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Appropriate Blood Usage and Adherence to Guidelines in Orthopaedic Patients Managed at Moi Teaching and Referral Hospital, Eldoret, Kenya

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ABSTRACT

Blood transfusion is required in the management of life threatening orthopaedic trauma hemorrhage. However, this practice is faced with erratic supply, increasing demand for safe blood and inappropriate transfusions which may expose patients to transfusion associated risks. Appropriate use of blood and related products as well as adherence to transfusion guidelines has been shown to ameliorate these challenges. This study set out to determine the appropriate blood and blood components usage and adherence to guidelines in orthopaedic patients managed at Moi Teaching and Referral Hospital (MTRH), Eldoret, Kenya. Descriptive cross-sectional study design was and involved 132 transfused orthopedic trauma patients, recruited by consecutive sampling, between March 2019 and January 2020. Data was collected using interviewer administered structured questionnaire. Continuous data were summarized as median (inter-quartile range) and categorical data as frequency tables and proportions. Fisher's Exact Test was used to assess associations between categorical variables and non-parametric Kruskal-Wallis Test was used for continuous independent variables. A *p* value < 0.05 was considered statistically significant. The results: Males were 101 (76.5%), median age was 36 (IQR 28, 47) years, majority of the patients, 95 (72%) were referrals, 64 (48.5%) were unskilled workers and 64 (48.5%) had primary school level of education. Most of the patients, 105 (79.5%) were injured in road traffic accidents. Most patients, 105 (79.5%) and 115 (87.1%) had normal pulse rate and systolic blood pressure respectively while 77 (58.3%) had increased respiratory rate. The median pre-transfusion haemoglobin was 8.90 (IQR 7.98, 10.35) g/dl and the commonest blood group was O positive. Patients with isolated femur fractures were 62 (47.0%). Patients who underwent primary open reduction and internal fixation were 61(46.2%). Majority of the patients, 127 (96.2%) received packed red blood cells. The proportion adherent to transfusion guidelines was 16.7% [95% CI: (10.75, 24.14)]. The factors associated with adherence were pre-transfusion haemoglobin and haematocrit levels, Fisher's Exact and Kruskal-Wallis *p* value

being < 0.001. Mild transfusion reactions were noted in 15 (11.4%) patients. Conclusions made were that most patients were males, transfused with packed red blood cells and majority of injuries sustained were due to road traffic accidents. The level of adherence to the institutional transfusion guidelines was low at 16.7%. Factors associated with transfusion guidelines adherence were pre-transfusion haemoglobin and haematocrit levels. The recommendation was that Moi Teaching and Referral Hospital Transfusion Committee should increase transfusion guidelines awareness among clinicians in orthopaedic trauma.

Keyword: Appropriate usage, Blood and blood components, adherence, Transfusion guidelines, Orthopaedic trauma, Haemorrhage.

INTRODUCTION

Appropriate usage of blood and blood components as well as adherence to transfusion guidelines in orthopaedics practice is quite important. Blood transfusion practice is therapeutic in life and / or limb threatening orthopaedic trauma hemorrhage. However, not all patients will gain or have a boost on outcomes as a result of blood transfusion. Therefore, this calls for its usage for the appropriate indications. Adherence to transfusion guidelines is helpful and must be tailored to individual circumstances.

As regards appropriate usage of blood and blood components, Packed red blood cells (PRBCs) in general give circulatory (volume-related), rheological (viscosity-related) and oxygen transport benefits [1]. Of these, the main function of red blood cells is transport of oxygen from lungs to various tissues. PRBCs are needed to restore oxygen carrying capacity of the circulating intravascular volume when 30-40% of blood volume has been lost [2]. Primarily, PRBCs is not considered a volume expander. Hence early and empirical administration of crystalloids is recommended before transfusion of PRBCs in patients with class III or IV of haemorrhagic shock [2]. The recommended quantity of fluid is one to two liters of crystalloid solution [3]. When cross matched PRBCs are unavailable, type O negative packed red blood cells are indicated for patients with exsanguinating bleeding [3]. Rhesus negative PRBCs are preferred for females of childbearing age to prevent sensitisation and resultant complications.

