients suggested that transfusion is not associated with a change in mortality or infection rates (Johnston et al., 2006). Further, no differences in mortality have been shown between

liberal and restrictive transfusion strategies (Parker, 2013). Need for more blood transfusion is among the most important determinants of outcome in traumatic pelvic fracture patients (Paydar et al., 2017). Transfusion is significantly associated with mortality in patients who receive blood during total knee arthroplasty (Hart et al., 2014; Newman et al., 2018). Studies have demonstrated no advantage in patient functional status with higher transfusion thresholds (Young et al., 2008). Locally at MTRH in Eldoret, Kenya, Ngetich, (2021) conducted a study on blood transfusion practices in orthopaedic trauma units for his thesis. The work was published entitled "Categorization of orthopaedic trauma patients and the need for blood transfusion" later by Kibiwot et al., (2024) (Ayumba, et al., 2024). It emerged clear that most patients were males, injured mostly in road traffic accidents with deranged vital signs and lower extremity fractures, and most were destined for debridement and open reduction and internal fixation, requiring mostly packed red blood cells. In the other publication entitled "Appropriate blood usage and adherence to guidelines in orthopaedic patients", it also emerged clear that the level of adherence to the institutional transfusion guidelines was low at 16.7%, and that the factors associated with transfusion guidelines adherence were pre-transfusion haemoglobin and haematocrit levels (Kibiwot et al., 2025).

It follows that strict categorization of the orthopaedic trauma patients on the need for blood transfusion as well as strictly adhering to blood transfusion guidelines may be associated with good outcomes. Hence the need for this study with special emphasis on establishing the blood transfusion outcomes as well as analyzing the factors associated with blood transfusion reactions in the orthopaedic trauma patients managed at Moi Teaching and Referral Hospital (MTRH), Eldoret, Kenya.

METHODOLOGY

Study Site

The study was conducted in orthopaedic wards at Moi Teaching and Referral Hospital (MTRH); an ISO 9001:2015 certified hospital which is located along Nandi Road in Eldoret Town, Uasin-Gishu County (310 kilometers North West of Nairobi). Eldoret is the headquarters of Uasin-Gishu County in the North Rift region of Western Kenya. Currently, MTRH is the second largest national teaching and referral hospital (level 6 public hospital) in the country with a bed capacity of at least 1000 patients. The hospital serves residents of Western Kenya region (representing at least 22 counties), parts of Eastern Uganda, Northern Tanzania and Southern Sudan catchment areas with a population of at least 24 million people (MTRH website, n.d.).

The hospital is a major trauma centre in the region being the highest referral center, its location along a major highway and having a wide catchment area. It has male, female and paediatric orthopaedic wards with a total bed capacity of at least 56 patients. Most patients admitted to these wards have conditions that are trauma related.

Majority of the patients are self-referrals who arrive in an unpredictable manner using a variety of means including public and private transport. Others are referred or transferred from peripheral health facilities. MTRH has a Blood Transfusion Unit (BTU) that issues packed red blood cells, platelets, fresh frozen plasma and cryoprecipitate. The hospital has a transfusion committee and haemovigilance officer to promote safe and appropriate blood transfusion practice.

Study Design

This was a hospital based descriptive cross-sectional study.

Study Population

Consisted of adult patients admitted into MTRH orthopaedic wards after sustaining trauma and being transfused with blood or blood components between March, 2019 and January, 2020.

Eligibility Criteria

Included were the adult orthopaedic trauma patients aged 18 years and above who were transfused with blood or blood components at MTRH and gave consent to participate in the study. Excluded were the orthopaedic trauma patient who had concomitant brain injury since lower threshold for transfusion is advised in head injury (Salverda et al., 2017). Brain injury was diagnosed by using a standard set of signs and symptoms and head computerized tomography scan images.

