PRESCRIPTION AND CONSUMPTION PATTERNS OF BLOOD AND BLOOD COMPONENTS IN PATIENTS UNDERGOING ORTHOPAEDIC AND NEUROSURGICAL PROCEDURES AT MUHIMBILI ORTHOPAEDIC INSTITUTE, DSM, TANZANIA.

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Department of Anaesthesiology

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By

Alex Loth Ernest (MD)

A Dissertation Submitted in (Partial) Fulfilment of the Requirements for the Degree of Master of Medicine (Anaesthesiology) of

Muhimbili University of Health and Allied Sciences
October, 2017

CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by Muhimbili University of Allied Sciences a dissertation titled ***Prescription and consumption patterns of blood and blood components in patients undergoing orthopaedic and neurosurgical procedures at Muhimbili Orthopaedic Institute, Dar Es Salaam, Tanzania, in*** (Partial) Fulfilment of the Requirements for the degree of Master of Medicine (Anaesthesiology) of Muhimbili University of Health and Allied Sciences.

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Date: _____

DECLARATION AND COPYRIGHT

I, **Dr. Alex Loth Ernest**, declare that this **dissertation** is my own original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

Signature……...…… Date……...……..…….

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DEDICATION

To my loving wife Dr. Beatrice P. Kisimbo, daughter Alice Loth and son Albert Loth for their love, encouragement and patience. I'm grateful.

TABLE OF CONTENTS

CERTIFICATION ii
DECLARATION AND COPYRIGHT iii
ACKNOWLEDGEMENT iv
DEDICATION v
LIST OF ABBREVIATIONS ix
DEFINITION OF KEY TERMS: x
ABSTRACT: xi
CHAPTER ONE 1
INTRODUCTION: 1
1.1 Background: 1
1.2 Literature review: 2
1.3 Statement of problem: 6
1.4 Rationale: 7
1.5 Research Question: 7
CHAPTER TWO 8
OBJECTIVES 8
2.1 Broad objective: 8
2.2 Specific objectives: 8
CHAPTER THREE 9
3.0 MATERIAL & METHODS 9
3.1 Study design 9
3.2 Study area 9
3.3 Study population 9
3.4 Sample Size 9
3.5 Inclusion criteria 10
3.6 Exclusion criteria 10
3.7 Data collection 10
3.8 Data Analysis 10
3.9 Ethical Considerations 10

CHAPTER FOUR 11
4.0 RESULTS 11
4.1 Demographic and other characteristics 11
4.2 Blood crossmatch and transfusion patterns. 12
4.3 Blood utilization indices for departments 13
4.4 Transfusion indices for orthopaedic procedures. 14
4.5 Transfusion indices for neurosurgical procedures 15
CHAPTER FIVE 16
5.0 DISCUSSION 16
CHAPTER SIX 19
6.0 CONCLUSION AND RECOMMENDATION. 19
REFERENCES: 20
APPENDICES 23
Appendix 1: Questionnaire 23
Appendix 2: Ethical clearance 24
Appendix 3: Permission to conduct research: 25

LIST OF TABLES

Table 1: DEMOGRAPHIC AND OTHER CHARACTERISTICS. 11
Table 2: BLOOD CROSSMATCH AND TRANSFUSION PATTERNS..... 12
Table 3: BLOOD UTILIZATION INDICES FOR DEPARTMENTS 13
Table 4: TRANSFUSION INDICES FOR ORTHOPAEDIC PROCEDURES..... 14
Table 5: TRANSFUSION INDICES FOR NEUROSURGICAL PROCEDURES 15

LIST OF ABBREVIATIONS:

ASA	American Society of Anesthesiologists
CTR	Crossmatch to Transfusion Ratio
DCR	Damage Control Resuscitation
FFP	Fresh Frozen Plasma
MUHAS	Muhimbili University of Health and Allied Sciences
MOI	Muhimbili Orthopaedic Institute
MT	Massive Transfusion
MTP	Massive Transfusion Protocol
MSBOS	Maximum Surgical Blood Ordering Schedules
NO	Nitric oxide
PRBCs	Packed Red Blood Cells
RBCs	Red Blood Cells
rFVII	Recombinant activated factor VII
2, 3-DPG	2 3-Diphosphoglycerate

DEFINITION OF KEY TERMS:

Blood transfusion: The transfer of blood or blood components from one person (the donor) into the bloodstream of another person (the recipient).

Blood Components:

(Red cell concentrates, Platelet concentrates, Fresh plasma and Cryoprecipitate)

Massive Transfusion: Massive blood transfusion is defined as the transfusion of blood volume to patient equivalent to his/her total blood volume (7%-8% of the body weight) in less than 24 hours, or as the acute administration of more than half the patient's estimated blood volume per hour or transfusions of 10 units or more in twenty-four hours.[1]

Crossmatch to transfusion ratio (CTR) = number of units crossmatched/number of units transfused. A ratio of 2.5 and below is considered indicative of significant blood usage.

Transfusion probability (%T) = number of patients transfused/number of patients crossmatched × 100. A value of 30% and above is considered indicative of significant blood usage.

Transfusion index (TI) = number of units transfused/number of patients crossmatched. A value of 0.5 or more is considered indicative of significant blood utilization.

Maximal Surgical Blood Order Schedule (MSBOS) = 1.5 × TI.