Transfusion of PRBCs does not promptly improve oxygen delivery or uptake in tissues hence its use is limited in acute situations. Nonetheless, its administration is desired to improve viscosity in cases of severe haemodilution yet more viscosity may slow blood circulation to tissues [1].

The haemoglobin threshold at which transfusion is warranted is controversial [4]. Conventionally, patients with haemoglobin below 10 g/dl are recommended for blood transfusion. Blood transfusion for a haemoglobin level >8g/dl in the absence of symptoms and signs of anaemia is not justified by current clinical evidence [5]. Furthermore, restrictive PRBCs transfusion at haemoglobin of 8 g/dl to patients undergoing orthopaedic surgery is not associated with elevated rates of unfavourable clinical outcomes [6]. Exceptions to this recommendation include patients with acute coronary syndromes [7], chronic transfusion-dependent anaemia and severe thrombocytopenia.

The trigger to give or hold back packed red blood cells in acute haemorrhage should not be based on packed cell volume (haematocrit) or haemoglobin as values do not fall for several hours [2]. It is not necessary to transfuse patients who are asymptomatic, not bleeding and have a haemoglobin level of greater than 8 g/dl [8]. In the non-existence of active bleeding and other risk factors, the transfusion trigger for PRBCs in a stable patient should be haemoglobin level less than 7 g/dl [9].

Avoiding aggressive fluid resuscitation in the bleeding patient until definitive control of haemorrhage may avert additional haemorrhage [2]. This is done by careful balanced resuscitation with regular re-evaluation [3]. Aggressive fluid resuscitation leads to more bleeding by increasing blood pressure and dislodging early thrombus. It can also alter micro-vascular permeability by activation of cascade processes leading to abnormal inter-compartmental relocation of fluid, hydraulic acceleration of bleeding and dilution of clotting factors.

Whole blood has been used as a replacement of blood in acute blood loss with hypovolaemia [10] yet transfusion of fresher whole blood does not boost clinical outcomes [6]. Whole blood is progressively infrequently issued, hence its clinical indications are limited [11]. It is rarely used in current practice in developed countries although in many resource poor countries, it accounts for most transfusions. At MTRH, its use has been declining [12].

Haemorrhage from trauma may result in increased consumption of platelets. Also, transfusion of PRBCs leads to thrombocytopenia from haemodilution. Some platelets are dysfunctional. Therefore, platelet concentrates which are prepared from whole blood or collected by platelet-pheresis are indicated in these situations [10]. Platelet transfusion should be based on both clinical criteria and laboratory values. Platelet levels should be maintained at ≥ 50 x 10^9/L for patients with ongoing bleeding; ≥ 100 x 10^9/L and ≥ 150 x 10^9/L among those due for minor and major surgery respectively [9].

Fresh frozen plasma (FFP) is made by separating plasma from whole blood within 6 hours of collection and rapidly freezing to negative twenty five degrees Celsius or colder [10]. It contains stable clotting factors that are useful during excessive micro-vascular bleeding, coagulation factor deficiency and urgent reversal of warfarin therapy when prothrombin complex concentrates are not available. It is also used in massively transfused patients with significant coagulation abnormalities. FFP is used in the presence of an International Normalized Ratio (INR) greater than 2.0 in the absence of heparin and activated Partial Thromboplastin Time (aPTT) one and half times mean normal value. The dosage is 10-15 ml/kg body weight [13]. It is not indicated if prothrombin test or INR and aPTT are normal. FFP is not used as a volume expander. A study among neonates in Eldoret, Kenya found that no coagulation tests were done before administration of FFP for the neonates who were given this component [14].

Cryoprecipitate is a blood product prepared from FFP containing factor VIII and fibrinogen [10]. It is indicated in patients with fibrinogen deficiency in the presence of excessive bleeding (hypofibrinogenemia). It can also be utilized as a supplement in massively transfused patients when fibrinogen levels cannot be measured in a timely fashion. Cryoprecipitate may be handy in situations of fibrinogenolysis, persistent hypofibrinogenemia refractory to FFP and dilutional hypofibrinogenemia. Additionally, it plays a role in the treatment of bleeding trauma

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patients with Haemophilia A (factor VIII deficiency), von Willebrand's disease and factor XIII deficiency. Cryoprecipitate is indicated when fibrinogen concentration is less than 100 mg/dl. The dosage is usually 2 ml/kg body weight.