Sample Size

The Cochran formula for calculating a sample size for proportions (Cochran & Wiley, 1977) was used to calculate the sample size as follows:

$$n_0 = Z^2pq/e^2$$

Where;

- n_0 = desired sample size
- Z = the standard normal deviation at desired confidence level (1.96 for 95% confidence level)
- p = 35% i.e. the proportion of orthopaedic surgery patients who received blood transfusion as per guidelines in a previous study conducted at Aga Khan University Hospital, Karachi, Pakistan (Abbas et al., 2014).

$$q = 1 - p$$

$$= 1 - 0.35 = 0.65$$

- e = 5% i.e. the desired level of precision

Substituted as:

$$n = \frac{1.96^2 \times 0.35 \times 0.65}{(0.05)^2}$$

= 349.6, rounded off to 350 patients.

MTRH Blood Transfusion Unit records for the year 2017 were checked and it was found that 211 patients with orthopaedic trauma were transfused. Therefore, the study population was anticipated to be smaller compared to the one in the Abbas et al., (2014)

study. As a result, the sample size obtained from Cochran formula above was adjusted using the following equation for finite population correction for proportions:

$$n = n_0 / (1 + ((n_0 - 1) / N))$$

Where:

- n_0 is Cochran's sample size recommendation
- N is the population size
- n is the new, adjusted sample size

The population size N was taken as 211, which is the number of orthopaedic trauma patients transfused with blood and blood components at MTRH in the year 2017 as per records at the Blood Transfusion Unit. These values were then substituted into the formula as follows:

$$n = 350 / (1 + (349/211)) = 132.$$

Sampling Method

Patients who met the inclusion criteria were enrolled consecutively upon admission until the desired sample size was reached.

Study Variables

Independent variables included Socio-demographic data- age, sex, education level, occupation, and referral status; Clinical characteristics- injury mechanism and type, Injury Severity Score (ISS), heart rate, respiratory rate, systolic blood pressure and expected or estimated blood loss; Pre transfusion laboratory characteristics encompassed haemoglobin, haematocrit, platelets and patient blood group. Injury Severity Score (ISS) is an anatomic scoring system with a range of 0 to 75. It is determined by identifying the three most injured body regions, then determining the severity of each as defined by the Abbreviated Injury Scale (AIS) designated as A, B, and C. The ISS = $A^2 + B^2 + C^2$ (Saidi, 2016). The Dependent variables included adherence to blood transfusion guidelines and blood transfusion reactions.

Data Collection Tool

Data was collected from patients or next of kin who gave consent using a structured questionnaire consisting of two sections. The first section was interviewer administered whereby patient or next of kin responses on socio-demographic and part of trauma data were obtained and filled in the questionnaire. In the second section, clinical and laboratory data was extracted from the medical charts. Questionnaire content was adopted from KNH Trauma Registry and MTRH Transfusion Guidelines then modified as per study objectives.

Study Execution

Data was collected from March, 2019 to January, 2020 by the Principal Investigator (PI) and three Research Assistants (RAs) under the Research Supervisors (RSs). The RAs included one

Clinical Officer Intern (COI) and two Nursing Officers (NOs). They were selected on the basis of availability and being conversant with our orthopaedic trauma care units. The PI trained the RAs on patient enrolment, ethics and data collection. The PI and RAs then identified orthopaedic trauma patients undergoing blood transfusion and checked for eligibility criteria. Patient's index transfusion episode was evaluated in this study. The decision to transfuse a patient was made by clinicians of various cadres including consultants, residents, medical and clinical officers. Estimated blood loss was done and documented by the primary clinicians in the patient medical records. Subsequently, those eligible and gave consent were enrolled into the study. Of interest in the study was the monitoring the patient for any blood transfusion reactions within a twenty four hour period post transfusion onset. The PI, the RAs and RSs were interested in the documenting of the following: blood transfusion complications and outcomes, association between socio demographic characteristics and blood transfusion reactions, association between trauma characteristics and blood transfusion reactions, and association between laboratory characteristics and blood transfusion reactions. The transfusion guidelines documents (KNBTS, 2009; MRH, 2016) were used while making the evaluations.