ABSTRACT:

Background: Blood is a scarce resource, since there's limited availability of donated blood and absence of effective substitute that can perform the vital functions of blood; therefore, clinicians should cautiously assess the appropriateness of prescription of blood and blood components to minimize wastage of blood resources and optimize the utilization of blood products.

Objective: To determine prescription and consumption patterns of blood and blood components in patients undergoing orthopaedic and neurosurgical procedures at Muhimbili Orthopaedic Institute, from May to September 2016.

Methodology: Prospective Descriptive Cross-Sectional study was conducted at MOI, over period of five months. Data for elective and emergency surgeries were collected from patient's case files, laboratory requisition forms and blood bank registries. Blood utilization was calculated using crossmatch to transfusion ratio (CTR), transfusion probability (%T), and transfusion index (TI) indices.

Results: During the study period, a total of 563 units of blood were crossmatched, and 502 units (89%) were transfused for 280 patients, and the overall blood transfusion of the requested blood which was explained by indices of CTR, %T, and TI were 1.12, 100%, and 1.79, respectively.

Conclusion: The data for the crossmatch to transfusion ratio (CTR), transfusion probability (%T), and transfusion index (TI) were optimal; Hence, Blood utilization was efficient in both orthopaedic and neurosurgical procedures.

CHAPTER ONE

INTRODUCTION:

1.1 Background:

The first successful transfuse blood from one human to another performed by British Obstetrician James Blundell in 1818.Karl Landsteiner discovered ABO blood groups in 1901.[2] Since then advances in transfusion medicine has made it rather safe, despite the phenomenal developments, blood transfusion still pose a risk for exposure to infectious and non-infectious complications.

Trauma is a major problem of public health importance. Globally, trauma is the leading cause of mortality and disability in adults.[3] An estimated five million people die every year worldwide from traumatic injuries.[4] Hemorrhage accounts for majority and early cause of preventable deaths, usually within the first 6 hours of admission.[5]Transfusion of blood and blood products is vital during trauma patient resuscitation and intraoperative. The development of whole blood fractionation in the 1940s led to component therapy to predominate as the primary transfusion approach, due to concerns for resource utilization and safety.[6] To date, most of the problems surrounding blood transfusion medicine, in the early days, have been resolved. Now, transfusion practice is oriented towards giving the actual component of blood best suited for the patient's particular needs. This leads to better replacement therapy and more economical use of blood and blood products.

The blood component implies separation of whole blood into various potential components like packed red blood cells, platelets concentrates, fresh plasma and cryoprecipitate. Blood component therapy is used to correct coagulopathy and thrombocytopenia once exsanguinations has been stopped by physical means.[7]

Blood component therapy should only be given when the expected benefits to the patient are likely to outweigh the potential risks. It is crucial for clinicians to be aware of these potential risks to the recipient of blood and its products.

Blood components preparation and separation are undertaken to maximize the potential benefits of all the components present in whole blood. These products should be managed and stored at their optimum storage temperature to maximize its use.

1.2 Literature review:

Blood transfusion is a rational replacement therapy of proven clinical value and efficacy. To date, most of the problems surrounding blood transfusion medicine, in the early days, have been resolved. Now, transfusion practice is oriented towards giving the actual component of blood best suited for the patient's particular needs. This leads to better replacement therapy and more economical use of blood and blood components.

Since the introduction of blood transfusion into clinical practice, its appropriate use has been the subject of debate. The appropriate use of blood and blood products means the transfusion of safe blood products only to treat a condition leading to significant morbidity or mortality that cannot be prevented or managed effectively by other means.[8]

Recent studies have suggested that only 25% of trauma patients require a blood transfusion, and only 2-3% of them receive a massive transfusion.[9] A patient transfused with ten or more packed red blood cells (PRBCs) within first 24hours is said to have received a MT.[10] These patients are at high risk of early hemorrhagic death with a mortality rate of 40-70%.[4] In the last four decades, transfusion therapy has changed from the use of whole blood to mainly component therapy. Most developed countries and major health centers primarily use blood component in MT. However, many developing countries and the armed forces are still using whole blood due to concerns for safety and also due to the scarce resources.[11]

Retrospective data from recent war experiences recommend that whole blood is clinically superior to component therapy in severely traumatized patient requiring MT.[11] Since whole blood is not easily available in the main hospitals; clinicians are widely using damage control resuscitation (DCR) practices with the increased ratios of Plasma: Platelets: PRBCs during transfusion.[12]

Problems of RBCs storage varies from biochemical to physical changes that occur in the RBCs themselves, as well as the resultant changes in the entire RBC product (RBCs and supernatant, which includes anticoagulant-preservative solution and plasma) during storage.[13] The decreased 2, 3-DPG results in a shift in the oxygen dissociation curve to the left, which leads to less oxygen release than normal RBCs at the same partial pressure oxygen. Therefore, stored RBCs may not deliver oxygen to the tissues as well as fresh RBCs. 2, 3-DPG levels return to normal levels within 24hours after transfusion. In addition to biochemical changes, RBCs change from a deformable biconcave disk, to reversibly deformed echinocytes, to irreversibly deformed spherochinocytes with increased membrane stiffness. These morphological changes may also result in decreased oxygen transport because of the inability of the RBC to flow through the microcirculation and the increase in RBC and vascular endothelial interactions.[14] Recent data suggest that stored RBCs have reduced nitric oxide (NO) bioavailability. Because NO plays a vital role in the vasodilatation of blood vessels and, therefore, in oxygen delivery to tissues, in conjunction with loss of 2, 3-DPG and changes in deformability, stored RBCs may not have optimal oxygen delivery.[15]

Clinical guidelines guide the decision to transfuse blood and blood components, A clinical guidelines set in a nation provides rational and practical framework on which to base transfusion decision and practice and thus maximize patient safety.