New evidence places greater emphasis on the preoperative assessment of the patient and the use of adjunct therapies to prevent and /or treat bleeding. This includes more use of pharmacologic therapies to minimize blood transfusions, such as erythropoietin for anaemic cases, prothrombin complex concentrates for urgent reversal of warfarin and intraoperative antifibrinolytic administration for procedures having a high risk of bleeding [15]. The use of platelets, cryoprecipitate, and FFP among injured patients who do not need massive transfusion should be informed by coagulation studies, along with fibrinogen levels and balanced resuscitation principles [3]. Need for assessment of coagulation tests (PT, INR, aPTT) and fibrinogen levels in patients with excessive bleeding before administration of FFP and cryoprecipitate respectively.

Concerning the blood transfusion guidelines, several are in existence but awareness and adherence to them in aiding appropriate indications of blood components appear to be inadequate [16]. In the United Kingdom, it was shown that there is an extensive inconsistency in attitudes and practices towards orthopaedic blood transfusion practice [17]. A study at Aga Khan University Hospital, Karachi, Pakistan revealed that the proportion of inappropriate transfusion in orthopaedic surgery was rather high at 65% [18].

Locally at MTRH, a number of researchers [19- 21] have conducted studies. In 2019, Ngetich and colleagues [19, 20] conducted a study whereby they characterized orthopaedic trauma patients and the need for blood transfusion. They found out that most patients were males, injured mostly in road traffic accidents with deranged vital signs and lower extremity fractures. Most were destined for debridement and open reduction and internal fixation, requiring mostly PRBCs. They recommended that orthopaedic surgeons should have high suspicion index in order to accurately categorize patients and match them with need for blood before surgery.

In another study at MTRH in 2022, Njoroge et al. [21] conducted a study on blood loss and transfusion during open femur fracture surgeries and documented that blood loss was high, with excessive cross-matching and wastage of blood indicated by a high cross match to transfusion ratio, while transfusion rates were low and primarily determined by anaesthetists' visual estimation. Factors contributing to blood loss included timing of surgery, fracture complexity, and surgery duration. From the study, prompt surgery to minimize blood loss, anticipation of significant blood loss in complex cases, selective cross-matching, transfusion only for patients with low haemoglobin levels, and early identification and mitigation of factors contributing to blood loss and transfusion were recommended.

In another study at MTRH, it was documented that the proportion of appropriate transfusions ranges from 4% to 66% [22], and that the knowledge of local blood recipients profile is useful in prediction of routine blood transfusion needs. Elsewhere, proportion of appropriate transfusion was documented to be from 3% to 42.3% [18]. Thus, it is evident that large proportions of transfusions do not adhere to guidelines criteria and result in unnecessary blood transfusions, thus wasting this important scarce resource.

Low haemoglobin and haemocrit levels should be considered important according to the adherence to blood transfusion guidelines [23], and it is considered inappropriate to transfuse blood to patients above 65 years old in general practice. In some setting, low pretransfusion haemoglobin level in patients scheduled for intervention of fracture femur, blood transfusion becomes appropriate [24].

Adherence to patient blood management guidelines significantly reduces transfusion rates [25, 26]. Pre-transfusion haemoglobin level is the most significant factor associated with adherence to transfusion guidelines and clinicians tend to use it as the sole deciding factor in initiating blood transfusion [23].

A study carried out at KNH on blood requests, cross-match and transfusion practices for elective multidisciplinary surgery recommended that clinicians standardize blood transfusion practice through adherence to guidelines on appropriate use of blood products and need for studies targeting specific disciplines such as orthopaedic surgery [27]. It is worth noting that this study was done more than half a decade ago yet blood transfusion practices evolve yearly due to advent of technology plus knowledge and skill updates from newly generated scientific evidence. Therefore, it is important to continually appraise existing practice and guidelines. A study done at MTRH on blood transfusion practices among neonates whose clinical conditions were largely non-trauma reported that adherence to transfusion guidelines is generally less than optimal. Perhaps these guidelines [13, 14] underestimate patient transfusion requirements.