Study Procedure Schema

A schema on the study procedure for each patient is as outlined in Figure 1 as follows:

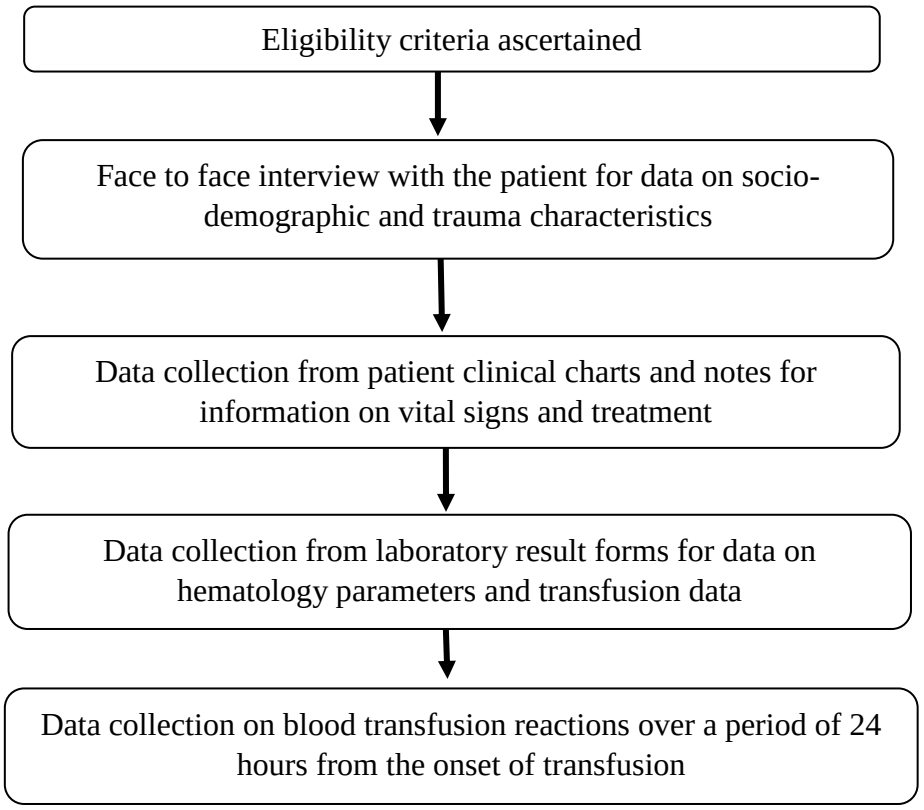

Figure 1: Study Procedure Schema

Data Management, Analysis and Presentation

Data management involved the checking of filled questionnaires for errors and corrected. They were also checked for completeness and coded accordingly. Data was entered in

Microsoft® Access® 2019 version 16.0 software package for storage and back up. Then, data was exported to R version 3.6.0 (R Core Team, 2019) statistical software for analysis. Strict patient confidentiality was maintained at all times with no use of identifiers on the questionnaires. Hard copies of the questionnaires were securely kept under lock and key while soft copy data was password protected. Data analysis was done using both the descriptive and inferential statistics. Descriptive analyses were done for socio-demographic characteristics of the population. Continuous data were summarized as mean with standard deviation and median with inter-quartile range while categorical data were summarized as frequency tables and proportion. The Inferential analyses were done using the Fisher's Exact Test to assess associations between categorical variables. A *p*- value of less than 0.05 was considered statistically significant. Data presentation involved use of prose and diagrams (tables and figures) formats.

Ethical Considerations

The study was done after approval from Moi University/Moi Teaching and Referral Hospital Institutional Research and Ethics Committee (Ref: IREC/2018/303; Approval Number: 0003213, Dated: 31st January, 2019). Permission to carry out the study was also obtained from Moi Teaching and Referral Hospital Chief Executive Officer (Ref: ELD/MTRH/R&P/10/2/V.2/2010, Dated: 25th March, 2019). Only patients who had given voluntary informed written consent participated in the study. A third party (adult relative/guardian) consented on behalf of critically ill patients who were unable to give informed consent on their own. All patients received routine care with no direct financial benefit. Additional costs on medical care were not meted on the patients for the purpose of this study. No coercion or payment was done to influence patients join the study. There were no risks associated with the study. Neither incentives nor inducements were used to coerce patients into the study. The patients were free to withdraw from the study at any point in time with no consequences.