Some indices are used to determine the efficiency of blood ordering system. Boral and Henry first suggested the use of crossmatch to transfusion ratio (CTR) in 1975.[16] Subsequently, a number of authors used CTR for evaluating blood transfusion practice. Ideally, this ratio should be 1.0, but a ratio of 2.5 and below was suggested to be indicative of efficient blood usage. The probability of a transfusion for a given procedure is denoted by %T and was proposed by Mead et al. in 1980. A value of 30% and above has been suggested as appropriate.[31] The average number of units used per patient crossmatched is indicated by the transfusion index (TI) and signifies the appropriateness of numbers of units crossmatched. A value of 0.5 or more is indicative of efficient blood usage.

The Ministry of Health, Community Development, Gender, Children and the Elderly through the National Blood Transfusion Service (NBTS) recently updated clinical guideline for the

appropriate use of blood and blood products, in which it ensures efficient utilization of blood and its component and at the same time ensuring the safety of the recipients. The guideline covers areas of general consideration to specific issues pertaining to each and every blood component available at the NBTS. Tanzania whole blood can be processed to four main components: Packed Red Blood cells, Fresh Frozen Plasma, single unit platelet (plasma rich) and whole blood units.[1]

The guideline also has Massive blood transfusion Protocol (MTP) in which aim of treatment is to restore an adequate blood volume and maintains blood composition within safe limits with regard to haemostasis, oxygen carrying capacity, oncotic pressure and biochemistry. The priority is for the definitive surgical arrest of haemorrhage in a patient with massive haemorrhage secondary to trauma.

The guideline also has the Maximum surgical blood-ordering schedule (MSBOS) which is designed to reduce blood wastage rates. It is a locally agreed tariff for ordering in elective surgery, which has been agreed by the surgeons, anaesthetists and Blood Bank.[1]

In 2007, Holcomb *et al*., while addressing early coagulopathy in trauma, advocated DCR, Early definitive hemorrhage control, Early and increased use of 1:1:1 FFP, PRBCs and platelets, and minimizing crystalloids, avoiding hypothermia, acidosis and coagulopathy, Hypotensive resuscitation strategies, use of other products like rFVII, tranexamic acid, and tris-hydroxymethyl aminomethane should be deliberated.[12]

In 2008, Holcomb *et al*., Addressed the optimal plasma and platelet to RBC ratios in massively transfused civilian trauma patients, found survival in civilian MT patients is associated with increased plasma and platelet ratios.[17]

In 2014, Mathew AS *et al*., made a comprehensive retrospective analysis of all conventional blood components over period of three years in a tertiary hospital. A total of 4013 blood units were supplied during the study period. PRBCs (42.5%) was the most utilized product followed by frozen plasma (30%) and platelets (27.5%).[18]

A survey on transfusion status in orthopaedic surgery at a trauma center by Soleimanha M*et al*.; found among 872 selected orthopaedic surgery candidates, 318 of them were crossmatched, and among those, 114 patients received a blood transfusion. In this study, the crossmatch to transfusion ratio was 6.4, transfusion possibility 36.47%, transfusion index 0.6, and maximal surgical blood order schedule 0.9.Therefore blood ordering was moderately higher than the standard.[19]

Ebose E M, *et al*.; 2008 conducted an audit of red blood cells ordering and pattern of utilization in different specialties in the hospital using the crossmatch ratio as a guide to achieving effective transfusion practices. The study revealed elevated CTR in different specialties, high CTR resulted in wastage of time and unnecessary costs of reagents.[20]

Tayara BK *et al*.; 2014 conducted a retrospective analysis blood utilization in orthopaedic and trauma practice. Blood products were requested for 223 trauma surgeries. In elective orthopaedic procedures, only 42.78% of the blood requested was utilized while in trauma patients it was 55.25%. They found major discrepancy between the blood requested and utilized.[21]

Davoudi-kiakalayeh *et al*. 2013; reviewed the blood ordering schedule in a tertiary trauma center, during the study period, 5981 units of blood were crossmatched for 1917 patients, and 1835 units of blood were transfused. This means that only 31% of blood was utilized while 69% was not needed.[22]

These studies show over ordering of blood, which leads to wastage of resources and recommends institutions on establishment and adherence to transfusion guidelines.

1.3 Statement of problem:

Blood is scarce resource, since there's limited availability of donated blood and absence of effective substitute that can perform the vital functions of blood; there is need for appropriate prescription of blood and blood components to minimize wastage of blood resources and optimize the utilization of blood products.

The clinicians should cautiously assess the appropriateness of indication before requesting various components, thereby preventing misuse and unnecessary exposure to various infectious and non-infectious complications. It's known, the supply of blood and blood components are finite, a high rate of inappropriate use has been reported around the world. At Muhimbili National Hospital in 2014, Akoko LO *et al*. observed that blood was over ordered for 76% of the patients who underwent elective general surgical and urological procedures.[23] This inappropriate use of blood and its components have a significant impact on the patients and the hospital staff in the form of health care cost, wastage of resources, depriving more needy patients and transmission of infection with unnecessary allergic reaction leading to high mortality and morbidity in patients.