In an endeavor to streamline blood transfusion service, MTRH in the year 2016 formulated, approved and issued policy guidelines on safe and appropriate use of blood and blood components. The guidelines are in line with Kenya National Blood Transfusion Service guidelines [13] which were largely adapted from World Health Organization [10]. This guideline is the one that is widely circulated and in use at MTRH to promote good practices in transfusion medicine by minimizing variations in blood use. It recommends restrictive (conservative) use of transfusion requiring a reduction in the use of blood and blood components and that transfusion should only be used when it is absolutely necessary after comprehensive consideration of the patient's clinical condition. The transfusion threshold should be primarily led by a criteria consisting of blood pressure level, estimated or expected blood loss and haemoglobin or haematocrit levels [9]. Acute blood loss or peri-operative transfusion is indicated when at least one criteria of the intended component is met [9].

Blood transfusion is considered adherent to MTRH guidelines [9] if any of the following thresholds (whole blood, PRBCs, and platelets transfusion) is observed.

Whole blood is indicated for: blood loss ≥ 40% of the total body blood volume, hypotension unresponsive to appropriate and adequate intravenous fluids, and packed cell volume < 15%. Packed red blood cells are indicated for: emergency cases with haemoglobin level <7g/dl with minimal blood loss, haemoglobin level <9g/dl and expected blood loss is >500mls, and haemoglobin <10g/dl with significant co-morbidities such as cardiovascular, respiratory and hepato-renal disorders. PRBCs are also indicated for: elective cases with haemoglobin < 10g/dl and blood loss > 30% of the patient's total blood volume.

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Platelets are indicated for: minor surgery with platelet count < 100 x 10^9/L, and major surgery with platelet count < 150 x 10^9/L.

Adherence to blood and blood components transfusion guidelines is therefore quite crucial in order to prevent complications and achieve desirable outcomes.

METHODOLOGY

Study Site

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) [28]. 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 around 1000 patients. It is known for excellence in healthcare, training and as a research centre. The hospital serves residents of Western Kenya region (representing at least 22 counties), parts of Eastern Uganda and Southern Sudan catchment areas with a population of about 24 million people. 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

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 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 orthopaedic trauma patients who had concomitant brain injury since lower threshold for transfusion is advised in head injury [11]. Brain injury was diagnosed by using a standard set of signs and symptoms and head computerized tomography scan images.

Sample Size

The Cochran and Wiley [29] formula was used to calculate the sample size as follows:

$$n_0 = Z^2pq/e^2 \quad (1)$$

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 [18].
- q = 1 – p = 1 - 0.35 = 0.65
- e = 5% i.e. the desired level of precision

Substituted as:

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

= 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 Abbas et al. [18] study.

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

$$n = n_0 / (1 + ((n_0 - 1) / N)) \quad (3)$$

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 was 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:

$$n = 350 / (1 + (349/211)) = 132. \quad (4)$$

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 were age, sex, education level, occupation, and referral status. Clinical characteristics included injury mechanism and type, Injury Severity Score (ISS), heart rate, respiratory rate, systolic blood pressure and expected or

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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- 75 [30]. 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 = $A^2 + B^2 + C^2$. The Dependent variables were adherence to blood transfusion guidelines and blood transfusion reactions.

Data Collection

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

From March 2019 to January 2020 by the Principal Investigator (PI) and three Research Assistants (RA) under the guidance of the supervisors. The RA included one Clinical Officer Intern and two Nursing Officers. They were selected on the basis of availability and being conversant with the orthopaedic trauma care units. The PI trained the RA on patient enrolment, ethics and data collection. The PI and RA 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.

The study objective was addressed by describing socio-demographic and clinical characteristics of transfused patients, evaluating clinical, laboratory and transfusion data against adherence to MTRH transfusion guidelines.