Dissemination of Findings

The research findings from this study were disseminated through relevant institution channels, including presentation at scientific conferences and publication in journals.

Study Limitation

A few patients had charts whose transfusion data entry was incomplete or unavailable. This was mitigated by verifying against the patients' files.

RESULTS

Blood transfusion outcomes: In this study, few patients 15 (11.4%) had acute blood transfusion reactions. These reactions were however mild in severity. Among the 15 patients who experienced the reactions, 11 (73.3%) had fever, 3 (20.0%) had chills/rigors and 1 (6.7%) had multiple symptoms consisting of rigors, urticaria and generalized body swelling. During

the study period, there was no mortality documented in the follow up period of 24 hours after onset of transfusion.

Table 1: Blood transfusion complications and outcomes

Characteristics	Overall n=132
Blood transfusion reaction	
None	117 (88.6%)
Present	15 (11.4%)
Mortality	
Alive	132 (100.0%)

Factors Associated with Blood Transfusion Reactions

There was no statistically significant association between socio-demographic characteristics and blood transfusion reactions at bivariate analysis as shown in Table 2.

Table 2: Association between socio demographic characteristics and blood transfusion reactions

Variable	Blood transfusion reactions		*p- value*
	None (n = 117)	Present (n = 15)	
Age in categories			0.3491
<20	7 (100.0%)	0 (0.0%)	
21 to 30	36 (85.7%)	6 (14.3%)	
31 to 40	31 (91.2%)	3 (8.8%)	
41 to 50	15 (75.0%)	5 (25.0%)	
51 to 60	7 (87.5%)	1 (12.5%)	
61-70	9 (100.0%)	0 (0.0%)	
>70	12 (100.0%)	0 (0.0%)	
Sex			0.3431
Female	26 (83.9%)	5 (16.1%)	
Male	91 (90.1%)	10 (9.9%)	
Referral			0.7611
Non-Referral	32 (86.5%)	5 (13.5%)	
Referral	85 (89.5%)	10 (10.5%)	

1 Fisher's Exact Test for Count Data

There was no statistically significant association between trauma characteristics and blood transfusion reactions at bivariate analysis as shown in Table 3.

Table 3: Association between trauma characteristics and blood transfusion reactions

Variable	Blood transfusion reactions		*p- value*
	None (n = 117)	**Present (n = 15)**	
Mechanism of Injury			0.0821
Assault	3 (60.0%)	2 (40.0%)	
Falls	19 (100.0%)	0 (0.0%)	
Gunshot	3 (100.0%)	0 (0.0%)	
RTA	92 (87.6%)	13 (12.4%)	
Type of Injury			0.5961
Long bones	88 (89.8%)	10 (10.2%)	
Multiple bones	25 (83.3%)	5 (16.7%)	
Pelvis	3 (100.0%)	0 (0.0%)	
Spine	1 (100.0%)	0 (0.0%)	
Type of Surgery			0.9591
Amputation	6 (100.0%)	0 (0.0%)	
Debridement	50 (86.2%)	8 (13.8%)	
External fixation	6 (100.0%)	0 (0.0%)	
Grafting	1 (100.0%)	0 (0.0%)	
ORIF	54 (88.5%)	7 (11.5%)	

1 Fisher's Exact Test for Count Data

There was no statistically significant association between laboratory haematological characteristics and blood transfusion reactions at bivariate analysis as shown in Table 4.

Table 4: Association between laboratory characteristics and blood transfusion reactions

Variable	Blood transfusion reactions		*p- value*
	None (n =117)	**Present (n = 15)**	
Haemoglobin			0.2491
<7	15 (93.8%)	1 (6.2%)	
>10	36 (94.7%)	2 (5.3%)	
7.1 to 10	66 (84.6%)	12 (15.4%)	

Blood group			0.1791
A-	1 (100.0%)	0 (0.0%)	
A+	39 (88.6%)	5 (11.4%)	
AB-	0 (0.0%)	1 (100.0%)	
AB+	2 (100.0%)	0 (0.0%)	
B-	2 (100.0%)	0 (0.0%)	
B+	17 (85.0%)	3 (15.0%)	
O-	1 (50.0%)	1 (50.0%)	
O+	55 (91.7%)	5 (8.3%)	