1.4 Rationale:

Blood and its components are scarce resources whose demand often exceeds its supply. Blood and blood components are considered drugs because they are used in treatment of disease. As with any treatment, adverse effects may occur, necessitating careful consideration of therapy. Like any other therapeutic decision, the need for transfusion should be considered based on risks and benefits and other alternative treatments available to avoid over or under transfusion.

Analysis of the blood and its components prescription and consumption pattern will help to improve transfusion practice. It will be useful in education of those ordering blood components, potentially resulting in reduction of inappropriate use of blood components.

No such study as this has attempted to examine the prescription and consumption patterns of blood and its components prescription at this center.

And as a requirement in partial fulfillment of the requirements for the degree of Master of Medicine (Anesthesiology) of Muhimbili University of Health and Allied Sciences.

1.5 Research Question:

Is there appropriate prescription and consumption pattern of blood and blood components for patients undergoing orthopaedic and neurosurgical procedures at MOI?

CHAPTER TWO

OBJECTIVES

2.1 Broad objective:

To determine prescription and consumption patterns of blood and blood components in patients undergoing orthopaedic and neurosurgical procedures at MOI from May to September 2016.

2.2 Specific objectives:

1. To determine prescription patterns of Blood and Blood components in patients undergoing orthopaedic and neurosurgical procedures at MOI, from May to September 2016.
2. To determine consumption patterns of Blood and Blood components in patients undergoing orthopaedic and neurosurgical procedures at MOI, from May to September 2016.

CHAPTER THREE

3.0 MATERIAL & METHODS

3.1 Study design

A Prospective Descriptive Cross-sectional Hospital based Study, was conducted from May to September 2016.

3.2 Study area

The study was conducted at Muhimbili Orthopaedic Institute (MOI) located in Dar es Salaam, Tanzania. This facility is National tertiary hospital for orthopaedic and neurosurgery. It also serves as the university teaching hospital for Muhimbili University of Health and Allied Sciences. There is a total of 6 operating theatres, 1 for emergencies, 4 for orthopaedic cases, 1 for neurosurgical cases.

3.3 Study population

The study recruited adult patient between the age of 18 to 65years undergoing orthopaedic and neurosurgical procedures whom blood or blood components were prescribed.

3.4 Sample Size

Sample Size: -The formula used to calculate the minimum sample size

$$N = \frac{Z^2 P (1-P)}{E^2}$$

Where:

N: Number of patients constituting the minimum sample size.

Z: 95% confidence interval=1.96

P: Prevalence of appropriate blood utilization major general and urological surgeries at Muhimbili National Hospital= 24%.[23]

E: Standard error=0.05

Hence: $N = \frac{1.96^2 \times 0.24 (1-0.24)}{0.05^2} = 280$ Patients.

Sample Size: A total of 280 patients were recruited in this study.

3.5 Inclusion criteria

1. Patients who were scheduled for orthopaedic and neurosurgical procedures whom blood or blood components were prescribed.
2. Adult between the ages of 18 to 65 years.
3. Patient with physical status ASA I and ASA II.

3.6 Exclusion criteria

1. Patients with known bleeding disorders.
2. Patients below 18 years and above 65 years.
3. Patient with physical status ASA III, IV and V.

3.7 Data collection

A structured questionnaire was used to collect data from laboratory blood requisition forms; patients case files and blood bank registry. Patient's age and sex, diagnosis, procedure performed, number of units prescribed, crossmatched, and transfused, number of patients crossmatched and transfused were collected. Patients were not interviewed.

3.8 Data Analysis

Data collected was cleaned, coded, entered and analyzed by SPSS computer software version 20. Crossmatch to transfusion, CTR (Units crossmatched/ Units transfused), transfusion probability (Units transfused X 100/ Patients crossmatched) and transfusion index (Units transfused/ Patients crossmatched) were computed. CTR of <2.5, Transfusion probability >30, and Transfusion index >0.5 indicated significant usage of blood.

3.9 Ethical Considerations

Ethical clearance was sought from the MUHAS research and publication committee, and MOI management approved permission to conduct this study. The confidentiality of the information obtained was assured by using code numbers rather than personal identification names and all the research data stored in the Anaesthesiology Department.

CHAPTER FOUR

4.0 RESULTS

During the study period which ran for five months, a total of 563 units of whole blood were crossmatched, and 502 units were transfused for 280 patients who met inclusion criteria. The study recruited a total of two hundred and eighty patients who were scheduled for orthopaedic and neurosurgical procedures from May 2016 to September 2016. Patients included were those who underwent both elective and emergency orthopaedic and neurosurgical procedures.

4.1 Demographic and other characteristics

Among those recruited into the study, 199(71.1%) patients were males, and 81(33.9%) were females. Majority of the patients, 185(66.1%) were elective procedures while 95 (33.9%) patients were emergency procedures. And according to department, 228 (81.4%) patients were orthopaedic cases while 52(18.6%) patients were neurosurgical cases.

Table 1: DEMOGRAPHIC AND OTHER CHARACTERISTICS.