Study Procedure Schema

A schema on the study procedure for each patient was as follows:

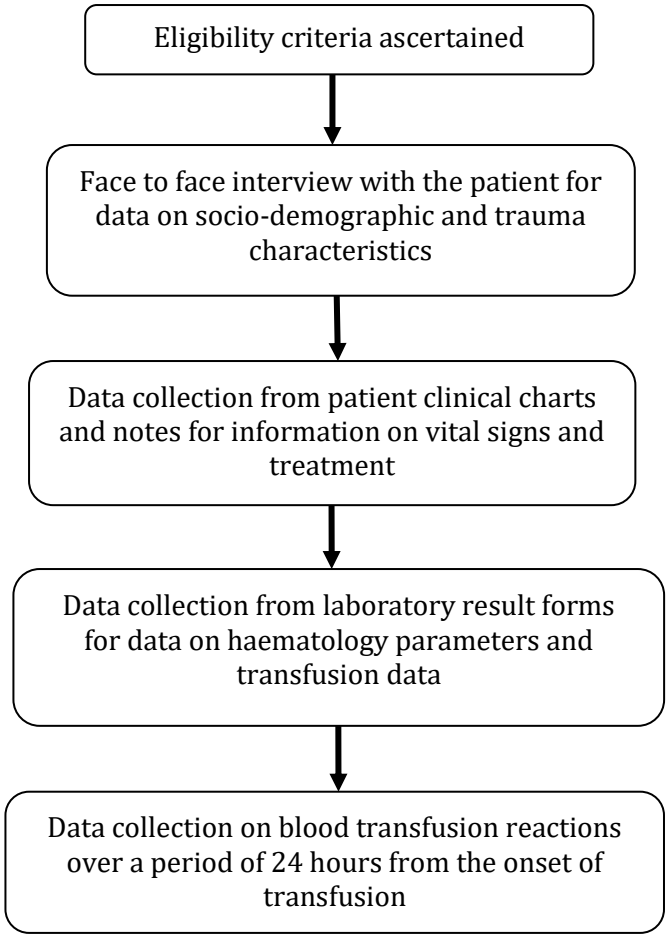

Figure 1: Study Procedure Schema

Data Management

The filled questionnaires were checked 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 [31] 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 involved use of descriptive statistics- 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. Data analysis also involved use of inferential statistics whereby Fisher's Exact Test was used to assess associations between categorical variables and Kruskal-Wallis Test was used for continuous independent variables. A *p*- value of less than 0.05 was considered statistically significant. Data presentation was eventually done in the forms of prose, tables and figures.

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:

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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

The Proportion of Adherence to Guidelines

The proportion adherent to blood transfusion guidelines criteria was 16.7% [95% CI: (10.75, 24.14)]. Majority of the patients, 127 of 132 (96.2%) received packed red blood cells followed by 5 of 132 (3.8%) patients who received whole blood. Only two patients received platelets in addition to packed red blood cells transfusion.

Out of the whole blood transfusions, the proportion adherent to guidelines was 20% attributed to compliance with pre-transfusion systolic blood pressure threshold while non-adherence to guidelines was 80 % due to non-compliance with any of the whole blood transfusion guidelines criteria.

Of packed red blood cells transfusions, the proportion adherent to guidelines was 16.5%. Of these, 81% were due to compliance to pre-transfusion haemoglobin / haematocrit thresholds, 9.5 % to estimated / expected blood loss threshold and another 9.5% due to both. Conversely, the proportion non-adherent to guidelines was 83.5%. Among packed red blood cells transfusions non-adherent to guidelines, 0.9% were due to non-compliance to haemoglobin / haematocrit thresholds, 70% to estimated / expected blood loss threshold and 29.1% due to non-compliance with both as shown in Figure 1.

According to the blood transfusion requests, the transfusion prescribers were residents at 55%, medical officers at 25% and clinical officers at 20%.