1 Fisher's Exact Test for Count Data

DISCUSSION

The results of this study revealed that 11.4% of patients had mild acute blood transfusion reactions in contrast to 3.2% in the study by Abbas et al., 2014. In this study, the findings were allergic and febrile nonhaemolytic transfusion reactions. Generally, allergic transfusion reactions occur in 1 to 3% of all transfusions (Hoffman et al., 2018) and 0.04 to 0.44% for febrile nonhaemolytic reactions (Murphy, Roberts & Yazer, 2017). It is noteworthy to recognise that many of these blood transfusion reactions can mimic sequelae of comorbidities such as infections and are not necessarily related to transfusion of blood products (Murphy, Roberts & Yazer, 2017). According to Greg McLatchie and colleagues, (2007) such confusing manifestations of anaphylaxis and allergic reactions include hypotension, bronchospasm and angioedema, while for non- haemolytic febrile reactions such as pyrexia and rigors mimic bacterial infections but are usually self- limiting.

By and large, allergic blood transfusion reactions are Type I IgE antibodies mediated hypersensitivity response. These antibodies bind to foreign plasma proteins, substances in the donor blood product that either is lacking or has a distinctly different allelic expression in the recipient (IgA, haptoglobin, C4) and to extraneous substances in the donor blood component (Murphy, Roberts & Yazer, 2017) leading to activation of mast cells. Some of the extraneous substances include IgE antibodies, drugs and other allergens.

Febrile nonhaemolytic blood transfusion reactions are due to patients' antibodies reacting with leucocytes in donor blood leading to pyrogens (cytokines) release which act on the hypothalamus to cause fever (Murphy, Roberts & Yazer, 2017). Also, during storage of donor blood, cytokines are gradually released into the blood. When this blood is infused, the preexisting cytokines cause fever. According to Greg McLatchie and colleagues, (2007) leucocyte- depleted blood to a great extent helps prevent these non- haemolytic febrile reactions. There was no mortality documented during the follow up period of 24 hours post transfusion.

According to Greg McLatchie and colleagues, (2007) the blood transfusion reactions may occur as result of clerical, bedside, sampling or laboratory error. The reaction may also occur due to undetectably low level of patient's antibody (rhesus E, Kell, Duffy and Kidd) in blood to be detected clinically. It therefore follows that caution need be put in place to

avoid the errors. A high suspicion index is also necessary for early detection and appropriate action to be taken in order to save patient from damages that arise in such blood transfusion reactions.

Considerations were then made for the association between socio demographic characteristics and blood transfusion reactions, association between trauma characteristics and blood transfusion reactions, and association between laboratory characteristics and blood transfusion reactions. No particular patient characteristic was found to be associated with blood transfusion reactions. Furthermore, there was no statistically significant association between blood transfusion reactions and the aforementioned factors as the *p*-value in each category was above 0.05.

CONCLUSIONS

1. Few and mild blood transfusion reactions were noted in 11.4% of patients. There was no statistically significant association between transfusion reactions and adherence to guidelines.
2. Majority of the patients were young (age group 21-30 years old), with 6 reacting to blood transfusion, and male dominating over female (ratio 2:1), and majority were referrals.
3. Majority of patients who reacted to blood transfusion were victims of RTA, had sustained long bones fractures and were done debridements.
4. Majority of patients who reacted to blood transfusion had Hb level of 7.1- 10.0g %, and had blood groups A+ and O+.

RECOMMENDATIONS

Based on results and the stated objectives, the following recommendations are proposed:

1. Moi Teaching and Referral Hospital Transfusion Committee to sensitize and encourage adherence to blood transfusion guidelines among clinicians in orthopaedic trauma units by increasing awareness.
2. Need for a high index of suspicion among clinicians and nurses for the diagnosis of blood transfusion reactions and cautions to minimize these reactions be put in place.
3. Further study among clinicians and nurses to assess their knowledge about blood transfusion and their experiences on transfusion practices in orthopaedic trauma units at MTRH.
4. Further study to highlight the association between blood transfusion reactions and the categories listed in this study need be encouraged.

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