CHARACTERISTICS	TOTAL No.	Percent (%)
SEX		
Male	199	71.1
Female	81	28.9
TYPE OF OPERATION		
Elective	185	66.1
Emergency	95	33.9
DEPARTMENT/CASES		
Orthopaedic	228	81.4
Neurosurgery	52	18.6

4.2 Blood crossmatch and transfusion patterns.

A total of 563 units of blood were crossmatched, and 502 units were transfused for 280 patients who underwent orthopaedic and neurosurgical procedures as emergency or elective cases. Among 95 patients who underwent emergency operation, 193 units of blood were crossmatched, and 178 units were transfused. In patients who underwent elective surgery, 370 units of blood were crossmatched, out of which only 324 units of blood for were transfused. The highest crossmatched units were made for elective patients (370) as compared to emergency cases (193), as shown in Table 2.

Table 2: BLOOD CROSSMATCH AND TRANSFUSION PATTERNS

DEPARTMENT	NUMBER OF UNITS		NUMBER OF PATIENTS	
	Crossmatched	Transfused	Crossmatched	Transfused
ORTHOPAEDIC				
Elective	292	264	145	145
Emergency	168	156	83	83
Subtotal	**460**	**420**	**228**	**228**
NEUROSURGERY				
Elective	78	60	40	40
Emergency	25	22	12	12
Subtotal	**103**	**82**	**52**	**52**
TOTAL	**563**	**502**	**280**	**280**

4.3 Blood utilization indices for departments

As shown in Table 3, a total of 563 units of blood were crossmatched, and 502 units (89%) were transfused for 280 patients and the overall blood transfusion of the requested blood which was explained by indices of CTR, %T, and TI were 1.12, 100%, and 1.79, respectively. And this translates to overall appropriate blood ordered and utilization. These blood utilization indices showed a different value between each department. In department of orthopaedic, for instance, overall CTR was 1.1 with high ratio in elective than emergency (1.1 versus 1.08). Also, the overall %T was 100% in both emergency and elective patients. On the other hand, in department of neurosurgery, the overall CTR was 1.26 with elective surgical patients having the high CTR (1.3) than emergency patients (1.13). Moreover, the overall %T and TI were 100% and 1.58, respectively.

Table 3: BLOOD UTILIZATION INDICES FOR DEPARTMENTS

DEPARTMENT	**CTR**	**%T**	**TI**
ORTHOPAEDIC			
Elective	292 /264 **1.1**	145/145, **1**	264/ 145, **1.82**
Emergency	168/156, **1.08**	83/ 83, **1**	156/83, **1.88**
Subtotal	**460/420, 1.1**	**228/228, 1**	**420/228, 1.84**
NEUROSURGERY			
Elective	78/60, **1.3**	40/40, **1**	60/40,**1.5**
Emergency	25/22, **1.13**	12/12**, 1**	22/12, **1.83**
Subtotal	**103/82, 1.26**	**52/52, 1**	**82/52, 1.58**
TOTAL	**(563/502), 1.12**	**(280/280), 1**	**(502/280), 1.79**

4.4 Transfusion indices for orthopaedic procedures.

Among 228 patients who underwent orthopaedic procedures, a total of 460 units of blood were crossmatched of which 91.3% (420) were transfused. Table 4 describes transfusion indices (**CTR**, **%T** and **TI)** according to each procedure. The overall transfusion indices for orthopaedic procedures were **CTR** (1.1), **%T (**100%) and **TI (**1.84) was within the optimal range.

Table 4: TRANSFUSION INDICES FOR ORTHOPAEDIC PROCEDURES.

PROCEDURE	**Frequency**	**CTR**	**%T**	**TI**
Acetabular Reconstruction	26	(56/53), **1.06**	(26/26), **1**	(53/26), **2.04**
AKA	7	(14/13), **1.08**	(7/7), **1**	(13/7), **1.86**
BKA	15	(36/34), **1.06**	(15/15), **1**	(34/15), **2.27**
External Fixation Femur	2	(4/4), **1**	(2/2), **1**	(4/2), **2**
External Fixation Humerus	3	(4/4),**1**	(3/3), **1**	(4/3), **1.33**
External Fixation Knee	8	(14/14),**1**	(8/8), **1**	(14/8),**1.75**
External Fixation Tibia	27	(51/51),**1**	(27/27), **1**	(51/27),**1.89**
Implant Removal Femur	4	(5/5),**1**	(4/4), **1**	(5/4), **1.25**
ORIF Femur	69	(132/114),**1.16**	(69/69), **1**	114/69, **1.65**
ORIF Humerus	4	(6/4), **1.5**	(4/4), **1**	(4/4), **1**
Revision THR	11	(29/27), **1.07**	(11/11),**1**	(27/11), **2.45**
Revision ORIF Femur	7	(14/10), **1.4**	(7/7), **1**	(10/7), **1.43**
THR	45	(91/87), **1.05**	(45/45), **1**	(87/45),**1.93**

4.5 Transfusion indices for neurosurgical procedures

Among 52 patients who underwent neurosurgical procedures, a total of 103 units of blood were crossmatched of which 82 (79.6%) were transfused. Table 5 describes transfusion indices (**CTR**, **%T** and **TI)** according to each neurosurgical procedure done. The overall transfusion indices for neurosurgical procedures were **CTR** (1.26), **%T (**100%) and **TI (**1.58) was within the optimal range.