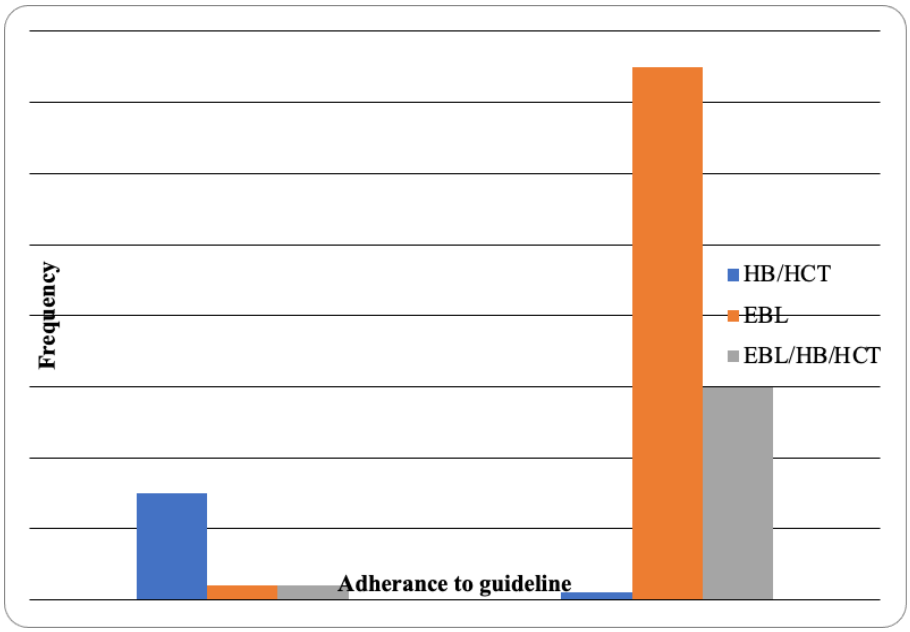

Figure 1: Comparison of reasons for adherence / non-adherence to guidelines

Factors Associated with Adherence to Blood Transfusion Guidelines

Table 1: Bivariate analysis of association between socio-demographic characteristics and adherence to blood transfusion guidelines

Characteristics	Adherence to blood transfusion guidelines		Total n=132	*p*-value
	Yes n = 22	No n = 110		
Age Group				0.54[1]
< 20 years	1 (14.3%)	6 (85.7%)	7 (100%)	
21 to 30 years	6 (14.3%)	36 (85.7%)	42 (100%)	
31 to 40 years	9 (26.5%)	25 (73.5%)	34 (100%)	
41 to 50 years	1 (5.0%)	19 (95.0%)	20 (100%)	
51 to 60 years	1 (12.5%)	7 (87.5%)	8 (100%)	
61 to 70 years	2 (22.2%)	7 (77.8%)	9 (100%)	
> 70 years	2 (16.7%)	10 (83.3%)	12 (100%)	
Sex				1.00[1]
Female	5 (16.1%)	26 (83.9%)	31 (100%)	
Male	17 (16.8%)	84 (83.2%)	101(100%)	
Education Level				0.77[1]
College/University	2 (25.0%)	6 (75.0%)	8 (100%)	
High School	9 (18.8%)	39 (81.2%)	48 (100%)	
Primary School	10 (15.6%)	54 (84.4%)	64 (100%)	
No Formal Education	1 (8.3%)	11 (91.7%)	12 (100%)	
Occupation				0.63[1]
Semi-skilled worker	9 (17.0%)	44 (83.0%)	53 (100%)	
Skilled worker	3 (30.0%)	7 (70.0%)	10 (100%)	
Student	0 (0.0%)	5 (100.0%)	5 (100%)	

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Unskilled worker	10 (15.6%)	54 (84.4%)	64 (100%)	
Referral Status				1.00[1]
Non-Referral	6 (16.2%)	31 (83.8%)	37 (100%)	
Referral	16 (16.8%)	79 (83.2%)	95(100%)	

[1]Fisher's Exact Test

There was no statistically significant association between socio-demographic characteristics and adherence to blood transfusion guidelines at bivariate analysis as shown in Table 1.