Table 5: TRANSFUSION INDICES FOR NEUROSURGICAL PROCEDURES

PROCEDURE	Frequency	CTR	%T	TI
Burr Hole for Haematoma drainage	2	(4/4), **1**	(2/2), **1**	(4/2), **2**
Craniotomy &Haematoma evacuation	13	(27/22),**1.23**	(13/13),**1**	(22/13),**1.69**
Craniotomy & Brain Tumor excision	9	(16/14),**1.14**	(9/9),**1**	(14/9),**1.56**
Laminectomy	12	(23/16),**1.44**	(12/12),**1**	(16/12),**1.33**
Laminectomy & Discectomy	7	(14/8),**1.75**	(7/7), **1**	(8/7),**1.14**
Laminectomy & Spine tumor excision	9	(19/15),**1.27**	(9/9),**1**	(15/9),**1.67**

CHAPTER FIVE

5.0 DISCUSSION

Blood and its component play a major role in the resuscitation and management of both elective and emergency surgical patients. Despite this advantage, currently, there is a limited supply with increasing demand and under-utilization of the requested blood worldwide. Ordering large quantities of crossmatched blood for surgical patients of which little is ultimately utilized, creates an artificial shortage in the reserves, wastes valuable technical time and squanders expensive reagent. Blood banks face an ever-increasing demand for blood and its components. When this demand exceeds the resources of the blood bank, implementation of the surgical lists will be compromised. Preoperative over ordering of blood has been documented since 1976 when Friedman et al. published their findings. Subsequently, a number of studies have also shown over ordering of blood in different parts of the countries.[16, 24] Data from developing countries have shown irrational over ordering of blood in 40% to 70% of patients transfused.[25]Since the introduction of blood transfusion into clinical practice; its appropriate use has been the subject of debate. It has been reported that only 30% of crossmatched blood is used in elective surgery.[26] This study revealed that 89%of the crossmatched blood was utilized, in contrast to a study conducted at Muhimbili National Hospital in2014, Akoko LO *et al* observed that only 23.6% of ordered blood were utilized for the patients who underwent elective general surgical and urological procedures.[23] In Zambia, Alick *et al.* conducted a study on analysis of blood crossmatch ordering practice in surgical patients, found only 35.2% of crossmatched blood units were transfused.[27] Musa, *et al,* they studied pattern of blood transfusion requests and utilization in Nigeria found that only 34.51% of crossmatched blood were transfused.[28]

Samaa Z. I *et al.,* in Egypt examined blood utilization for elective surgeries found only 25.2% of total blood crossmatched was utilized.[29]In India, a study done by Vibhute *et al*, which evaluated blood ordering and transfusion practices in elective general surgical procedure only 23.14 % of blood was utilized.[24]A study in Saudi Arabia by Tayara BK *et al*; 2014 on blood utilization in orthopaedic and trauma practice, in elective orthopaedic procedures only 42.78%

of the blood requested was utilized while in trauma patients it was 55.25%.[21]In Iran, Davoudi-kiakalayeh *et al*, reviewed the blood ordering schedule in a tertiary trauma center and found that only 31% of blood was utilized.[22]

Boral Henry was the first, and a number of authors thereafter, used crossmatch to transfusion ratio for evaluating blood transfusion practices. Ideally, this ratio should be 1.0, but a ratio of 2.5 and below was suggested to be indicative of efficient blood usage.[16]According to this recommendation, the overall CTR of 1.12 that was reported in the current study was considered to be indicative efficient blood usage. Other studies demonstrated high CTR, in Zambia Alick *et al* found overall CTR 2.8, [27] in Nigeria, Musa*et al* observed CTR of 2.9. [28] The overall CTR of 3.9 was reported in Egypt, by Samaa Z. I et al.[29]In Ethiopia, Tadesse Belayneh *et al.,* conducted a study on Blood Requisition and Utilization Practice in Surgical Patients, the overall CTR was2.3.[30]

Mead et al., suggested the probability of transfusion for a given procedure (%T), which indicates efficient use of blood. Accordingly, a value of 30% and above has been suggested to be appropriate and signifies the appropriateness of number of units crossmatched.[31] Based on what is recommended in the above literature, the results of this study revealed an overall %T of 100%, which was indicative of appropriate utilization compared to unit crossmatched blood. This finding was different from that reported by other studies, in study conducted in Zambia it was 20%[27] in a study done in Egypt where it was 36.9% [29],in Ethiopia overall transfusion probability (%T) was 47%.[30]Similar to overall %T, this study reported the probability of transfusion (%T) of 100% in both orthopaedic and neurosurgery departments; and hence was considered appropriate showing efficient utilization in all the departments. Regarding transfusion index (TI), a value of 0.5 or more is indicative of efficient blood usage and signifies the appropriateness of number of units transfused.[16] The overall TI reported in the current study was 1.79. This finding was higher than that which has been found in studies conducted in Zambia 0.40,[27] Egypt 0.69,[29]and that reported in Ethiopia 0.77.[30] Transfusion index (TI) for both emergency and elective patients under the current study was considered appropriate in both departments.

The overall finding of this study, a total of 563 units of blood were crossmatched and 502 units (89%) were transfused for 280 patients and the overall blood transfusion of the requested blood which was explained by indices of C/T ratio, %T, and TI were 1.12, 100%, and 1.79, respectively. From literature, a CTR of <2.5, Transfusion probability(%T) >30%, and Transfusion index(TI) >0.5 indicated significant usage of blood.[16] Therefore CTR, %T, and TI index were considered to be optimal as compared with the standard figures. Blood utilization was efficient in both emergency and elective procedures.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION.

Results from this study have revealed optimal ordering of blood for crossmatching for those for patients undergoing orthopaedic and neurosurgical procedures, as the overall transfusion indices CTR, %T, and TI were considered to be optimal as compared with the standard figures.

Despite the results shown by this study, developing a blood ordering policy, which is a guide to expect normal blood usage for surgical procedures, can decrease over ordering of blood thereby reducing unnecessary compatibility testing, returning of unused blood, and wastage due to outdating. It also allows for a more efficient management of blood inventory. In this respect, the hospital blood transfusion committee should formulate maximum surgical blood order schedules for selected surgical procedures, conduct regular auditing about the effectiveness of the blood requesting policy using the crossmatch to transfusion ratio, and offer periodic feedbacks to improve blood ordering, handling, distribution, and utilization practices of this scarce resource.

Acute normovolemic haemodilution in patients with ASA status I and II could minimize the need for perioperative homologous blood transfusion**.**

Further study is recommended to address the perioperative transfusion triggers for blood and its components.

REFERENCES:

1. The United Republic Of Tanzania.Clinical Guideline for Appropriate Use of Blood and Blood Products. Second Edition. June, 2015.
2. Giangrande PLF. The history of blood transfusion. Br J Haematol. 2000;110(4):758–67.
3. Lopez AD, Mathers CD, Ezzati M, Jamison DT, Murray CJL. Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data. Lancet. 2016 Jan 2;367(9524):1747–57.
4. Holcomb JB. Optimal use of blood products in severely injured trauma patients. Hematology Am Soc Hematol Educ Program. 2010;2010(1):465–9.
5. Demetriades D, Murray J, Charalambides K, Alo K, Velmahos G, Rhee P, et al. Trauma fatalities. J Am Coll Surg. 2016 Jan 4;198(1):20–6.
6. Holcomb JB, Spinella PC. Optimal use of blood in trauma patients. Biologicals. 2010;38(1):72–7.
7. Devon R, Hospital E. BLOOD COMPONENT THERAPY. ANAESTHESIA TUTORIAL OF THE WEEK 262. 2012.
8. World Health Organization. The Clinical Use of Blood The Clinical Use of Blood. 2002;349.
9. Como JJ, Dutton RP, Scalea TM, Edelman BB, Hess JR. Blood transfusion rates in the care of acute trauma. Transfusion. 2004;44(6):809–13.
10. Malone DL, Hess JR, Fingerhut A. Massive transfusion practices around the globe and a suggestion for a common massive transfusion protocol. J Trauma. 2006;60(6 Suppl): S91–6.
11. Spinella PC, Perkins JG, Grathwohl KW, Beekley AC, Holcomb JB. Warm Fresh Whole Blood Is Independently Associated With Improved Survival for Patients With Combat-Related Traumatic Injuries. J Trauma Acute Care Surg. 2009;66(4).
12. Holcomb JB, Jenkins D, Rhee P, Johannigman J, Mahoney P, Mehta S, et al. Damage control resuscitation: directly addressing the early coagulopathy of trauma. J Trauma. 2007;62(2):307–10.

13. Tinmouth A, Fergusson D, Yee IC, Hébert PC. Clinical consequences of red cell storage in the critically ill. Transfusion. 2006;46(11):2014–27.
14. Alessandro AD, Liumbruno G, Grazzini G, Zolla L. Red blood cell storage : the story so far. Blood Transfus. 2010 Apr;8(2):82-8
15. Bonaventura J.Clinical implications of the loss of vasoactive nitric oxide during red blood cell storage. PNAS.2007;104(49) 19165-6.
16. Friedman BA, Oberman HA, Chadwick AR, Kincdon ANDKI. The Maximum Surgical Blood Order Schedule and Surgical Blood Use in the United States.Transfusion.1976;16.
17. Holcomb JB, Wade CE, Michalek JE, Chisholm GB, Zarzabal LA, Schreiber MA, et al. Increased Plasma and Platelet to Red Blood Cell Ratios Improves Outcome in 466 Massively Transfused Civilian Trauma Patients. Trans . Meet Am Surg Assoc. 2008;(126):97–108.
18. Mathew AS, Kurian SS, Sundaresan NP, Prema F, John A, Chitra B. Pattern of Blood Component Utilization in a Teaching Hospital in South Kerala. Acad Med J India. 2014;II(1):28–31.
19. Soleimanha M, Mirbolook A, Sedighinejad A, Mardani-kivi M, Naderi-nabi B, Chavoshi T, et al. A Survey on Transfusion Status in Orthopaedic Surgery at a Trauma Center. Arch Bone Jt Surg. 2016;4(1):70–4.
20. Ebose EM, Osalumese IC. Blood shortage situation: An audit of red blood cells order and pattern of utilization. African J Biotechnol . 2009;8(21):5922–5.
21. Sadat-Ali M, Tayara B, Al-Faraidy M, Al-Sayel F, Al-Omran A. Blood utilization in orthopaedic and trauma practice. Int J Appl Basic Med Res . 2015;5(2):111.
22. Davoudi- kiakalayeh A, Faranoush M, Haghbin A, Behboudi F. Reviewing the Blood Ordering Schedule in a Tertiary Trauma Center. IJBC. 2013; 6 (1) :27-31
23. Akoko LO, Joseph AB. Blood utilization in elective surgery in a tertiary hospital in Dar es Salaam , Tanzania. Tanzan J Health Res. 2015;17(4):1–8.
24. Vibhute M, Kamath SK, Shetty a. Blood utilisation in elective general surgery cases: requirements, ordering and transfusion practices. J Postgrad Med. 2000;46(1):1–9.