Table 2: Bivariate analysis of association between trauma characteristics and adherence to blood transfusion guidelines

Characteristics	**Adherence to blood transfusion guidelines**		**Total n=132**	***p*- value**
	Yes n = 22	**No n = 110**		
Mechanism of injury				0.83[1]
Assault	1 (20.0%)	4 (80.0%)	5 (100%)	
Falls	2 (10.5%)	17 (89.5%)	19 (100%)	
Gunshot	0 (0.0%)	3 (100.0%)	3 (100%)	
Road Traffic Accidents	19 (18.1%)	86 (81.9%)	105(100%)	
Injury Severity Score				0.26[2]
Count	22	110	132	
Median (IQR)	10 (9, 14)	10 (9, 13)	10 (9, 13)	
Site of injury				0.48[1]
Isolated long bone	15 (15.3%)	83 (84.7%)	98 (100%)	
Multiple trauma	6 (20.0%)	24 (80.0%)	30 (100%)	
Pelvis	1 (33.3%)	2 (66.7%)	3 (100%)	
Spine	0 (0.0%)	1 (100.0%)	1 (100%)	
Surgery				0.40[1]
Amputation	0 (0.0%)	6 (100.0%)	6 (100%)	
Debridement	12 (20.7%)	46 (79.3%)	58 (100%)	
External fixation	2 (33.3%)	4 (66.7%)	6 (100%)	
Grafting	0 (0.0%)	1 (100.0%)	1 (100%)	
ORIF	8(13.1%)	53(86.9%)	61(100%)	

[1]Fisher's Exact Test
[2]Kruskal-Wallis rank sum test

There was no statistically significant association between trauma characteristics and adherence to blood transfusion guidelines at bivariate analysis as shown in Table 2.

Table 3: Bivariate analysis of association between laboratory characteristics and adherence to blood transfusion guidelines

Characteristics	**Adherence to blood transfusion guidelines**		**Total n=132**	***p*-value**
	Yes n = 22	**No n = 110**		
Haemoglobin(g/dl)				**<0.001[1]**
Count	22	110	132	
Median (IQR)	6.90 (6.38, 7.53)	9.00 (8.50, 10.80)	8.90 (7.98, 10.35)	

Haemoglobin Category				**<0.001[2]**
<7	15 (93.8%)	1 (6.2%)	16 (100%)	
7 – 10	3 (3.8%)	75 (96.2%)	78 (100%)	
>10	4 (10.5%)	34 (89.5%)	38 (100%)	
Haematocrit (%)				**<0.001[1]**
Count	22	110	132	
Median (IQR)	19.15 (17.80, 22.65)	26.85 (24.23, 31.88)	26.10 (23.15, 30.48)	
Platelets (10^9/L)				0.838[1]
Count	22	110	132	
Median (IQR)	437.00 (196.50, 589.25)	325.00 (223.00, 548.25)	330.00 (218.5, 578.00)	
Blood component				1.000[2]
PRBC	21 (16.5%)	106 (83.5%)	127 (100%)	
Whole blood	1 (20.0%)	4 (80.0%)	5 (100%)	

[1]Kruskal-Wallis rank sum test
[2]Fisher's Exact Test

There was a statistically significant association between adherence to blood transfusion guidelines and pre-transfusion haemoglobin and haematocrit levels at bivariate analysis (*p* <0.001) as shown in Table 3.

Table 4: Association between blood transfusion reactions and adherence to blood transfusion guidelines

	Adherence to blood transfusion guidelines		**Total (n=132)**	***p*-value**
	Yes n = 22	**No n = 110**		
Blood Transfusion reaction				0.464[1]
None	21 (17.9%)	96 (82.1%)	117 (100.0%)	
Present	1 (6.7%)	14 (93.3%)	15 (100.0%)	

[1]Fisher's Exact Test for Count Data

There was no statistically significant association between blood transfusion reactions and adherence to blood transfusion guidelines at bivariate analysis as shown in Table 4.