25. Rb B, Lamichhane D, Vk S. A Study of blood Requisition and transfusion Practice in Surgery at bir Hospital. Order A J Theory Ordered Sets Its Appl. 2009;9(2):14–9.
26. Sowayan SA. Use of blood in elective surgery: An area of wasted hospital resource. Ann Saudi Med. 1994 Jul;14(4):326–8.
27. Mwambungu A, Siulapwa N, Mugala D, Chishimba M. Analysis of Blood Crossmatch Ordering Practice in Surgical Patients at Ndola Central Hospital.IJHS. 2015;3(1):278–84.
28. Musa A, Hassan A-A, Kilishi A, Kwaifa I, Ndakotsu M. Pattern of blood transfusion request and utilization at a Nigerian University Teaching Hospital. Sahel Med J . 2014;17(1):19.
29. Samaa Z. Ibrahim, Heba M. Mamdouh, Amal M. Ramadan. Blood Utilization for Elective Surgeries at Main University Hospital in Alexandria, Egypt. Journal of American Science. 2011;7(6):683-689
30. Belayneh T, Messele G, Abdissa Z, Tegene B. Blood requisition and utilization practice in surgical patients at university of gondar hospital, northwest ethiopia. J blood Transfus. 2013;2013:758910.
31. Mead JH, Anthony CD, Sattler M. Hemotherapy in elective surgery: an incidence report, review of the literature, and alternatives for guideline appraisal. Am J Clin Pathol. 1980 Aug;74(2):223–7.

APPENDICES

Appendix 1: Questionnaire

The study titled ***'Prescription and consumption patterns of blood and blood components in patients undergoing orthopaedic and neurosurgical procedures at Muhimbili Orthopaedic Institute.'*** By Dr. Alex L. Ernest. (MMed Anaesthesiology Candidate)

QUESTIONNAIRE/CHECKLIST

1. Registration No …….
2. Age …….
3. Sex ……...
4. Diagnosis ……...
5. Surgical Procedure performed……
6. Patient category

   a). Emergency…... b). Elective …...
7. Preoperative Hemoglobin …...
8. Blood component prescribed

   a). Whole Blood…. b). PRBC…. c). FFP…. d). Platelets….
9. Number of units prescribed …….
10. Number of units crossmatched …….
11. Blood component transfused

    a). Whole Blood…. b). PRBC…. c). FFP…. d). Platelets….
12. Number units Transfused …….

Appendix 2: Ethical clearance

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Ref. No. MU/ PGS/SAEC/Vol. XVI/

27th May, 2016

Dr. Alex L. Ernest
MMed. Anaesthesiology,
MUHAS.

RE: APPROVAL OF ETHICAL CLEARANCE FOR A STUDY TITLED "PRESCRIPTION AND CONSUMPTION PATTERNS OF BLOOD AND BLOOD COMPONENTS IN TRAUMA PATIENTS UNDERGOING ORTHOPEDIC AND NEUROSURGICAL PROCEDURES AT MOI"

Reference is made to the above heading.

I am pleased to inform you that, the Chairman has, on behalf of the Senate, approved ethical clearance for the above-mentioned study. Hence you may proceed with the planned study.

The ethical clearance is valid for one year only, from 26th May, 2016 to 25th May, 2017. In case you do not complete data analysis and dissertation report writing by 25th May, 2017, you will have to apply for renewal of ethical clearance prior to the expiry date.

Prof. Andrea B. Pembe
DIRECTOR OF POSTGRADUATE STUDIES

cc: Director of Research and Publications
cc: Dean, School of Medicine

Appendix 3: Permission to conduct research:

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AB.145/292/01B/165 **14 June, 2016**

DIRECTOR , POSTGRADUATE STUDIES
P.O. BOX 65001
DAR ES SALAAM

RE: APPROVAL FOR PERMISSION TO CONDUCT RESEARCH AT MOI

Reference is made to your letter dated 30th May, 2016 with reference NO: **HD/MUH/T.150/2014** captioned the above subject matter.

I am pleased to officially inform you that, your request for **Dr. Alex Loth Ernest** to conduct a research at MOI on the '**Prescription and consumption patterns of blood and blood components in trauma patients undergoing Orthopaedic and Neurosurgical procedures at Muhimbili Orthopaedic Institute, Dar es Salaam, Tanzania"** has been approved. Therefore very kindly you're requested to inform him to start collection of data as requested.

It's our hope that you will extend enough cooperation regarding this matter.

.....
Abdallah Mbuguni
For: Executive Director

Cc: Medical Director

Cc: Dr. Alex Loth Ernest