Table 5: Association between prescribing clinician cadre and adherence to blood transfusion guidelines

Cadre	**Adherence to blood transfusion guidelines**		***p*-value**
	Yes n = 22	**No n = 110**	
Resident	13 (17.8)	60 (82.2)	0.815[1]
Medical officer	6 (18.2)	27 (81.8)	
Clinical officer	3 (11.5)	23 (88.5)	

[1]Fisher's Exact Test for Count Data

There was no statistically significant association between the prescribing clinician cadre and adherence to blood transfusion guidelines at bivariate analysis as shown in Table 5.

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DISCUSSION

Although numerous blood products are now in existence, this study in concurrence with Rotich [12] who found out that packed red blood cells was the most transfused blood component followed by whole blood and platelets being the least. Perhaps the health workers are now more knowledgeable about available blood products plus their uses and are utilizing the transfusion guidelines in their prescription. Whole blood is also increasingly being separated into various blood components at the local regional blood bank. Additionally, packed red blood cells are the appropriate blood products for correction of anaemia.

The proportion adherent to blood transfusion guidelines in this study was low at 16.7 % in contrast with findings by Abbas et al. [18] where 35% of transfusions were adherent to guidelines criteria. This difference could be attributed to variance in specific transfusion criteria thresholds applied in evaluation of adherence to transfusion guidelines. In literature, the proportion of appropriate transfusions ranges from 3% to 42.3% [18] and 4% to 66% as documented by Kipkulei et al. [22]. Thus, it is evident that large proportions of transfusions do not adhere to guidelines criteria and result in unnecessary blood transfusions. The low proportion of adherence in this study could also suggest inadequate awareness of institutional transfusion guidelines. Njoroge et al. [21] also reiterated on the need for selective cross-matching, transfusion only for patients with low haemoglobin levels, and early identification and mitigation of factors contributing to blood loss and transfusion.

Generally, transfusion practices vary enormously because of variability in guidelines criteria, study population characteristics, institutional processes and practices. In this study, the reasons for non-adherence to the blood transfusion guidelines were non-compliance with patient's clinical status findings threshold at 70 %, haemoglobin threshold at 0.9 % and both at 29. 1%.

In this study, only 5.3% of patients had documentation for estimated blood loss in contrast with findings by Abbas et al. [18] in a study among transfused orthopaedic trauma patients at Aga Khan University Hospital, Karachi, Pakistan where estimated blood loss was documented for all patients. Estimated and / or expected blood loss forms an essential part of decision making in blood transfusion [18]. Blood requests in which clinical findings including blood loss are documented have a reduced risk of inappropriate transfusions. If clinical findings are well documented and given a proper consideration as per blood transfusion guidelines, inappropriate transfusions are eventually reduced resulting in blood conservation. Hospital blood transfusion units might be of help in issuing blood only for properly documented requests that meet transfusion thresholds.

Most of the prescriptions were done by the residents with the least by clinical officers. The variation in the prescription pattern among these cadres could be attributed to level of knowledge hierarchy and responsibility in decision making. These cadres may not be the actual decision makers since clinical decisions in patient care are usually made by the senior most health care team member, usually a consultant.

This study found that the factors significantly associated with adherence to transfusion guidelines were hemoglobin and haematocrit levels ($p < 0.001$) in agreement with Shander et al. [23] where pre-transfusion haemoglobin was noted to be associated with appropriateness

of transfusion. This finding also concurs with the observation made by Verlicchi et al. [24]. where clinicians waited for lower haemoglobin values for blood transfusion to be triggered. Factors not significantly associated with adherence to transfusion guidelines included socio-demographic and trauma characteristics plus blood transfusion reactions.

CONCLUSION AND RECOMMENDATIONS

The conclusion made emanated from the discussed results, guided by the specific objectives:

1. Most patients were males, majority of injuries sustained were due to road traffic accidents, majority were transfused with packed red blood cells
2. The proportion adherent to the institutional transfusion guidelines was low at 16.7%. Pre-transfusion haemoglobin and haematocrit levels were the factors associated with adherence to guidelines.

Recommendations: Emanated from conclusion made:

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. A further study among clinicians to assess their knowledge about blood transfusion and their experiences on transfusion practices in orthopaedic trauma units at MTRH is necessary.

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